RETURN TO WORK FOR WOMEN WITH COGNITIVE CHANGES FOLLOWING BREAST CANCER TREATMENT: IMPLICATIONS FOR ASSESSMENT AND THE ROLE OF OCCUPATIONAL THERAPY

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Statement of Originality

This is to certify that to the best of my knowledge, the content of this thesis is my own work.

This thesis has not been submitted for any degree or other purposes.

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

Joanne Lewis

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Author Attribution Statement

Publications

There are three peer-reviewed publications and one manuscript currently under review that have been submitted as part of this thesis. Permission has been requested from the editors of all journals for the inclusion of these publications in this thesis.

The article in Chapter 2 of this thesis has been published as:

> Lewis, J., Mackenzie, L., & Black, D. (2020). Workforce participation of Australian women with breast cancer. *Psycho-Oncology*. https://doi.org/10.1002/pon.5392

I co-designed the study under the guidance of Professor Lynette Mackenzie. I was responsible for analysing the data and drafting the manuscript. I developed the final manuscript based on feedback from Professor Lynette Mackenzie and Professor Deborah Black. Statistical support and data expertise were provided by Professor Julie Byles and Dr Tazeen Majeed from the University of Newcastle, as part of the Australian Longitudinal Study on Women's Health research team. Professor Deborah Black and Dr Rob Heard also contributed to the study through their involvement in data interpretation and methodological input. I am the corresponding author for this article.

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I am the lead and corresponding author for all publications in this thesis. My role in the research for each publication has been described above.

Joanne Lewis

18th September 2025

As supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.

Professor Lynette Mackenzie

18th September 2025

Use of Generative AI

The author used Copilot for text enhancement during the preparation of this thesis. This included spelling and grammar correction, sentence restructuring, and improvements in clarity. Where generative AI was used to modify text, the author reviewed all content for potential errors, inaccuracies, and bias. The author takes full responsibility for the submitted thesis, confirms that the work is their own, and has used generative AI in accordance with the University of Sydney guidelines and policies.

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- Lewis, J. (2015, July). Work after Breast Cancer: Identification of Cognitive Difficulties Using the PRPP. Paper presented at the Occupational Therapy Australia National Conference, Melbourne, Victoria.

Specialist Media

- Lewis, J. (2022, December). Ask the Expert: Returning to work after breast cancer. *The Beacon*, (93). Breast Cancer Network Australia. Retrieved from https://www.bcna.org.au/news-events/the-beacon-magazine/issue-93-december-2022

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- Lewis, J. (2021, May 4). How can employers support a return to work after serious illness or injury? *Salesforce ANZ Blog*. Retrieved from https://www.salesforce.com/au/blog/how-can-you-support-a-return-to-work-after-serious-illness-or-injury
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Abstract

Breast cancer is the most commonly diagnosed cancer among women in Australia. While survival rates have improved, many women face persistent cognitive challenges that significantly affect their ability to return to work. This thesis investigates the impact of breast cancer on women's workforce participation, with a particular focus on cancer-related cognitive impairment and its implications for return-to-work outcomes. Despite growing recognition of cancer-related cognitive changes, structured assessment, intervention, and support remain limited within Australia's healthcare and employment systems.

Guided by the overarching research question, "how do cognitive changes associated with breast cancer influence women's work participation and performance, and how can these effects be measured?", the thesis explores sub-questions across four research stages. These include: (1) What evidence suggests that women with breast cancer have reduced work participation compared to the general population of women in Australia? (2) How do cognitive changes impact the work performance and participation of women with breast cancer during their employment? (3) Which specific cognitive areas are affected in women with breast cancer that could impact their worker roles? (4) How effective is the PRPP-A (PRPP@WORK) in assessing work-related cognitive changes in women with breast cancer?

Using a mixed-methods approach, the research combines longitudinal data analysis from the Australian Longitudinal Study on Women's Health (ALSWH), a scoping review, secondary content analysis, qualitative interviews, and pilot testing of the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A) and its workplace-adapted version, PRPP@WORK. Findings confirm that breast cancer significantly reduces workforce participation, with many women transitioning to part-time roles or leaving employment altogether. Cognitive impairments, particularly in attention, planning, and executive

functioning, are identified as key contributors to reduced work performance. The PRPP@WORK tool demonstrates strong ecological validity and predictive value, correlating with neuropsychological assessments and identifying women at risk of not returning to pre-illness worker roles.

The research highlights systemic gaps across the cancer care continuum, including missed opportunities for early cognitive screening, limited survivorship support, and fragmented referral pathways between healthcare and employment services. Occupational therapists are identified as key professionals in bridging these divides, yet their involvement in workplace and cancer rehabilitation remains underutilised. The thesis advocates for integrated survivorship care plans, policy reform, and the development of cancer-specific employment support services.

This work contributes empirically, methodologically, and practically to the fields of occupational therapy and cancer rehabilitation. It introduces PRPP@WORK as a novel assessment tool, expands the theoretical understanding of functional cognition, and underscores the importance of work as both a meaningful occupation and a form of cognitive rehabilitation. Ultimately, the thesis calls for a paradigm shift in how cognitive changes after breast cancer are understood and managed, ensuring women are supported to return to their roles, rebuild their lives, and thrive beyond cancer.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

This opening chapter introduces the scope and structure of the thesis, outlining the rationale for the research and the key questions it seeks to address. It provides an overview of the context in which the study is situated, including the growing recognition of cognitive changes following breast cancer and their implications for work participation. The chapter sets the foundation for the thesis by presenting the research background, identifying the need for investigation, and defining the aims and questions that guide the study. It also introduces key terminology, clarifies the population and focus of the research, and outlines the methodological approach. Finally, the chapter provides a roadmap for the thesis's structure, offering a summary of each subsequent chapter.

1.2 Research background

Breast cancer remains the most diagnosed cancer among Australian women, with incidence rates steadily rising over the past decades (AIHW, 2012; Australian Institute of Health and Welfare, 2024a). Advances in early detection, public awareness, and treatment have significantly improved survival outcomes, with five-year survival rates now exceeding 90% (AIHW, 2012; Australian Institute of Health and Welfare, 2024a). However, survivorship brings its own set of challenges, particularly for women of working age who seek to resume their pre-illness roles, including paid employment (Islam et al., 2014; Lloyd et al., 2025; E. Park et al., 2025). While physical and emotional recovery has been the focus of much survivorship research, cognitive changes, often subtle, invisible, and persistent, are starting to be identified

as a barrier to returning to meaningful work (Islam et al., 2014; Lange et al., 2024; Munir et al., 2010)

Cancer-related cognitive changes, colloquially referred to as “chemo brain,” encompass a range of symptoms including difficulties with attention, memory, executive functioning, and information processing (Boykoff et al., 2009; Munir et al., 2010; Raffa et al., 2006). These impairments may arise during treatment and persist well into survivorship, affecting women’s ability to manage complex work tasks, meet occupational demands and remain employed (Koppelmans et al., 2012; Lange et al., 2024; Von Ah et al., 2016). Despite growing international evidence (Wefel et al., 2011), cognitive changes related to breast cancer are under-recognised and poorly assessed within Australian healthcare and employment systems (Player et al., 2014). Traditional neuropsychological assessments often fail to capture the nuanced impact of cognitive changes on real-world occupational performance, particularly in dynamic work environments (Calvio et al., 2010; Wolf & Dobson, 2012).

Occupational performance in the workplace exists on a continuum, ranging from routine, procedural tasks to cognitively demanding roles, which require sustained attention, multitasking, and strategic planning. Women with breast cancer report varying capacities to manage these demands, with many experiencing difficulties that are not adequately addressed in clinical or workplace rehabilitation settings (Munir et al., 2010). Occupational therapists are well-positioned to assess and support cognitive functioning in the workplace (Newman & Campbell, 2013; Ryan et al., 2011; Wolf & Dobson, 2012), yet they lack access to assessment tools that are both ecologically valid and context-sensitive and a starting point for building intervention plans.

This research originated from the observations and reports about the challenges faced by an occupational therapy academic colleague with breast cancer, returning to work with cognitive changes. This, along with clinical experience in workplace rehabilitation, highlighted

how cognitive challenges were often invisible, poorly understood, and inadequately addressed by existing assessment frameworks (Head of Workers Compensation Authorities Australia and New Zealand, 2015). Gaps were noted in how cognitive impairments were identified, communicated to employers, and used to inform workplace accommodations or return-to-work planning (Phan, 2022). These observations led to the development of this research, which aimed to explore the cognitive changes experienced by women with breast cancer, examine their impact on work participation, and evaluate the utility of the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP@WORK) (Bootes & Chapparo, 2013; Ranka et al., 2025) in bridging the divide between cognitive assessment and occupational performance (Bootes & Chapparo, 2013). By exploring the utility of this tool, the study aims to strengthen the role of occupational therapy in cancer survivorship and inform policy, practice, and service delivery to better support women with breast cancer in reclaiming their occupational identity (Newman, 2013) through participation in employment.

In summary, while breast cancer survival rates have improved, the long-term cognitive effects of treatment remain a significant barrier to work participation. This research addresses a critical gap in the literature by examining how cognitive changes impact women's ability to return to meaningful employment and by evaluating a novel assessment tool that supports occupational therapists in addressing these challenges within real-world work contexts.

1.3 Research need

With increasing numbers of women surviving breast cancer and being of working age (Lloyd et al., 2025), understanding the impact of cognitive changes on work participation is both timely and essential (Mao et al., 2025). Employment is not only a source of financial security but also a key contributor to identity, self-esteem, and quality of life (Feuerstein et al., 2010; Hansen et al., 2008; Park et al., 2025). Yet, many survivors face barriers to returning to work, particularly

when cognitive impairments are subtle, poorly understood, and inadequately supported within existing healthcare and employment systems (Smidt et al., 2016; Von Ah et al., 2016).

Despite growing international recognition of cancer-related cognitive impairment, its impact on employment remains under-researched in Australia. Most existing studies originate from North America and Europe, where healthcare and employment support systems differ markedly. For example, in the United States, access to healthcare is often tied to employment-based insurance, creating a distinct context for understanding work-related outcomes following a cancer diagnosis (Newman et al., 2024). These differences highlight the need for Australian-specific research to inform the development of appropriate support services and return-to-work strategies (Koczwara, 2016). In 2015, a preliminary exploration revealed a critical gap: no Australian studies had examined return-to-work rates for women with breast cancer, nor had occupational therapy research addressed the cognitive challenges these women face in the workplace. This absence of evidence prompted a series of research questions aimed at understanding how cognitive changes associated with breast cancer influence women's work participation and performance, and how these effects can be effectively assessed and supported.

The consequences of not addressing these issues are significant. Without appropriate support, women may withdraw from the workforce, face financial hardship, and experience reduced well-being (Islam et al., 2014; Lloyd et al., 2025; Munir et al., 2010). The financial toxicity of cancer, primarily due to treatment-related costs and reduced income, can have long-term implications for survivors and their families (Park et al., 2025). Moreover, the loss of employment can lead to diminished self-worth, social isolation, and a sense of disconnection from valued roles and routines (Von Ah et al., 2016). Between 2022 and 2031, work loss due to breast cancer is projected to result in over 16,000 lost productivity-adjusted life years (PALYs) in Australia, equating to AU$3.26 billion in lost GDP (Lloyd et al., 2025). This indicates the need for

urgent targeted research into the intersection of breast cancer and employment, and for developing services that support recovery and reintegration into the workforce.

Occupational therapists can address the cognitive challenges experienced by women with breast cancer in relation to work, given their expertise in enabling participation in meaningful occupations such as work (Newman et al., 2024; World Health Organisation, 2023). Existing tools often fail to accurately reflect the nuanced cognitive demands of employment, leaving occupational therapists without effective means to identify, measure, or intervene, as well as inconsistent methods for reporting cognitive assessment findings. This absence of appropriate assessment methods could contribute to missed opportunities for early intervention, fragmented care across the cancer continuum, and poor return-to-work outcomes (Lange et al., 2024).

This research responds to the pressing need for a functional, clinician-administered cognitive assessment tool that bridges the gap between self-report and neuropsychological assessments. By examining the utility of the PRPP@WORK, a tool designed to assess cognitive strategy use in real-world work tasks (Bootes & Chapparo, 2013), this thesis aims to provide occupational therapists with a reliable and context-sensitive method for evaluating cognitive impairments and guiding rehabilitation. In doing so, it seeks to strengthen the role of occupational therapy in cancer survivorship, promote continuity of care, and support women with breast cancer in returning to employment (Hatton et al., 2021; Newman et al., 2024; World Health Organisation, 2023).

Ultimately, this research contributes to a broader understanding of how cognitive changes affect work participation and highlights the need for integrated, evidence-based approaches to support women with breast cancer in returning to meaningful employment. It calls for improved education, policy reform, and service integration to ensure that cognitive impairments are recognised, assessed, and addressed across the cancer care continuum.

1.4 Research aims and questions

The research need prompted a series of research questions aimed at answering the overall research question:

How do cognitive changes associated with breast cancer influence women's work participation and performance, and how can these effects be measured?

Four sub-questions emerged:

1. What evidence suggests that women with breast cancer have reduced work participation compared to the general population of women in Australia?
2. How do cognitive changes impact the work performance and participation of women with breast cancer at work?
3. Which specific cognitive areas are affected in women with breast cancer that could impact their worker roles?
4. How effective is the PRPP-A (PRPP@WORK) in assessing work-related cognitive changes in women with breast cancer?

1.5 Definition of terms

The following definitions are provided to clarify the use of the terms in this thesis:

Return to Work

Return to work refers to the process of resuming paid employment following a breast cancer diagnosis and treatment. It involves a gradual and supported re-engagement with work tasks, often requiring adjustments to hours, duties, or the work environment. Return to work programs are developed in consideration of the individual's health status, treatment side effects, personal circumstances in collaboration with the employee, employer, and healthcare

team to ensure a safe and sustainable transition back to a pre-illness role (same employer) or employment with a new employer (Cancer Council Australia, 2023; Innes, 2012).

Work performance

Work performance or job performance refers to the dynamic and complex interaction between a worker's skills, abilities, and their work environment, as they engage in tasks, routines, roles, and interpersonal interactions for "creation, production and distribution of products and services; initiation, sustainment and completion of work; and compliance with work norms and procedures" (Braveman, 2012, p.9). In occupational therapy, work performance is assessed in simulated or real work environments as part of workplace rehabilitation to develop return-to-work programs for individuals with injuries, illnesses, and/or disabilities. This type of work assessment is distinct from a management performance review, which typically evaluates an employee's output for purposes such as salary reviews, promotions/demotions, career development, or probation evaluations.

Presenteeism

Presenteeism refers to the situation where individuals attend work despite experiencing health conditions or personal challenges that significantly impact their ability to perform tasks, resulting in reduced productivity. For women with breast cancer, this often stems from economic necessity or concerns about job security, returning to work not because they are well, but because they feel they must. Presenteeism is not simply about being present; it reflects a complex interplay between health, workplace expectations, and personal circumstances. It often masks the true extent of work-related disability and can lead to long-term consequences for both the individual and the organisation (Liu et al., 2021; Sanderson & Cocker, 2013).

Australian Longitudinal Study on Women's Health (ALSWH)

Long-term, national health data can reveal important trends in health, behaviour, and participation. The Australian Longitudinal Study on Women's Health (ALSWH) is a comprehensive study that monitors the well-being of Australian women, including identifying those with breast cancer. Established in 1996, the study is the largest and longest-running project of its kind in Australia, involving over 57,000 women across four age cohorts. The ALSWH aims to explore a wide range of factors that influence women's health throughout their lives, including physical, mental, and social aspects. (Brown et al., 1996). The study is jointly managed by the University of Queensland and the University of Newcastle, with funding from the Australian Government Department of Health and Ageing, to gather data on the health and well-being of Australian women, informing policy and service funding. Initially, in 1996, 40,000 women in Australia were randomly selected to complete self-reported surveys using the Australian Medicare database. Data have been collected via self-reported surveys that asked questions about physical, cognitive, psychological, and social health, activities of daily living, community and employment participation, as well as family well-being. Surveys have been sent to women every three years since 1996. The initial 40,000 women were categorised into age groups based on their ages at the time of the first survey in 1996. These three categories were: 'young' (born 1973 – 1978), 'middle-aged' (born 1946 – 1951) and 'old' (born 1921 – 1926). However, since this time, another cohort has been established, which includes women born from 1989-95 (Australian Government, 2025b).

The ALSWH employs a multidisciplinary approach, integrating data from extensive surveys and national and state administrative health records. This methodology enables researchers to gain a holistic understanding of women's health issues and their underlying determinants, providing a comprehensive view of these issues. The study's findings have been instrumental in shaping health policies and programs at both federal and state levels, addressing issues such as chronic disease, reproductive health, and mental health. By

providing valuable insights into the health trajectories of women, the ALSWH contributes to the development of targeted interventions and health services that better meet the needs of Australian women (Australian Government, 2025b).

Workplace rehabilitation

Workplace rehabilitation "is a managed process involving timely intervention with appropriate and adequate services based on assessed need. It is also aimed at maintaining injured or ill employees in, or returning them to suitable employment," (Page 4, Head of Workers Compensation Authorities Australia and New Zealand, 2015), being with the same employer or a new employer. In consideration of international literature, this thesis will refer to workplace rehabilitation as encompassing both 'occupational rehabilitation' and 'vocational rehabilitation'.

Occupational participation

Occupational participation has been defined as "having access to, initiating, and sustaining valued occupations within meaningful relationships and contexts" (Egan & Restall, 2022), which also includes engagement in work roles as part of broader life activities and identity.

Occupational identity

Occupational identity refers to a unified sense of who a person is and aspires to become as an occupational being, shaped by their history of occupational participation. In most societies, work is typically regarded as having a positive status and is associated with achievement and contribution. Through work, individuals can meet personal needs and experience a sense of mastery. Because work occupies a significant portion of adult life, many people define themselves through their work and developing an identity as a worker has become a social norm in developed countries. In the context of this thesis, where the focus is on work,

occupational identity is primarily understood as identity related to being a worker (Braveman, 2012a).

Cognition

Mental functions of the brain are essential for a person's ability to carry out daily activities and participate in broader community life (World Health Organization, 2001). These functions encompass cognition, defined as "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses" (Oxford University Press, 1989). Cognition enables individuals to learn from and remember their occupational experiences, assign meaning to those experiences, and construct a personal history of occupational participation (Ranka et al., 2025a).

Cognitive impairment

The International Cancer and Cognition Task Force (ICCTF) has indicated that two or more neuropsychological test scores that are ≤−1.5 standard deviations below the normative mean (or an appropriate control group) or one test score that is ≤−2.0 standard deviations below the normative mean indicate the diagnosis of cognitive impairment (Wefel et al., 2011). In this thesis, terms used interchangeably with, or implying, cognitive impairment include cancer-related cognitive impairment, chemo brain, chemo fog, cognitive dysfunction, cognitive changes and difficulties with cognition.

Neuropsychology

Neuropsychology is a speciality of psychology that studies the physiological processes of the nervous system and relates them to behaviour and cognition, in terms both of their normal function and of the dysfunctional processes associated with brain injury (American Psychological Association, 2025). Neuropsychological assessment is a performance-based

method to assess cognitive functioning. This method is used to evaluate the cognitive consequences of brain injury, brain disease, and severe mental illness (Harvey, 2012).

Breast cancer survivorship

The survivorship phase of breast cancer is described as the period following the completion of active treatment (Clinical Oncology Society of Australia, 2016), encompassing both short-term recovery and long-term adjustment to the ongoing effects of cancer. Survivorship is a contentious term, and in this thesis, reference will be made to "women with breast cancer", "breast cancer survivors", or "women living with breast cancer". For this thesis, a variety of terms will be used to reflect the different ways women describe their "experience", "care", or "journey" with breast cancer.

1.6 Understanding the population, disease, treatment and impact on health

The research in this thesis has focused on women with breast cancer and understanding that specific treatments received for managing the disease, as well as the disease itself, have side effects that impact functional abilities. The International Classification of Functioning, Disability and Health (World Health Organization, 2001) is discussed as a model for understanding how the side effects from breast cancer impact functioning and participation.

1.6.1 Population

The population focus for this thesis is women with breast cancer. Although men can also be diagnosed with breast cancer, they represent approximately 1% of all cases annually in Australia (Cancer Australia, 2025c) and their experiences, particularly regarding hormone-related challenges, differ significantly from those of women. Therefore, the scope of this

research is intentionally limited to women with breast cancer, acknowledging the unique cognitive, psychological, and occupational challenges they face in relation to paid employment.

1.6.2 Breast cancer diagnosis

Breast cancer is characterised by the abnormal growth of cells within the epithelium of the lobules, ducts, or glandular tissue of the breast. When these cancerous cells remain confined to the lobules, ducts, or breast tissue, the condition is called "in situ" and is considered non-invasive. Over time, however, the cancer may progress and invade surrounding breast tissue, which is then classified as invasive breast cancer. Because the axillary lymph nodes are close to the breast, they are a common site for cancer spread. Once cancer cells enter the lymphatic system, there is a risk of metastasis to other parts of the body (Cancer Council NSW, 2025; National Breast Cancer Foundation, 2025a)

Breast cancer is usually diagnosed in stages, which are based on the size of the initial tumour and how far it has spread. Stage 0 is described as "pre-invasive breast cancer," where the tumour remains localised within the breast and has not spread to lymph nodes or other organs. Stages 1 and 2 are called "early breast cancer," indicating that cancer cells have begun to invade surrounding tissue and may have reached the lymph nodes in the armpit. Stage 3 is called "locally advanced breast cancer," where the tumour is larger than 5 cm or has spread more extensively to multiple lymph nodes, or into the skin, ribs, or muscles of the chest wall. Stage 4 is known as advanced or metastatic breast cancer, in which cancer cells have spread to distant organs, most often the bones, liver, lungs, or brain (National Breast Cancer Foundation, 2025b).

Besides the anatomical location of the tumour, breast cancer is further classified by its genetic expression, which provides important indicators for targeted treatment. The three main subtypes are hormone receptor-positive breast cancer, human epidermal growth factor

receptor 2 (HER2-positive) breast cancer, and triple-negative breast cancer. Hormone receptor-positive breast cancers depend on estrogen and/or progesterone for growth, and about two-thirds of all breast cancers fall into this category. HER2-positive breast cancers are characterised by an overexpression of the human epidermal growth factor receptor 2 (HER2) on the surface of cancer cells, which promotes cell proliferation. These cancers tend to be more aggressive and account for approximately 20% of all breast cancer cases. HER2-positive tumours may also be hormone receptor-positive or negative. Triple-negative breast cancers lack oestrogen, progesterone, and HER2 receptors, making them more difficult to treat with hormone or targeted therapies. About 15% of breast cancers are triple-negative (Cancer Australia, 2025a; Waks & Winer, 2019).

1.6.3 Breast cancer incidence

The incidence of breast cancer in Australian women has been steadily increasing each year. In 2020, Australia had the 7th highest incidence rate of breast cancer in women in the world (96 in every 100,000) (World Cancer Research Fund, 2025). In 2017, breast cancer was the second most diagnosed cancer and the most diagnosed cancer in females in Australia. There were 17,589 new cases of breast cancer diagnosed in Australian women in 2017. Women in Australia have a 1:7 chance of being diagnosed with breast cancer by the time they are 85 years of age (Breast Cancer Trials, 2023). The age-standardised incidence rate of breast cancer for females was highest for those of higher socio-economic status (122 per 100,000) compared to lower socio-economic status (103 per 100,000). Breast cancer incidence tends to decrease with increasing remoteness, possibly due to reduced access to diagnostic services. Major cities report an incidence rate of 114 per 100,000, compared to 94 per 100,000 in remote and very remote areas. Also, Aboriginal and Torres Strait Islander females were less likely to be diagnosed with breast cancer (81 per 100,000) compared to non-Indigenous counterparts (103 per 100,000) (AIHW, 2012). In 2008, more than two in three (69%) breast cancers in females

were diagnosed in those aged 40–69, while one in four (25%) were diagnosed in those aged 70 and over. The mean age at first diagnosis was 60 years (AIHW, 2012). This increasing incidence is attributed to several factors, including reproductive and hormonal factors, as well as advancements in public screening campaigns, increased awareness, and improved diagnostic technology (Breast Cancer Trials, 2025).

1.6.4 Breast cancer treatments

The type, combination, and regimen of treatment depend on the molecular characteristics and the type, size, stage, and grade of breast cancer. Typically, treatments for breast cancer include surgery, chemotherapy, radiotherapy, hormonal blocking therapy, or targeted therapy. Neoadjuvant treatments are administered before surgery, while adjuvant treatments are given afterwards.

1.6.4.1 Surgery

Surgery for breast cancer can be either curative or reconstructive. Women may choose breast-conserving surgery, such as a lumpectomy, to remove the cancerous tumour while preserving as much of the breast as possible. Alternatively, they may undergo a mastectomy, which involves the complete removal of the breast. If necessary, an axillary dissection may also be performed to remove affected lymph nodes. Reconstructive surgery can be undertaken after active treatment has concluded, often using abdominal fatty tissue to rebuild the breast following a mastectomy (Breast Cancer Network Australia, 2025a; Waks & Winer, 2019).

1.6.4.2 Chemotherapy

Chemotherapy targets and destroys cancer cells, as well as other rapidly dividing cells, using cytotoxic drugs. It is a systemic treatment that affects the entire body and is designed to reduce the risk of cancer recurrence. Chemotherapy is generally administered intravenously, either through a cannula during each visit or via a port, a central line that is surgically inserted

for long-term treatment. In some cases, chemotherapy may be given orally in tablet form (Breast Cancer Network Australia, 2025b; Waks & Winer, 2019).

The main chemotherapy drugs used to treat breast cancer include several different classes of cytotoxic agents. These are:

- Anthracyclines, such as epirubicin (Pharmorubicin®) and doxorubicin (Adriamycin®)
- Mitotic inhibitors, such as taxanes - e.g., paclitaxel (Taxol®) and docetaxel (Taxotere®)
- Antimetabolites, including 5-fluorouracil (5-FU), capecitabine, and gemcitabine (Gemzar®)
- Alkylating agents, such as cyclophosphamide
- Taxanes, including paclitaxel (Taxol®) and docetaxel (Taxotere®)
- Vinorelbine (Navelbine®)

These chemotherapy drugs may be used individually or in combination, depending on the type and characteristics of the tumour (Waks & Winer, 2019).

Chemotherapy is administered in cycles, with each cycle consisting of a short period of treatment followed by a rest period. This allows the body time to recover between treatments. The number of cycles, the duration of each treatment period, and the length of the rest period depend on the stage and grade of the breast cancer, as well as the specific type of chemotherapy being used. Chemotherapy can be used as either neoadjuvant or adjuvant therapy. In early breast cancer, neoadjuvant chemotherapy is used to shrink the tumour before breast-conserving surgery and to help doctors assess how the tumour responds to specific chemotherapy drugs. Neoadjuvant chemotherapy is commonly used for women with HER2-positive or triple-negative breast cancer. Adjuvant chemotherapy, on the other hand, is used after surgery to reduce the risk of the cancer returning or spreading to different parts of the body (Cancer Australia, 2025d; Waks & Winer, 2019).

1.6.4.3 Radiation Therapy

Radiation therapy uses high-energy X-rays to destroy cancer cells in the breast. It can be administered externally through external beam radiation therapy (EBRT) or internally via brachytherapy. Brachytherapy involves the surgical insertion of small radioactive particles directly into the breast tissue. EBRT is the most used form of radiation therapy in breast cancer and is typically applied as adjuvant treatment across all breast cancer types. It may be targeted specifically at tumour sites in the breast, chest, or lymph nodes, or it may involve irradiating the entire breast. The radiation beams are delivered through the skin, and treatment is generally administered daily over a period of 3 to 7 weeks (Cancer Australia, 2025d; Waks & Winer, 2019).

1.6.4.4 Hormonal Treatments

Hormonal treatments are prescribed for hormone receptor-positive and HER2-positive breast cancers. These treatments are typically taken in oral form, usually for five to ten years after other breast cancer treatments have concluded. The type of hormone therapy prescribed depends on whether the woman is pre- or post-menopausal. Before menopause, the ovaries produce oestrogen to regulate the menstrual cycle. During menopause, oestrogen production declines, leading to symptoms such as irregular menstrual cycles, hot flushes, and sleep disturbances. After menopause, menstrual cycles cease entirely due to the lack of oestrogen production by the ovaries. At this stage, another hormone called aromatase, produced in fatty tissue, acts on androgens released by the adrenal glands, converting them into oestrogen. Therefore, the type of hormone blocker prescribed depends on menopausal status. Tamoxifen is an anti-oestrogen medication that works by preventing cancer cells from receiving oestrogen and can be used in both pre- and post-menopausal women. Pre-menopausal women may also require ovarian suppression therapy to stop oestrogen production, effectively inducing menopause, as some breast cancers rely on oestrogen to grow. Post-menopausal women are typically prescribed aromatase inhibitors, such as anastrozole or letrozole, which block the

conversion of androgens into oestrogen (Breast Cancer Network Australia, 2025b; Cancer Australia, 2025d; Waks & Winer, 2019).

1.6.4.5 Targeted Treatments

Targeted therapies are used to treat breast cancers that are HER2-positive. This form of biological treatment works by stopping HER2-positive cancer cells from growing and dividing. Trastuzumab (Herceptin®) is the most prescribed targeted therapy for women with HER2-positive breast cancer (Breast Cancer Network Australia, 2025b; Cancer Australia, 2025d; Waks & Winer, 2019).

1.6.4.6 Treatment combinations and pathways

In Australia, the Breast Cancer Optimal Care Pathway outlines the approach and timing for delivering breast cancer treatment. Women may receive a single form of treatment or a combination of therapies, such as surgery, chemotherapy, radiation, hormone therapy, or targeted therapy, depending on their individual diagnosis and needs. As a result, the treatment phase can range from a few weeks to several months, aiming to provide the most effective and personalised care (Cancer Council Victoria & Department of Health Victoria, 2021).

1.6.5 Breast cancer survivorship

Breast cancer mortality among females in Australia is decreasing, and survival rates are improving. In 2019, breast cancer was the second most common cause of cancer-related death among Australian women, with approximately nine women dying from the disease each day. The five-year relative survival rate for women diagnosed with breast cancer has significantly increased, from 76% between 1988 and 1992 to 92% between 2013 and 2017. However, some sub-groups of the population experience lower survival rates. These include women living in remote and very remote areas, Aboriginal and Torres Strait Islander women, and younger women, compared to those living in metropolitan areas and non-Indigenous women (Cancer

Australia, 2025b). Globally, Australian women diagnosed with breast cancer have better survival prospects than many of their international counterparts. For example, South African women have a five-year survival rate of 40%, compared to Australia's 92% (World Health Organization, 2025).

While developed countries tend to have the highest incidence of breast cancer, their well-established healthcare systems support better education, screening, earlier diagnosis, and access to effective treatments and clinical trials, contributing to higher survival rates. Despite these improvements, breast cancer survivorship presents ongoing challenges that can persist for many years after treatment ends. Disability-adjusted life years (DALYs) represent the sum of years lost due to premature mortality and years lived with disability or poor health resulting from a disease or condition. Globally, breast cancer accounts for more lost DALYs among women than any other type of cancer (World Health Organization, 2025). The increase in survival rates, alongside a reduction in DALYs, reflects significant progress in breast cancer treatment. However, it also highlights a gap in the long-term management of survivorship issues. There is a growing need to recognise cancer as a chronic health condition, like diabetes or asthma, that requires ongoing symptom management and support (Australian Government, 2025a).

1.6.6 International Classification of Functioning, Disability and Health

Cognitive difficulties affecting work performance and participation for women with breast cancer represent a biopsychosocial issue. The International Classification of Functioning, Disability and Health (ICF) (World Health Organization, 2001) provides a comprehensive framework for understanding this complexity. It serves as a guide for considering the multiple dimensions of functioning (physical, psychological, and social) that influence a person's ability to engage in work.

The impact of breast cancer on a woman's life, both during and after treatment, can be conceptualised through the ICF model. Health conditions such as breast cancer may affect body functions and structures, limit the ability to carry out daily activities, and restrict participation in valued life roles, including employment. Women often experience a combination of physical, cognitive, and psychological symptoms across the cancer trajectory, which may stem from the disease itself or be side effects of treatment. These are briefly described below. Chapter 3 will look more deeply at the application of the ICF model with a specific focus on cognitive difficulties affecting work performance and participation for women with breast cancer.

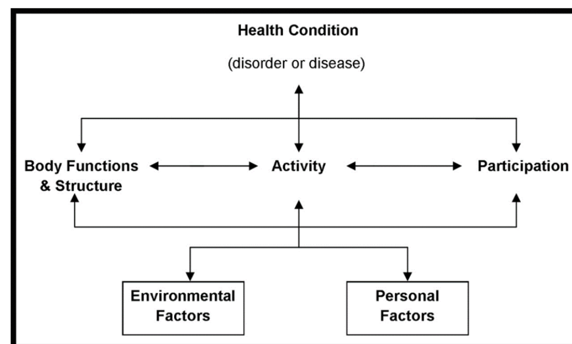

Figure 1.1: The ICF Framework

(World Health Organization, 2001)

1.6.6.1 Body Functions and Structures

Physical Symptoms and Side Effects

Breast cancer itself, or its treatments, can lead to a range of physical symptoms and side effects. Surgery may involve the removal of lymph nodes from the neck, chest wall, and axillary region. Side effects from this procedure can include ongoing pain, lymphoedema, or cording. Lymphoedema occurs when lymph nodes are removed and fluid accumulates in the affected arm, resulting in swelling, pain, sensitivity, and reduced range of motion (NSW Agency for Clinical Innovation, 2018). Cording, also known as axillary web syndrome, can develop when

the remaining lymphatic vessels in the affected area harden, resulting in a web-like structure across the chest wall or down the affected arm, further limiting arm movement (NSW Agency for Clinical Innovation, 2018). During chemotherapy, women may experience a variety of side effects due to the cytotoxic drugs used. These include nausea and vomiting, mouth ulcers, taste changes, diarrhoea, constipation, hair loss, fatigue, and peripheral neuropathy. Radiation therapy can also cause fatigue, skin integrity issues, and lymphoedema. Targeted therapies may lead to cardiac complications in some patients. Hormone therapy can cause menopausal-like symptoms such as hot flushes, night sweats, heart palpitations, weight gain, reduced libido, fatigue, and sleep disturbances. A potential side effect of surgery, chemotherapy, radiation therapy, and hormone treatment is reduced fertility or, in some cases, sterilisation. Some women may be eligible for fertility preservation treatment before starting cancer therapy (Tommasi et al., 2022). Although these are physical side effects, research has shown that they often lead to secondary psychosocial symptoms, including poor body image, low self-esteem, anxiety, and depression (Heidary et al., 2023).

Cognitive symptoms and side effects

Cognitive symptoms and side effects are more difficult to quantify and link to a specific cause compared to physical symptoms. However, research into cognitive changes following breast cancer is growing (Dhillon, 2014; Ganz & Van Dyk, 2020; Whittaker et al., 2022). As cognitive changes after breast cancer are the focus of this thesis, they will be addressed comprehensively in a later section. For now, it is important to note that many women with breast cancer report difficulties with concentration, memory, and processing new information (Joly et al., 2019; Oliva et al., 2024; The Cancer Council Australia, 2023). These cognitive changes are believed to be linked to the breast cancer itself, as well as to treatments such as surgery, chemotherapy, radiotherapy, targeted therapy, and hormone therapy. Some women

report that cognitive side effects are more distressing than physical ones following breast cancer treatment (Boykoff et al., 2009; Haywood et al., 2023; Whittaker et al., 2022).

Psychosocial symptoms and side effects

Psychological symptoms are generally linked to the emotional response following a breast cancer diagnosis. These may include the fear of facing a potentially life-threatening illness, anxiety about recurrence, difficulty coping with the physical and cognitive side effects of treatment, and the emotional impact of adjusting to life after treatment or dealing with fertility loss. Depression and anxiety are among the most common mental health challenges, affecting over 50% of women diagnosed with early breast cancer (Dinapoli et al., 2021).

Combined symptoms and side effects

Fatigue is a common side effect experienced during and after breast cancer treatment, and it encompasses physical, cognitive, and psychosocial dimensions. It could be discussed under all of the above sections. Fatigue is associated with chemotherapy, radiation therapy, and hormone therapy. Cancer-related fatigue differs from general fatigue in its severity, persistence, and resistance to relief through rest or sleep. According to some studies, fatigue can be one of the most long-lasting and distressing side effects of breast cancer (Schmidt et al., 2018) Medical-induced menopause is another side effect of certain chemotherapy drugs and hormone treatments. It can result in a combination of physical, cognitive, and psychosocial symptoms, including hot flushes, night sweats, insomnia, urogynaecological difficulties, cognitive changes, and low mood (Schmidt et al., 2018).

1.6.6.2 Impact on functional activities

Changes to body structure and function caused by breast cancer and its treatment can significantly affect a woman’s ability to perform everyday activities. The physical, cognitive, and

psychosocial impacts combine to influence both activities of daily living (e.g., mobility, showering, dressing, toileting, eating, sexual functioning, breastfeeding, exercise, communication) and instrumental activities of daily living (e.g., food preparation, shopping, accessing the community, driving, washing, cleaning, and childcare) (Sleight et al., 2022). While there is a growing body of research demonstrating the impact of breast cancer on work participation (as outlined in Chapter 2), the evidence on how work abilities are affected remains limited. Much of the research focuses on how changes to body functions and structures influence overall work performance, but there is limited application to how specific activities and tasks within occupations are impacted.

1.6.6.3 Effect on participation and roles

When women are unable to perform tasks or activities due to breast cancer and its associated treatments, this can significantly impact their ability to participate in previous life roles, as well as future ones. Women with breast cancer report difficulties returning to roles such as partner, spouse, parent, mother, caregiver, community member, friend, or worker, as they may only be able to complete some of the tasks required by these roles, or, in some cases, none at all (Player et al., 2014; Sleight et al., 2022). While it is challenging to quantify reduced participation in personal life roles, such as partner, parent, or friend, participation in work roles is more easily measured through employment rates and hours worked (Islam et al., 2014; Park et al., 2025). As participation in work following breast cancer is the focus of this thesis, it will be addressed comprehensively in a later section. Suffice to say, international research indicates that women with breast cancer are 1.28 times less likely to be employed than healthy matched controls, with strong evidence suggesting that breast cancer is the primary reason for reduced employment participation (de Boer et al., 2009). However, these employment statistics are based on international studies. At the time of commencing this PhD project, no studies had specifically examined the impact of breast cancer on Australian women's work participation.

1.7 Scope of the research

This research focuses specifically on women diagnosed with breast cancer who experience cognitive difficulties because of the disease and its treatments. It examines how these cognitive changes affect participation in paid employment. The study is situated within the Australian healthcare and workplace systems and explores the role of occupational therapy in assessing and supporting cognitive functioning in real-world work contexts.

The scope is intentionally limited to paid or remunerated employment, acknowledging its significance for identity, financial stability, and recovery. It does not extend to unpaid domestic or volunteer roles. Throughout the thesis, the terms work, employment, and job are used interchangeably to refer to this context. Similarly, return to work refers to re-entering or maintaining a position within the paid workforce.

It is acknowledged that breast cancer can lead to a wide range of changes in body structure, function, and functional abilities, as well as personal and environmental factors that may influence work participation. The research scope centres on cognitive side effects resulting from breast cancer and its treatment. The ICF framework is used to guide the exploration of these impacts. While this study focuses specifically on cognitive changes, it recognises that women may experience other concurrent challenges during recovery that also affect their ability to work.

This study includes only women of working age diagnosed with breast cancer, reflecting its focus on workforce participation. As such, findings are intended to be relevant to the needs and experiences of this demographic.

Finally, the research is situated within the Australian context, where healthcare and employment support systems differ significantly from those in other countries. International research on cancer-related cognitive impairment and employment, largely conducted in North

America and Europe, may not be directly applicable due to differences in system design, such as the US model, where access to healthcare is often tied to employment-based insurance. This underscores the importance of research tailored to the Australian landscape.

1.8 Methodology

1.8.1 Research study one

Research Study One employed a retrospective longitudinal design to examine workforce participation among women with breast cancer in Australia. Using secondary data from the Australian Longitudinal Study on Women's Health (ALSWH), this study analysed employment trajectories before and after breast cancer diagnosis. The sample was drawn from the 1946–1951 birth cohort, with inclusion criteria based on self-reported breast cancer diagnosis and availability of work status data across multiple survey waves. Workforce participation was categorised into full-time, part-time, or not in paid work, and compared across time points three years before and after diagnosis. The methodology involved three stages of analysis. First, descriptive and inferential statistics were used to identify significant changes in employment status. Second, latent class analysis (LCA) was conducted to identify patterns of workforce participation over time, resulting in a five-class model that reflected distinct employment trajectories. Third, multinomial logistic regression was used to examine associations between class membership and demographic, geographic, and health-related variables.

1.8.2 Research study two

Research Study Two utilised a scoping review methodology to examine the impact of cognitive changes on work performance and participation for women with breast cancer. The review followed the structured framework developed by Arksey & O'Malley (2005) with enhancements from Levac et al. (2010), and was guided by the PRISMA-ScR checklist to ensure

transparency and rigour. The review was conducted in five stages: identifying the research question, locating relevant studies, selecting eligible studies, charting the data, and synthesising the findings. The sixth stage of consultation was excluded due to the breadth of existing literature capturing lived experiences through qualitative, mixed methods, and case study designs. A systematic search was undertaken across five databases (Medline, CINAHL, Web of Science, Scopus, and the Cochrane Library), covering publications from 2000 to 2020. Studies were included if they were peer-reviewed, written in English, and addressed cognitive changes in relation to work performance or participation among women with breast cancer. Eligible designs included qualitative, quantitative, mixed methods, and case studies. Data were extracted and charted using a structured spreadsheet, capturing study characteristics, methodologies, and key findings. Studies were grouped by design type and critically appraised using the Joanna Briggs Institute (JBI) tools and the Mixed Methods Appraisal Tool (MMAT). A scoring system was applied to assess methodological quality. Findings were synthesised according to the review's objectives, with separate reporting of quantitative and qualitative results. The synthesis focused on the nature and impact of cognitive deficits, assessment methods used in occupational contexts, and strategies or interventions supporting work performance. This phase established a conceptual foundation for understanding the relationship between cognitive changes and employment outcomes, informing the development and testing of functional assessment tools in later phases.

1.8.3 Research study three

Research Study Three adopted a mixed methods design to explore cognitive strategy use in women with breast cancer who had returned to work following chemotherapy. The study aimed to determine whether the Perceive, Recall, Plan, and Perform (PRPP) System of Task Analysis could identify specific cognitive difficulties and strengths in the context of occupational performance. The qualitative component involved deductive content analysis of

secondary interview data originally collected for an ethnographic study (Player et al., 2014). Although the interviews were not structured around cognitive assessment, participants voluntarily described the impact of cognitive changes on their worker roles, making the data suitable for re-analysis using the PRPP framework. Thirty-four PRPP cognitive strategy descriptors were used as pre-determined codes, and transcripts were systematically coded to identify strategy use across the quadrants of Perceive, Recall, Plan, and Perform. Coding was guided by the PRPP assessment manual (Chapparo & Ranka, 2014), and consensus was reached between researchers when ambiguity arose. The quantitative component involved scoring each identified strategy using the PRPP's standardised three-point scale (3 = effective, 2 = questionable, 1 = not effective). Scores were entered into a database and analysed descriptively to identify patterns of cognitive strengths and vulnerabilities. Radar graphs were used to visually represent sub-quadrant scores across the group.

1.8.4 Research study four

A cross-sectional pilot study design was used in Research Stage Four to evaluate cognitive difficulties experienced by women with breast cancer in relation to their work performance and participation. The study aimed to compare the utility of two cognitive assessment tools: the clinician-administered Perceive, Recall, Plan and Perform System of Task Analysis Assessment (PRPP@WORK) and the Cambridge Neuropsychological Test Automated Battery (CANTAB), to determine their effectiveness in identifying cognitive impairments relevant to the performance of work tasks. Data collection involved two assessment formats. The PRPP@WORK was administered via a one-hour online semi-structured interview conducted by an occupational therapist, focusing on cognitive strategy use across four quadrants: Perceive, Recall, Plan, and Perform. Three CANTAB assessments, Rapid Visual Processing (RVP), Delayed Match to Sample (DMS), and Spatial Working Memory (SWM) were completed remotely and targeted sustained attention, visual memory, and executive functioning, respectively. The

PRPP@WORK was selected for its ecological validity and ability to contextualise cognitive strategy use within occupational tasks, while the CANTAB provided standardised, norm-referenced data. Statistical analysis included descriptive statistics to summarise demographic and performance data, Kendall's Tau to assess correlations between PRPP@WORK and CANTAB scores, and Receiver Operating Characteristic (ROC) analysis to evaluate the predictive power of each tool in determining return-to-work outcomes.

1.9 Chapter outlines

This thesis is structured around a series of research studies, each presented as an individual chapter. Peer-reviewed publications are embedded within these chapters and are accompanied by extended literature reviews that provide additional context and theoretical grounding. For earlier studies, where the literature may have evolved since publication, an updated review is provided following the published paper to ensure relevance and currency. A summary of the thesis structure, indicating which chapters are published and unpublished, is provided in Table 1.1.

Table 1.1: Thesis structure outline

Chapter	Thesis Section
One	**Introduction** Chapter 1 outlines the rationale, scope, and structure of the thesis. Introduces the research context, aims, questions, definitions, and theoretical framework.
Two	**Research study one – Retrospective longitudinal analysis** Chapter 2 reports on a population-level study using ALSWH data to examine workforce participation before and after breast cancer diagnosis. Methodology includes descriptive statistics, latent class analysis, and multinomial logistic regression. This chapter contains the peer-reviewed publication: Lewis, J., Mackenzie, L., & Black, D. (2020). Workforce participation of Australian women with breast cancer. *Psycho-Oncology*. https://doi.org/10.1002/pon.5392
Three	**Research study two – Scoping review** Chapter 3 presents a scoping review exploring the impact of cognitive changes on work performance and participation. Follows the Arksey & O'Malley framework with PRISMA-Sc guidance and includes critical appraisal and updated literature. This chapter contains the peer-reviewed publication: Lewis, J., & Mackenzie, L. (2022). Cognitive changes after breast cancer: a scoping review to identify problems encountered by women when returning to work. *Disability and Rehabilitation*, *44*(18), 5310–5328. https://doi.org/10.1080/09638288.2021.1919216
Four	**Research study three – Qualitative secondary analysis** Chapter 4 details a pilot study using deductive content analysis of interview data to identify cognitive strategy use via the PRPP-A framework. Combines qualitative coding with quantitative scoring to explore functional cognition in occupational contexts. This chapter contains the peer-reviewed publication: Lewis, J., Chapparo, C., Mackenzie, L., & Ranka, J. (2016). Work after breast cancer: Identification of cognitive difficulties using the Perceive, Recall, Plan, and Perform (PRPP) system of task analysis. *British Journal of Occupational Therapy*, *79*(5), 323–332. https://doi.org/10.1177/0308022616639983
Five	**Research study four – Cross-sectional pilot study** Chapter 5 compares the PRPP@WORK and CANTAB assessments to evaluate cognitive difficulties and predict return-to-work outcomes. Methodology includes semi-structured interviews, remote neuropsychological testing, and statistical analysis using Kendall's tau and ROC curves. This chapter contains a publication that is currently under review with the Australian Occupational Therapy Journal: Lewis, J., Mackenzie, L., Chapparo, C., & Ranka, J. (under review). Assessment of cognitive difficulties and impact on work for women with breast cancer: Comparing results from the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A) and Cambridge Neuropsychological Test Automated Battery (CANTAB*). Australian Occupational Therapy Journal*. Manuscript ID 2924815.
Six	**Discussion and Conclusion** Chapter 6 is a synthesis of findings across all research phases. Uses the cancer care continuum to frame implications for occupational therapy, policy, and service delivery. This chapter summarises key findings and presents recommendations for practice, policy, and future research.

CHAPTER 2: WORKFORCE PARTICIPATION OF AUSTRALIAN WOMEN WITH BREAST CANCER

2.1 Introduction

This chapter addresses the question: *Does breast cancer affect the work participation of women with breast cancer in Australia?* To explore this, the chapter begins with a narrative review of the overall workforce participation of women and the impact of health conditions on their employment, including cancer and work participation, as well as the services available to support this. The focus is on the workforce participation of Australian women with breast cancer, and this is examined through the inclusion of a published retrospective longitudinal study using data from the Australian Longitudinal Study of Women's Health:

Lewis, J., Mackenzie, L., & Black, D. (2020). Workforce participation of Australian women with breast cancer. *Psycho-Oncology*, *29*(7), 1156–1164. https://doi.org/10.1002/pon.5392

This study identified patterns of workforce participation among women with breast cancer and compared them to healthy age-matched controls, revealing significant differences in employment outcomes. The chapter concludes with a review of updated research, noting an increase in studies within Australia and emphasising the need for an in-depth examination of the reasons behind the reduced workforce participation of women with breast cancer, both internationally and in Australia.

2.2 Workforce participation of women in Australia

Over the past three decades, women's workforce participation in Australia has seen considerable progress. Since 1990, the participation rate has increased from 52% to 62.1% in 2022 (Cassells, 2019; Workplace Gender Equality Agency, 2022). Women now constitute 47.9%

of all employed persons in Australia, are 38.4% of full-time employees and 68.5% of part-time employees (Workplace Gender Equality Agency, 2022). This progress is attributed to various policy changes and initiatives aimed at increasing female employment and addressing the gender pay gap, where women earn 12 to 19% less than men on average (Australian Bureau of Statistics, 2023a; Workplace Gender Equality Agency, 2024) and have 25% less superannuation (Australian Taxation Office, 2023).

Increasing women's workforce participation is essential to meet their financial needs and address their insecurities, due to rising living costs and the need for retirement due to longer life expectancy. Women in Australia face more financial insecurities than men, with 83% of single-parent families led by single mothers (Australian Bureau of Statistics, 2023b). Additionally, women perform over nine hours more unpaid work and care each week compared to men, and female parents spend an hour and 15 minutes more on unpaid childcare daily than male parents (Australian Bureau of Statistics, 2022). Women are also more likely to be unpaid carers for their older parents, with working-aged women (15-64 years) comprising 60% of unpaid carers for family or loved ones with disabilities or long-term health conditions (Australian Bureau of Statistics, 2018). Along with unpaid work, women are more likely to work part-time than men (Australian Bureau of Statistics, 2024b). The highest employment rate among women is in the 45–49-year age group (Australian Institute of Family Studies, 2023).

While improvements in education and greater access to childcare services have contributed to the increased workforce participation of women in Australia, the trend is also partly due to changes in the qualifying age for the Age Pension. Since 1995, the qualifying age has gradually risen from 60 years to 67 years in 2023 (Australian Institute of Family Studies, 2023). More older women need to work due to the financial pressures of not having sufficient superannuation to retire, so they remain in the workforce before accessing the age pension. While some women

want to continue working into older age, an increasing number need to do so for financial stability.

2.3 Health conditions and women's workforce participation in Australia

As more women remain in the workforce for longer periods, the likelihood that age-related health factors will impact work participation increases. While many individuals face very personal health issues, there are some common health challenges among women. The top five disease groups contributing to the overall disease burden for women are cancer (16%), musculoskeletal disorders (16%), mental and substance use disorders (12%), cardiovascular diseases (11%), and neurological conditions (10%) (Australian Institute of Health and Welfare, 2022b). Anxiety and depressive disorders are prevalent among all working-age women and are most common in younger women. However, for women aged 45–64, the primary causes of ill health and mortality are back pain and related problems, breast cancer, osteoarthritis, followed by anxiety and depressive disorders, then anxiety disorders and depressive disorders (Australian Institute of Health and Welfare, 2022b).

With women aged 45–49 now having the highest employment rate across all female age groups in Australia, many of them face the challenge of managing health issues such as musculoskeletal disease, breast cancer, osteoarthritis, and mental health disorders while staying employed. The burden of back pain and related problems was clear in the 25–44-year-old group; however, in the 45-64-year-old group, breast cancer emerged as a significant health concern, raising questions about how it affects women's work participation (Australian Institute of Health and Welfare, 2022).

As women in Australia live longer, they need to manage chronic health conditions while continuing to work. In 2009, the Australian Government published a report on the impact of

chronic disease on work participation (Australian Institute of Health and Welfare, 2009a). The chronic diseases included arthritis, asthma, chronic obstructive pulmonary disease (COPD), coronary heart disease (CHD), depression, diabetes, osteoporosis, and stroke. Of the working female population aged between 25 and 64 years, 35 percent reported at least one of these chronic health conditions. Females were more likely than males to self-report chronic disease (35% compared with 28%). Older women reported chronic disease more often than younger people—54 percent of those aged 55–64 years compared to 21 percent of those aged 25–34 years. Women with chronic disease were more than 1.2 times more likely not to participate in the labour force than women without chronic disease. Women with chronic disease were less likely to be employed full-time and more likely to be unemployed than those without chronic disease. Although this research highlights the impact of chronic disease on workforce participation and absenteeism, these figures are likely underestimated, as they do not include the effect of morbidity due to cancer (Australian Institute of Health and Welfare, 2009a). Additionally, these statistics exclude the impact of reduced on-the-job productivity, known as presenteeism, associated with chronic diseases and cancer, overlooking a significant aspect of how health conditions affect workforce participation (Australian Institute of Health and Welfare, 2009a).

A U.S. study indicated that lost productivity due to cancer is comparable to that of heart disease and diabetes (Dowling et al., 2013). When this paper was published in 2020, there were growing calls for cancer to be recognised as a chronic health condition, given rising survival rates and the need to manage persistent side effects over the long term (Dowling et al., 2013). In 2025, this recognition has been formalised, with cancer now included under the Australian Government's Chronic Disease Management framework (Australian Government, 2025a), reinforcing the importance of addressing ongoing impacts on work performance and participation. This is especially true for employed women with cancer, who often face additional financial stressors such as childcare responsibilities and sole parenting.

2.4 Cancer and work participation in Australia

Over the past five years, there has been a growing number of studies examining the work participation of people with cancer in Australia. However, before that, there were limited studies. International literature was often relied upon when considering the reduced work participation of people with cancer. A meta-analysis and meta-regression (de Boer et al., 2009) found that people with cancer were 1.37 times more likely to be unemployed compared to age-matched samples. Of the 36 studies included, one was from Australia (Eakin et al., 2006). In 2011, a Cochrane Review, further updated in 2015 (de Boer et al., 2015), found that people with cancer are 1.4 times more likely to be unemployed than healthy individuals. This international systematic review highlighted the importance of providing cancer patients with programs to support the return-to-work process (de Boer et al., 2015). One Australian study (Purcell et al., 2011) was included in this systematic review (de Boer et al., 2015); however, this study did not focus solely on return-to-work outcomes. It aimed to evaluate the effectiveness of an intervention on fatigue levels in cancer patients and their return to paid employment. The intervention did not increase return-to-work rates, as fewer participants were working after the intervention compared to those who did not participate (Purcell et al., 2011). The scarcity of Australian studies in these systematic reviews highlights the limited research in this country on return-to-work and cancer survivorship.

Before 2020, four studies in Australia directly studied the return-to-work outcomes and issues for people with cancer: two quantitative and two qualitative studies. Gordon et al. (2014) examined the return-to-work outcomes of middle-aged workers with colorectal cancer. The study found that a higher proportion of participants with colorectal cancer (27%) stopped working at 12 months compared to the comparison group (8%). Those who returned to work took a median of 91 days (about 3 months) off. Predictors of not working at 12 months following cancer diagnosis included older age, lower BMI, and lower physical well-being. Delayed work re-

entry was associated with a lack of university education, employment with large employers in non-professional roles, longer hospital stays, poorer financial status, and chemotherapy. Gordon et al. (2014) concluded that those treated with chemotherapy, without a university degree, and from large employers may need targeted assistance for return to work. Paul et al. (2016) examined the impact of cancer diagnosis and treatment on employment, income, treatment decisions, and financial assistance. Over two-thirds (67%) of those employed reported a change in their employment 12 months following their cancer diagnosis, particularly retirement, unemployment, or resignation. This was associated with significantly higher odds of patients reporting a reduction in income since diagnosis. In this study, Paul et al. (2016) called for greater financial and service support for people with cancer to ease the financial burden they experience. This could include supporting people with cancer and their employers in maintaining employment.

McKay et al. (2013) conducted a qualitative study in Australia to understand the return-to-work experiences of cancer survivors, managers, and Employee Assistance Program (EAP) health professionals in the public and private sectors. Several factors impacting return to work were identified, including personal factors for cancer survivors and workplace/employer aspects. The importance of work in maintaining normality and regaining identity was highlighted. Another key finding was that negotiating a return to work was complex, and better support services, structures, and employer education were needed to improve the process and communication channels. A qualitative study by Knott et al. (2014) sought the views and experiences of cancer survivors and health professionals about returning to work after cancer. Themes identified included participants' reduced work capacity to meet pre-illness work hours and demands, the financial pressures causing them to return to work before they felt fit and capable, reduced self-confidence, and health barriers (fatigue, 'chemo brain', gastrointestinal problems, managing a stoma, peripheral neuropathy, and lymphedema). Like McKay et al.

(2013), the lack of coordinated support services to assist in returning to work after cancer was also highlighted (Knott et al., 2014).

2.5 Services to support work participation

Rehabilitation services support people with health conditions or disabilities with (re)entering the workforce, maintaining work, or returning to work. These services have been labelled and defined as different things internationally. In Australia, there has been a move away from the term 'occupational rehabilitation' to 'workplace rehabilitation.' Workplace rehabilitation services are provided by allied health professionals (e.g., occupational therapists) in clients' workplaces and involve collaboration with the employer and medical personnel to identify barriers to work performance and devise strategies to address these barriers. Health professionals undertake a range of services from functional and workplace assessments and advice concerning job modification, to vocational retraining and assistance with job seeking (Safe Work Australia, 2022).Some large organisations employ health professionals to provide in-house workplace rehabilitation services for injured and ill employees.

In Australia, access to and payment for workplace rehabilitation services are often linked to schemes set up to support people with health conditions. Some schemes are set up based on liability status and individuals meeting the inclusion criterion. For example, each state in Australia has an insurance scheme set up for worker compensation injuries and motor vehicle accident injuries. Both schemes offer wage replacement benefits and payment for treatment, hospital or outpatient rehabilitation and access to workplace rehabilitation. Various income protection, disability and superannuation policies are also provided by life insurance and related schemes in Australia and will fund workplace rehabilitation services. However, many people may still experience illness and injury not covered by one of the schemes described above (NSW Government Agency for Clinical Innovation, 2024a).

For those who experience illness and injuries not covered under an insurance-based scheme, the Australian Government, through the social security system, provides payments, pensions and some basic access to workplace rehabilitation services. ‘Services Australia’ provides the interface between the public and Commonwealth government public servants who determine people’s eligibility for pensions, payments and access to services. The Disability Support Pension (DSP) is financial assistance for those with a physical, intellectual, or psychiatric condition likely to persist for over two years and prevent work participation. There are strict medical and non-medical criteria to determine eligibility. If people with health conditions do not meet the criteria, they will receive the Job Seeker payment, which is less and has stringent job-seeking requirements. People who have become unwell and unable to work, but are still employed, may be eligible for the Job Seeker payment. Services Australia staff can refer people to various disability or employment assistance service providers based on the barriers that are impacting work participation. For some, the health condition may be the primary reason for not being able to attend work or resigning from work. Therefore, workplace rehabilitation services may need to focus on assisting that person to manage their health condition at work in collaboration with their employer, or assistance in finding work that is better matched to their functional abilities. For others, their health condition may have led to secondary issues, such as homelessness or drug/alcohol addiction. Services Australia would refer to appropriate agencies to address accommodation and drug/alcohol rehabilitation, as all these barriers would impact work participation.

Disability employment and workplace rehabilitation providers can access Commonwealth government funding through the ‘Employment Assistance Fund’ for aids, equipment, assistive technology and workplace modifications to support work participation for people with disabilities (Australian Government, 2025). The ‘Work Assist’ program also assists employees with an acquired illness or disability (e.g., cancer) in accessing workplace rehabilitation services to assist with employer negotiations, workplace assessment and

providing interventions to help the employee meet the demands of their pre-illness / disability role (Australian Government, 2025d).

People with cancer could access workplace rehabilitation through the various schemes described above. If the cancer is deemed work-related (e.g., mesothelioma), workplace rehabilitation and access to an occupational therapist could be provided through the workers' compensation systems. An employer may wish to support the return to work of employees with cancer and contract an occupational therapist to assist with workplace rehabilitation. People with cancer who have an income protection or disability-related policy through their superannuation insurance may also be provided with an occupational therapist to support their return to work.

The workplace rehabilitation systems designed to support people with health conditions and disabilities in returning to work, as described above, are what McKay et al. (2013) and Knott et al. (2014) are referring to when calling for more to be done to support people with cancer in returning to work. The description above indicates the complexity of workplace rehabilitation services that are often in separate silos, each with its own eligibility and accessibility criteria. For instance, the NSW Government Agency for Clinical Innovation has launched a website to support clinicians with decision-making for funding return-to-work activities for acquired brain injury (including stroke) (NSW Government Agency for Clinical Innovation, 2024b) . However, there is no resource like this for supporting cancer patients. Access to income protection and disability claim data from insurers is often difficult to obtain. In 2020, the Australian Financial Services Council released figures on the percentage of claims. Cancer was the highest Trauma (Critical Illness) Claim at 58% and the second highest claim for Income Protection at 14% (Financial Services Council, 2019). Unfortunately, there is no data available on how many of these claimants received rehabilitation services to support their return to work.

2.6 Health benefits of work

Research has shown that work benefits health and well-being for everyone, including those with and without injury, illness, or disability (Australian Faculty of Occupational and Environmental Medicine, 2011; Waddell et al., 2006). Work is essential for personal growth, financial independence, and contributing to the national economy. Evidence suggests that for most injuries, illnesses, and disabilities, either remaining at work during recovery or returning to work as soon as possible supports physical, psychological, and social well-being. Conversely, long-term unemployment can negatively impact health and quality of life (Høyer et al., 2012). The evidence supporting the health benefits of returning to work after illness is also relevant to individuals with cancer.

2.7 Use of the Australian Longitudinal Study on Women's Health to examine breast cancer and work participation

To understand the health and workforce participation of women with breast cancer in Australia, data from the Australian Longitudinal Study on Women's Health (ALSWH) were utilised. Specifically, the ALSWH study has been collecting self-reported data from Australian women about breast cancer diagnosis, and participation in the workforce (employment status, hours of work, type of work). As such, this made it an ideal data set to gain a macro perspective on the research question regarding the workforce participation of women with breast cancer in Australia. A study in 2014 (Wade & Lee, 2005) used the ALSWH to consider the impact of breast cancer on the lives of middle-aged women. Wade & Lee (2005) indicated that two years after diagnosis, women had lower general health, physical functioning, and social functioning

compared to those without breast cancer. During the two years studied, women with breast cancer had decreased their hours of paid work (Wade & Lee, 2005).

The following paper was published in 2020, and as far as the authors are aware, was the first paper to examine the workforce participation of women with breast cancer in Australia. The study is robust as it was a large study that used longitudinal data from a randomly selected national population of Australian women. Those who reported breast cancer as it occurred during the study period could be compared to those who did not report breast cancer in terms of their work participation. This study allowed an answer to the research question: *Does breast cancer affect the work participation of women with breast cancer in Australia*?

2.8 Paper: Workforce participation of Australian women with breast cancer

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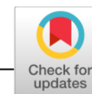

PAPER

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Workforce participation of Australian women with breast cancer

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Abstract

Objective: International research suggests that many women do not return to their previous work after breast cancer. This study aimed to identify workforce participation patterns for Australian women with breast cancer and compare these to healthy aged matched women.

Methods: Using the 1946–1951 birth cohort of the Australian Longitudinal Study on Women's Health, the work status of women was compared three years before and three years after their first reported breast cancer diagnosis. Latent class analysis was used to identify workforce participation patterns of women with breast cancer and healthy aged matched women. Multinomial logistic regression examined associations between work patterns and other risk factors.

Results: Pre and post breast cancer diagnosis work status data were available for 448 women with breast cancer between 1998 and 2010. Three years after diagnosis, 48% of full-time workers returned to full-time work but 52% returned to part time work or were not in paid work. Latent class analysis identified five classes. Women with breast cancer were more likely to be in the 'mostly full-time work' and 'mostly not in paid work' classes compared to healthy women. Odds ratios showed that women in remote areas, partnered, with less education or with chronic health condition were more likely to be 'not in paid work'.

Conclusion: Breast cancer has a negative impact on the workforce participation of Australian women. Women with breast cancer need support to return to work.

KEYWORDS
Australia, breast neoplasms, cancer, employment, oncology, rehabilitation, return to work, survivorship

1 | BACKGROUND

Breast cancer is the most common cancer amongst women in Australia,[1] and one in nine women will be diagnosed with breast cancer in their lifetime.[1] Significant research advancements have led to increased survival rates for women with breast cancer,[2] with 90% of women in Australia now surviving for more than 5 years.[1] However, ongoing symptoms have been reported, which may become chronic thus affecting capacity to perform everyday activities and participate in pre-cancer work roles.[3]

Work is essential for personal growth, financial independence, and contributing to the national economy.[4] The health benefits of work are well recognized[5] in Australia.[6] Women have reported that returning to the workforce helps them restore social networks, provides a distraction from their symptoms and worries, assists in the re-establishment of habits and routines and provides a sense of achievement[7] as they contribute financially to their family.[8]

Many women are juggling full-time or part-time work with caring responsibilities of children and/or elderly parents when diagnosed.[9] A breast cancer diagnosis and treatment may cause some women to

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change their life priorities, including withdrawal from work, by choosing to resign or retire[10] to focus on their health and family needs. However, women may choose or have to continue working whilst having breast cancer treatment or return to work soon after treatment.[11] Side effects such as fatigue, cognitive difficulties, insomnia and pain[12] can impact on work performance.[13] Some breast cancer survivors may be forced to hide concerns to protect their job or to avoid being thought less able at work if there is little knowledge or support available.[13] A Japanese study found that 40 months after a breast cancer, 30% had lost their job or resigned, 10% could not find another job, 48% were receiving a lower income, 75% reported problems with the return to work process and 26% did not disclose their breast cancer diagnosis.[14] A systematic review indicated that internationally the prevalence of return to work within 1 year of diagnosis varies from 43% to 93%.[2] Studies of workforce participation of women with breast cancer beyond 12 months have also shown a continued reduction.[10] There are no Australian studies exploring the return to work or workforce participation of women with breast cancer and comparison with international studies can be problematic due to differences in health care,[15] insurance and social security welfare systems.[16] Therefore, this study aimed to identify workforce participation patterns for Australian women with breast cancer and how these compare to healthy aged matched women.

2 | METHOD

2.1 | Design

Ethics approval was received from the University of Queensland (EoI # A631-May 19, 2016), to use longitudinal data from the Australian Longitudinal Study of Women's Health (ALSWH). All participants gave informed consent for their data to be used in secondary analyses. The ALSWH is funded by the Australian Government Department of Health and Ageing and gathers data about the health and well-being of Australian women to inform policy and service funding.

2.2 | Population

In 1996, 40 000 women in Australia were randomly selected to complete self-reported surveys using the Australian Medicare database. Surveys asked questions about all aspects of health and well-being. Surveys were sent to the same women over a 17-year period in 1996, 1998, 2001, 2004, 2007, 2010 and 2013. The initial 40 000 women were categorised into age groups based on their ages at the first survey in 1996. The categories were: 'young', born between 1973 and 1978 (aged 18 to 23 years in Survey 1), 'middle aged', born between 1946 and 1951 (aged 45 to 51 years old in Survey 1) and 'old', born 1921 and 1926 (aged 70 to 75 years old in Survey 1). This study analysed the 'middle aged' group of women because they were more likely to experience breast cancer and be at work.[9] There were 13 715 'middle-aged' respondents in the original 1996 survey who are broadly representative of the national population from the same age cohort,[17] who would be experiencing similar life events and challenges.

2.3 | Measurement

At each of the seven surveys, women in the 'middle-aged' cohort were asked to indicate if they had been diagnosed with breast cancer, various forms of other cancers or other major illnesses. Based on these responses, the 'middle-aged' cohort was split into diagnostic groups according to self-reported status of:

- Breast cancer
- Other cancer
- Other major illness (eg, stroke, cardiac)

Women diagnosed with breast cancer at any of the survey points formed the 'breast cancer' group. Any women that did not report a major illness, breast cancer or another form of cancer in any of the seven surveys was placed in the 'healthy group'. As data were collected every 3 years, the exact date of breast cancer diagnosis was unknown. Accordingly, the first survey at which they reported a breast cancer diagnosis was considered the 'year' of diagnosis.

At each survey, women were asked if they were in full-time work (35 hours or more per week), part-time work (1-34 h/wk) or not in paid work. The work status of 'full-time work' (FT), 'part-time work' (PT) and 'not in paid work' (NPW) was based on these responses.

2.4 | Data analysis

The workforce participation status for each survey point was matched with year of breast cancer diagnosis. To determine if there was a change in work status before and after a breast cancer diagnosis, the reported work status (FT, PT or NPW) 3 years before the year of breast cancer diagnosis was the 'pre-diagnosis work status' and work status three years after the year of diagnosis was the 'post -diagnosis work status'. From the 1009 breast cancer cases, only the women reporting a diagnosis in 1998, 2001, 2004, 2007 and 2010 (n = 608) were included, as the 'pre-diagnosis work status' was not known for the 1996 diagnosis group and the 'post-diagnosis work status' was not known for the 2013 diagnosis group. Of these 608 women, n = 448 cases were included in the analysis, due to missing work status data. Pearson's Chi-square analysis was used to determine if the change in work status for women pre and post breast cancer was significant at the 5% level.

Latent class analysis (LCA) identifies latent subgroups within a population based on multiple observed variables.[18] LCA assumes that an underlying latent variable derived from a set of categorical, observed indicator variables.[18] In this study, the latent variable is workforce participation and was measured by observed variables

'work status' (FT, PT, NPW) at seven time points over the 17-year period (from 1996 to 2013).

To reliably identify workforce participation patterns over time, the analysis was restricted to participants who had at least three valid survey observations for work status.[19] LCA procedure identified underlying subgroups of workforce participation patterns of women with and without breast cancer, based on their work status. To ensure reliable tracking of workforce patterns over the seven surveys, participant had to:

1 Be alive for all seven survey points and
2 Have indicated their work status in at least three out of the seven surveys

SAS 9.4 (SAS Institute, 2014) was used to conduct the LCA procedure which was developed by the Methodology Centre, Penn State University.[20] Two to seven latent classes were fitted. Five latent classes were found to have the best fit using the principle of best model fit, parsimony and information criteria (Akaike's information criteria, Bayesian information criteria and entropy).[18] This created an LCA model with the prevalence of each latent class. Each class was labelled using the item response probability. The results from the LCA model were then treated as an independent variable, and its association with breast cancer and healthy status was explored.[18] Regression analysis was performed to assess the effect of breast cancer on workforce participation patterns. Participants were then assigned to workforce participation classes using the first maximum probability rule.[18] The latent class membership was then used as the dependent variable, and multinomial regression was performed to determine the association between workforce participation classes and other competing factors, including area of residence, partner status, education, occupation, caring responsibilities and other health conditions (diabetes, depression, asthma and arthritis).

3 | RESULTS

3.1 | Characteristics of the study sample

The 13 715 women in the 'middle aged' cohort were categorised into four groups, based on their reported health status. Women were deemed eligible for the 'healthy' group if they did not report a cancer diagnosis or other major illness over the 17 years of the surveys:

- Healthy group: n = 7297 (53.2%)
- Breast cancer group: n = 1009 (7.4%)
- Other cancer diagnosis group: n = 1245 (9.1%)
- Other major illness group: n = 4164 (30.4%)

The survey in which a breast cancer diagnosis was first reported was considered the 'year' of diagnosis. The number of breast cancer diagnoses reported at each survey was as follows: Survey 1 (1996) n = 279; Survey 2 (1998) n = 94; Survey 3 (2001) n = 106; Survey 4 (2004) n = 109; Survey 5 (2007) n = 146; Survey 6 (2010) n = 153 and Survey 7 (2013) n = 122. The high number of diagnoses in Survey 1 (279) is a result of the cumulative capture of breast cancer diagnosis at any time before 1996.

3.2 | Workforce participation rates of women before and after breast cancer diagnosis

Paid work status (FT, PT or NPW) before self-reported breast cancer diagnosis was compared with the paid work status 3 years after breast cancer diagnosis. This included self-employment. The overall participation in FT and PT work decreased, and the number of women NPW increased over time. Women diagnosed with breast cancer in 1998 (average age 49.52) and 2001 (average age 52.51) were as likely or more likely to be returning to pre-cancer FT work status. However, as the age of diagnosis increased, the likelihood of returning to pre-cancer FT work status decreased. For women diagnosed with breast cancer in 2004 (average age 55.47), 40.5% were in FT work before their diagnosis, but only 26.6% returned to FT work. Of the women diagnosed in 2007 (average age 58.48), 36.6% were in FT work before their breast cancer diagnosis, but only 21.4% returned to FT work. For those diagnosed with breast cancer in 2010 (average age 64.78), 41.2% were in FT work prior to diagnosis, but only 16% returned to FT work.

As shown in Table 1A, at each of the five timepoints, there was a statistically significant reduction in workforce participation of women after a breast cancer diagnosis ($P \leq .001$). Changes in work status (reduced participation in FT, reduced PT work and increased NPW) were associated with breast cancer diagnosis. Table 1A demonstrates that the number of women NPW prior to a breast cancer remained stable. However, there is an increasing number of women NPW after their breast cancer diagnosis. Pre-diagnosis work status and post-diagnosis work status were combined, and the results are presented in Table 1B.

3.3 | Work patterns of women with breast cancer compared with healthy age-matched women

There were n = 6589 women in the 'healthy and 'breast cancer' groups combined ('healthy' n = 5756; 'breast cancer' n = 833) which were eligible to be a part of the LCA. The demographics of healthy group and breast cancer group for latent class analysis are detailed in Table 2A. Although there were statistically significant differences between the groups, this occurred because of the high level of power to detect true differences given the large sample sizes. However, the differences were not considered to be clinically significant.

Five latent classes were selected based on the Akaike's information criterion (AIC), Bayesian information criteria (BIC) and entropy, as shown in Table 2B. The drop in G2 ratio relative to the drop in degrees of freedom is substantial up to a five class model, with no real improvement in fit with classes six and seven. Models less than five

TABLE 1 Workforce participation rates of women 3 years before and 3 years after breast cancer diagnosis (A) by survey and (B) combined across surveys

	1998 Diagnosis		2001 Diagnosis		2004 Diagnosis		2007 Diagnosis		2010 Diagnosis	
	n = 67		n = 71		n = 79		n = 112		n = 119	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Not in labour force (unemployed)	15 (22.4%)	18 (26.9%)	18 (24.5%)	24 (33.8%)	16 (20.3%)	17 (21.5%)	37 (33.0%)	54 (48.2%)	32 (26.9%)	67 (56.3%)
Part-time work (1-34 h/wk)	27 (40.3%)	24 (35.8%)	29 (40.8%)	22 (31.0%)	31 (39.2%)	41 (51.9%)	34 (30.4%)	34 (30.4%)	48 (31.9%)	33 (27.7%)
Full-time work (35+ h/wk)	25 (37.3%)	25 (37.3%)	24 (33.8%)	25 (35.2%)	32 (40.5%)	21 (26.6%)	41 (36.6%)	24 (21.4%)	49 (41.2%)	19 (16.0%)
Significance	$P < .001$		$P < .001$		$P < .001$		$P < .001$		$P = .001$	

		3 years post breast cancer diagnosis		
		Full-time work	Part-Time work	No paid work
3 years pre-breast cancer diagnosis	Full-time work n = 171	82 (48%)	52 (30%)	37 (22%)
	Part-time work n = 159	26 (16%)	86 (54%)	47 (30%)
	No paid work n = 118	6 (5%)	16 (13.5%)	96 (81.5%)
	Total N = 448	n = 114	n = 154	n = 180

classes lacked reliable estimation based on AIC and BIC.[21] Models with more than five classes had lower entropy scores; however, there was little variance in the AIC and BIC scores.

The five latent classes generated for both groups combined were reviewed for item response probabilities (FT, PT, NPW) and assigned logical and distinctive labels, as shown in Table 2C. The item response probability and percentage of each class are shown in Table 2C and Figure 1. Latent classes 1, 2 and 4 were considered more constant classes, because item responses probabilities were close to 1 at all survey points (Class 1: [low 0.8055-high 0.9259]; Class 2: [low 0.6024-high 0.7813]; Class 4: [low 0.5237-high 0.9168]. However, in the transitional classes, item response probabilities started close to 1 in surveys 1, 2 and 3, but in surveys 4 to 7, the item response probabilities were closer to 0. This pattern in the transitional classes is likely to be reflective of age-related retirement from the workforce. For all women, 27% were 'mostly in part-time work' over the 17 year survey timeframe, followed by 23% being 'mostly in fulltime work' over the 17 years, 19% were 'moving from full-time work to no paid work', 16% were 'mostly not in any paid work' over all the surveys and 15% were 'moving from part-time work to no paid work'.

The five latent classes were used as the independent variable, and the dependent variable of 'breast cancer' or 'no breast cancer' (healthy) was used to compare the class of workforce participation for women with breast cancer to healthy aged matched women. Table 2D shows that the highest-class membership for healthy women was 'mostly in part-time work' followed by 'mostly in full-time work'. Conversely, women with breast cancer were slightly more likely to belong to the class of 'mostly in full-time work', then 'mostly in part-time work'. Overall, there is a higher-class membership of healthy women in the work participation classes (classes 1 and 2) than women with breast cancer. There is an almost equal proportion of women with and without breast cancer transitioning from full- time or paid work into no paid work. But the third highest-class membership for women with breast cancer was 'not in paid work', with this being the fourth highest for healthy women, indicating that women with breast cancer were more likely to be out of the workforce than healthy women.

3.4 | Impact of other factors on workforce participation

Factors that may impact on workforce participation were analysed using multinomial regression. The table in Data S1 presents the fully adjusted model with the odds of being in a category other than 'mostly in full-time work'. Workforce participation categories when compared to the reference category, 'mostly in full-time work', were found to be associated with area of residence, partnered status, education, occupation and having a caring role. Those in remote / rural areas were more likely to be 'mostly not in paid work' (OR = 0.647; 95% CI, 0.441-0.950) or 'moving from part-time work to no paid work' (OR = 0.778; 95% CI, 0.649-0.932) compared to those in urban areas.

TABLE 2 Latent class analysis: (A) Demographics of healthy group and breast cancer group; (B) Model fit statistics for baseline latent models for evaluation of workforce participation patterns in 6589 women (healthy and breast cancer groups); (C) Probability of being in work, over each timepoint, according to five latent classes for 6589 middle-aged women (healthy and breast cancer groups); (D) Percentage of healthy group and breast cancer group in each of the five latent classes

A		Healthy (n = 5756)	Breast cancer (n = 833)	P value
Partnered	Yes	85.9%	81.6%	.001
	No	14.1%	18.4%	
Geographical location	City/metro	35.3%	36.3%	.738
	Country/rural	64.7%	63.7%	
Education	None	16.7%	16.1%	.705
	School certificate	50.4%	49.5%	
	Post school qualifications	32.9%	34.3%	
Occupation	No paid work	1.5%	0.8%	.09
	Professional/management	37.7%	41.8%	
	Administration/sales	41.1%	38.6%	
	Trade	3.7%	4.1%	
	Manual work	14.7	13.0%	
	Other	1.4%	1.8%	

B No. of classes	G2 ratio	Degrees of freedom	AIC	BIC	Entrophy
2	11 205.78	2157	11 263.78	11 460.78	0.81
3	6177.79	2142	6265.79	6564.69	0.82
4	4728.20	2127	4846.20	5247.00	0.81
5	**3558.59**	**2112**	**3706.59**	**4209.28**	**0.80**
6	3091.20	2097	3091.20	3269.20	0.77
7	2659.93	2082	2867.93	3574.42	0.77

C	Latent classes				
	Class 1 Mostly not in paid work (Constant) (16%)	Class 2 Mostly in part-time work (Constant) (27%)	Class 3 Moving from part-time work to no paid work (Transitional) (15%)	Class 4 Mostly in full-time work (Constant) (23%)	Class 5 Moving from full-time work to no paid work (Transitional) (19%)
1996 Survey 1	0.8738	0.6907	0.7226	0.7013	0.8849
1998 Survey 2	0.9259	0.7790	0.7966	0.7786	0.9483
2001 Survey 3	0.8055	0.7338	0.6352	0.8886	0.8006
2004 Survey 4	0.8374	0.7801	0.4895	0.8978	0.5567
2007 Survey 5	0.8323	0.7791	0.3393	0.9168	0.2966
2010 Survey 6	0.8684	0.7813	0.1001	0.8578	0.0408
2013 Survey 7	0.9013	0.6024	0.0364	0.5237	0.0323

D	Mostly in part-time work	Mostly in full-time work	Moving from full-time work to no work	Mostly not in paid work	Moving from part-time work to no work
Healthy	27.58% (1)	23.06% (2)	18.64% (3)	15.96% (4)	14.76% (5)
Breast cancer	23.67% (2)	24.38% (1)	15.11% (5)	19.8% (3)	17.04% (4)

Note: (Bracketed numbers present rank). Bold indicates that the 5 class model was chosen as the best fit.

Non-partnered women were more likely to be 'mostly in full-time work' than any other category (OR = 0.367; 95% CI, 0.285-0.472; OR = 0.455; 95% CI, 0.375-0.552; OR = 0.272; 95% CI, 0.207-0.359; OR = 0.641; 95% CI, 0.524-0.784), compared with partnered women. Women with no education were more likely to be 'not in paid work' than 'mostly in full-time work' compared to those with school level

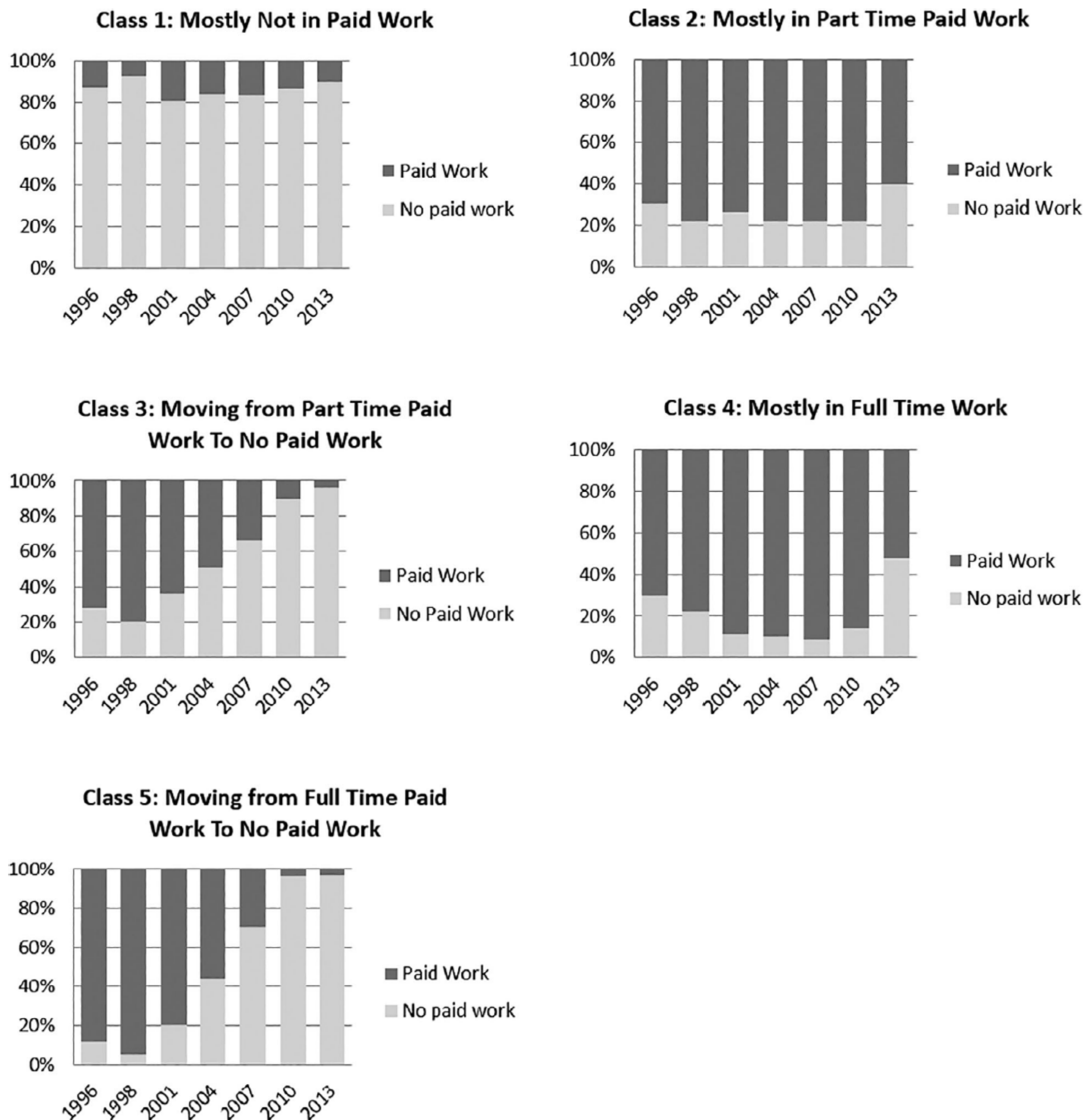

FIGURE 1 Five latent classes established using model fit statistics

(OR = 0.466; 95% CI, 0.366-0.594) and post school (OR = 0.320; 95% CI, 0.239-0.427) qualifications. Being in professional / management roles meant women were more likely to be 'in mostly full-time work' then "mostly in part-time work" compared to women in trade / manual work (OR = 2.449; 95% CI, 1.941-3.092) or administration/sales-based work (OR = 1.857; 95% CI, 1.559-2.211). Women who provided regular (OR = 1.532; 95% CI, 1.102-2.130) or occasional care (OR = 1.944; 95% CI, 1.434-2.636) were more likely to be 'moving from part time to no paid work' then those who do not provide care. Chronic health conditions of arthritis (OR = 1.450; 95% CI, 1.212-1.735), diabetes (OR = 1.376; 95% CI, 1.047-1.808) and depression (OR = 1.537; 95% CI, 1.259-1.875) were also associated with being 'mostly not in paid work' categories other than 'mostly in full-time work'.

4 | DISCUSSION

4.1 | Main findings

This study has shown that some women with breast cancer have difficulty participating in the workforce after diagnosis and treatment. Workforce participation was significantly associated with having breast cancer and other factors being partnered, having caring

responsibilities, lower education, occupation type, diabetes, depression or arthritis.

4.2 | Participation in full-time work

Study findings were consistent with other studies that have found factors associated with returning to work after breast cancer are related to not having caring responsibilities,[2,11] being in a professional / managerial role,[11] having a comorbid chronic disease[22] or less education.[2,12,23]

The LCA shows that healthy women and women that have ever had breast cancer appear to have similar FT participation rates. Being in the 'mostly in full-time work' class means that these women had a high probability of being in paid work at all time points. However, women that were working FT 3 years before their breast cancer diagnosis had reduced work hours post diagnosis. This appears to be inconsistent with the finding that women with breast cancer were equally as likely to be in FT work as healthy women across all surveys. Women may have been able to return to FT work within 3 years of the diagnosis and so any time off work was not captured. Furthermore, women may have had Stage 0 ductal carcinoma in situ (DCIS) without treatment side effects and were more likely to return to work[2,24] or had a supportive work environment enabling a return to work.[2,10] Women with higher occupational status can have a faster rate of return to work.[25] These women may be in more autonomous work roles where there are opportunities to change and modify their work demands and output to better match their work capacity.[26]

However, despite participation in FT work, there were a substantial proportion of women who had difficulty returning to their previous FT role. Results suggest some women with breast cancer could benefit from rehabilitation services after treatment, to help them return to the workforce.

4.3 | Participation in part-time work

This study demonstrated that women with breast cancer consistently have lower rates of participation in PT work compared to healthy aged matched women. When comparing pre and post breast cancer work status, there were women in PT work that did not return to paid work. In this study, PT work was one to 34 hours per week. Although most women in PT work maintained their PT status, the data could not reveal if post-cancer PT work hours were reduced. This may indicate another subgroup of women that need workplace rehabilitation services.

4.4 | Not participating in paid work

Results highlighted that many women with breast cancer were NPW and had a higher likelihood of this than healthy women. Work status prior to diagnosis is important, as 81.5% of the women that were unemployed prior to breast cancer remained unemployed 3 years after their breast cancer diagnosis. These findings are consistent with a study that reported 2 years after treatment, the 20% of women with breast cancer who had not returned to work.[27] Workplace or vocational rehabilitation services may help women with breast cancer who want to enter or return to the workforce. This study also found that 'not being in paid work' was significantly associated with other factors. It may be difficult to make workplace accommodations for women with breast cancer returning to work in trades and laboring roles. For women that have caring roles, they are most likely to be 'moving from part-time work to no paid work'. Therefore, the reasons for not being in paid work could be many—poor health, difficulty finding or performing work or choosing to gradually move out of the workforce to take up volunteering or caring roles. Many women with breast cancer may choose this life event to re-evaluate their roles and move into retirement earlier than previously planned.[23]

4.5 | Clinical implications

Reduced participation in work or not being in paid work at all has implications for the psychological and financial well-being of women with breast cancer and their families. An Australian survey by Breast Cancer Network Australia (2017) found the financial burden from breast cancer was partially due to reduced household income, with the total number of hours worked in a household dropping 50% in the first year after diagnosis and 13% in the second year.[28] In this study, we found that 3 years post breast cancer diagnosis, over 30% of women had not returned to their pre-cancer hours of work. This demonstrates that reduced workforce participation after breast cancer is not a short-term problem. Clinicians should be aware of the work status of breast cancer survivors, and difficulties with return to work should be managed in a similar way to any chronic illness requiring ongoing financial support and rehabilitation services.

4.6 | Study strengths and limitations

A strength of this study was the use of a large cohort of women surveyed over multiple points in time from a longitudinal, nationally representative sample study of women in Australia.[17] However, this study was limited by self-reported retrospective data, which did not allow exploration of the type or stage of breast cancer diagnosis, cancer treatments undertaken or reasons for not returning to work. Women were excluded from the LCA due to missing observations, but these cases were likely to have had negligible impact on results. It has been suggested that breast cancer survivors are more likely to be highly educated which may influence work status compared to healthy controls.[29] However, in this sample there was no difference between level of education in the breast cancer group and the healthy group ($P = .705$).

5 | CONCLUSION

In this study, breast cancer had a negative impact on the workforce participation of Australian women. Further research is needed to explore reasons why workforce participation reduced and how these might be related to health care policies and return to work systems in an Australian context.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL APPROVAL

#A361 (Statement Governing the Analysis, Use and Publication of Data Women's Health Australia; University of Newcastle; University of Queensland).

INFORMED CONSENT

Participant's informed consent is covered by ethical approval.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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Additional notes on study methods and limitations

Cancer diagnosis and work status are commonly collected through self-report, as individuals know these details and this method is widely accepted in research. While linking to medical or employment records could reduce error, this was not feasible given resource constraints and the large sample size. Self-reporting, however, can introduce recall bias, misclassification, and social desirability bias, and lacks clinical detail on cancer stage or treatment. Missing data may also skew results if non-response relates to illness severity or employment changes. Future studies could improve accuracy by linking surveys with registries, validating subsets, and using sensitivity analyses. The dataset excluded workplace factors such as environment, employer support, or job type, reflecting the study's focus on participation patterns rather than workplace determinants. Yet, these factors likely influence return-to-work outcomes - flexible roles and supportive employers can ease reintegration, while demanding jobs or a lack of accommodations may hinder it. Understanding these interactions remains an important area for future research and is recommended for future studies.

2.9 Updated evidence for the participation of Australian women with breast cancer

Whilst there has been substantial growth in research about the work disability and work participation of people with cancer in Australia, there is still only a small number of research publications focusing purely on breast cancer. Since the publication of our paper in 2020, there have been five additional studies examining return-to-work issues for Australian women with breast cancer, with one of these being an additional study by this author contributing to this thesis. The four other studies focused on women with breast cancer.

Thandrayen et al. (2022) examined the workforce participation of middle-aged people with various cancers in Australia. From this, a breast cancer subgroup could be established. The study found that 58% of women with breast cancer were engaged in paid employment, with 42% working full-time. This contrasts with a participation rate of 71% among individuals without a prior cancer diagnosis, with 55% of them employed full-time. The study also revealed that women diagnosed with breast cancer less than five years previously were 1.2 times more likely not to be actively participating in paid work, while those five or more years post-diagnosis were 1.1 times more likely not to be actively participating in paid work. These findings are similar to our study (Lewis et al., 2020).

A study by Kim et al. (2022) found that work conditions changed for one-third of breast cancer survivors after treatment, resulting in reduced income and fewer working hours. Correspondingly, the rates of part-time employment and retirement increased. These findings are similar to our study (Lewis et al., 2020). Survivors with depression had approximately four times higher limitation scores in their work performance compared to those without depression. Higher at-work productivity losses were associated with a current diagnosis of depression (Kim et al., 2022).

Sheppard et al. (2023) reported on an intervention, “Beyond Cancer,” to support breast cancer survivors to return to health, wellness, and work. Participants showed significantly greater improvements in work capacity compared to the usual care group (65.5% vs. 32.5%). Although there was an improved return-to-work rate for breast cancer patients, this was not significant.

Lloyd et al. (2025) used the Productivity Adjusted Life Year (PALY) metric to determine the loss of work productivity due to breast cancer among working-age Australian women. The PALY metric captures the impact of disease on people's work productivity, arising from unemployment, days off work, reduced work efficiency, and premature death. The findings revealed that breast cancer accounts for over 16,000 PALYs lost, equating to AU$3.3 billion in lost GDP over the 10 years following diagnosis, or AU$1.4 billion in lost wage earnings. This study has added a monetary value to the reduced return to work outcomes, whereas other studies have purely identified reduced work performance and participation (Lloyd et al., 2025).

Additionally, an article written by a life insurer discussed the need for a better understanding of the complex needs of cancer survivors, and how rehabilitation services through a multidisciplinary team were needed to support return to work for people with cancer with income protection and disability insurance claims (Daniels, 2023). Daniels (2023) acknowledges that insurers use a range of factors to estimate when an individual may return to work, but still there remains a need to understand why some people with cancer return to work within the deferred period, some remain at work during and between treatments, others return to work months or years after treatment finishes, yet some are never able to return to work (Daniels, 2023). The article highlights ‘chemo brain’ as one of the cancer side effects that is difficult for insurers to manage and substantially contributes to claimants' reduced work capacity (Daniels, 2023). The paper we published did not explore the reasons behind the reduced workforce participation rates of women with breast cancer, of which cognitive changes

have been highlighted as a concern and a related factor. The reasons for not participating in work are unclear from the methodology we used. International research shows cognition could be one of these areas that is unexplored and hard to define. Further exploration of this is needed.

2.10 Key findings

This chapter has examined the complex effects of breast cancer on women's participation in the workforce in Australia. It highlighted significant progress in women's employment over recent decades, the health issues that influence their work, and the specific challenges women with breast cancer face. Using data from the Australian Longitudinal Study of Women's Health, the publication showed that breast cancer negatively affects Australian women's workforce participation, with 48% of full-time workers returning to full-time work, while 52% either returned to part-time work or were not in paid employment. Latent class analysis identified five groups. Women with breast cancer were more likely to belong to the 'mostly full-time work' and 'mostly not in paid work' groups compared to healthy women. Odds ratios indicated that women in remote areas, those who are partnered, less educated, or have chronic health conditions, are more likely to be 'not in paid work.' Our research revealed that women with breast cancer need support to return to work, but face challenges accessing services. The chapter provided insights into the lower workforce participation rates among women with breast cancer and emphasised the importance of targeted interventions. It sets the stage for further analysis and discussion on understanding survivor aspects that most influence return to work and contribute to decreased work participation.

CHAPTER 3: SCOPING REVIEW OF BREAST CANCER, COGNITIVE CHANGES AND WORK

3.1 Introduction

This chapter explores one of the potential reasons why women may have trouble returning to employment after breast cancer: impaired cognition. Cognition underpins all human activity, enabling individuals to interpret information, make decisions, and carry out tasks essential for personal, social, and occupational function. From simple routines to complex problem-solving, cognitive processes form the foundation of how we operate and engage in meaningful activities. Although cognitive changes following breast cancer are often subtle, they can have a significant impact on work performance. The chapter aims to address the question: *How do cognitive changes impact the work participation and performance of women with breast cancer?* To answer this, it begins with an examination of the aetiology and neuroanatomical changes associated with breast cancer and related interventions. This provides a foundation for understanding the condition before presenting a scoping review of international research conducted from January 2000 to December 2020, which explores the impact of cognitive changes on work performance and participation:

> Lewis, J., & Mackenzie, L. (2022). Cognitive changes after breast cancer: a scoping review to identify problems encountered by women when returning to work. *Disability and Rehabilitation*, *44*(18), 5310–5328. https://doi.org/10.1080/09638288.2021.1919216

An updated review of the literature from January 2021 to May 2025 is presented after the published scoping review.

3.2 Cognitive changes – Difficult to see and even harder to explain

Using data from the Australian Longitudinal Study of Women's Health (ALSWH), the previous chapter confirmed that breast cancer negatively impacts Australian women's workforce participation (Lewis et al., 2020). The ALSWH primarily collected quantitative data through surveys for descriptive statistical analysis. The final survey question invited participants to share additional information with the following prompted question: "Have we missed anything? If you have anything else you would like to tell us, please write on the lines below." Although this question provided an opportunity for women with breast cancer to offer further insights, responses were optional and varied widely in content and detail. As a result, these qualitative responses were not included in the ALSWH study in Research Stage One, presented in Chapter 2 (Lewis et al., 2020). However, those written responses from women with breast cancer were analysed by Campbell et al. (2024), who confirmed that breast cancer survivors who responded experienced ongoing effects post-diagnosis and treatment, including changes in work ability and cognition, with comments such as:

- "I did not retire of my own volition. I was replaced in my casual job when I had breast cancer" (804282).
- "Because of the cancer treatment, my mind was dull and confused…I was unable to carry out all of my work duties, and I felt sleepy whilst I was working" (813396).

Campbell et al. (2024) concluded that while breast cancer is increasingly defined as a chronic disease, the experiences reported by women in the survey suggested they received little follow-up or continued professional support. The women with breast cancer in the Lewis et al. (2020) and Campbell et al. (2024) studies were from the 1996 to 2013 cohort. Since then, there has been increased awareness and services developed for some side effects, such as

lymphoedema. Across Australia, there are many lymphoedema clinics in both state health services and private clinics. Early screening and assessment, as well as clinical guidelines, have been developed to improve physical and functional outcomes for women with breast cancer (NSW Agency for Clinical Innovation, 2018). While this is positive news, cognitive changes have not received the same attention or increase in service delivery. The root cause is likely that lymphoedema can be seen and objectively measured, whereas cognitive deficits are harder to 'see' and measure objectively. There are issues around the veracity of self-reported symptoms (Smidt et al., 2016), resulting in evaluation difficulties. Cognitive changes after breast cancer have been described by women as a 'hidden disability,' which is difficult for others to detect and even harder for women to explain (Lewis et al., 2016; Player et al., 2014). Increased recognition of this issue might start with exploring research that demonstrates the aetiology and neuroanatomical background of cognitive impairments after breast cancer and therefore provide more propositional evidence of cognitive changes. Further awareness of the challenges women experience post-breast cancer treatment is needed, particularly as this side effect can substantially impact quality of life and work capacity.

3.3 Prevalence of cognitive changes in women with breast cancer

Research indicates that cognitive impairment rates among breast cancer survivors vary significantly depending on the assessment method used. Self-report prevalence figures are notably higher, with 44% of survivors reporting cognitive issues, compared to 16% identified through short cognitive screening tools and 21-34% through neuropsychological test batteries (Whittaker et al., 2022). Synthesised findings suggest that approximately one in three breast cancer survivors may experience clinically significant cognitive impairment, with self-reports reflecting a higher prevalence based on patient experiences (Whittaker et al., 2022).

The incidence of cancer-related cognitive impairment among breast cancer patients undergoing chemotherapy ranges widely from 12% to 82%, highlighting the variability in reported cognitive changes based on treatment received. Kanaskie & Loeb (2015) found that 16% to 50% of women experience cognitive symptoms post-chemotherapy. Dhillon (2014) estimated that overall, 17% to 75% of women with breast cancer experience cognitive decline, while Janelsins et al. (2014) suggested a prevalence of 12-82%.

These variations are likely due to differences in study designs, timing of assessments, patient populations, treatment regimens, and methods for assessing cognitive function. Since cognitive changes are primarily self-reported and there is no compulsory registration, the actual prevalence could be higher. Additionally, challenges in defining and diagnosing cognitive impairment further complicate establishing accurate prevalence rates.

3.4 Severity of cognitive changes

The International Cognition and Cancer Task Force (ICCTF) Guidelines (Wefel et al., 2011) indicate parameters for a diagnosis of cognitive impairment based on neuropsychological testing (see 1.5). However, there remains a lack of recognition of self-reported experiences using these criteria, despite cognitive changes most often being described according to how women subjectively report the symptoms affect their function. These changes are often depicted on a spectrum, which includes subtle, mild, moderate, or severe. They encompass alterations in attention, concentration, memory, executive functioning, and processing speed (Fleming et al., 2023). On the mild end of the spectrum, women report difficulties with word finding, forgetfulness, and being easily distracted from tasks. On the moderate to severe end, women report impaired attention and judgment that affects safety, thereby limiting their ability to drive, work, or care for others. There are no standardised definitions for each of these categories. Severity can also be indicated through changes in neuropsychological test scores.

Although patient-reported cognitive complaints hold significant clinical importance, neuropsychological testing offers objective evaluations across various cognitive domains. Yet, neuropsychological test results for women with breast cancer fail to reliably correlate with their self-reported cognitive impairment (Lange et al., 2019).

The timing of cognitive assessments could also impact definitions of severity. If women had high cognitive capacity before breast cancer, this would not be known. Clinicians and researchers only begin testing cognition once a diagnosis or treatment has commenced. Neuropsychological tests could show cognitive test results within 'normal' limits, resulting in the woman's test results not meeting the threshold for a diagnosis of cognitive impairment. However, if the woman's functioning was 'above average' before breast cancer, then a drop after diagnosis of breast cancer to the 'average' or 'normal' categories could have significant implications for performing everyday activities, particularly work tasks. This reduction in cognitive capacity, which manifests in difficulty performing everyday tasks women typically did 'automatically' before breast cancer, is not captured in objective neuropsychological test scores. Hence, there is scepticism among some health professionals regarding the broad adoption of the ICCTF guidelines. In summary so far, the challenges with cognitive assessments in women with breast cancer are already becoming evident and will be addressed further in the next chapter.

3.5 Duration of cognitive changes

A question many women with breast cancer ask when they experience cognitive changes is: "Will it get better?" The research indicates that generally, the initial acute experience of cognitive changes, which often starts during treatment, is the most severe. Cancer-related cognitive changes may improve, but very often do not resolve or return to 'normal'. A prospective longitudinal study (Collins et al., 2014) compared cognitive functioning using

neuropsychological test scores in breast cancer patients one year after chemotherapy with healthy individuals. The study found that one-third of the breast cancer patients with impaired cognition immediately after chemotherapy still had impairments 12 months later (Collins et al., 2014). Persistent cognitive changes have been shown in multiple studies for more than 12 months. Wagner et al. (2020) also found that women who had been treated with chemotherapy and/or endocrine (hormone) therapy still had cognitive impairments 12 months after treatment (Wagner et al., 2020). Furthermore, Schmidt et al. (2018) reported that 36% of women in that study continued to report cognitive difficulties five years after completing treatment. Multi-site, longitudinal studies are recommended to determine the permanence of these longer-term cognitive effects and the severity over time.

3.6 Assumptions about the causality of cognitive changes

Historically, two basic assumptions underpinned studies on cognitive changes following cancer, driven largely by methodological and ethical concerns. First, it was assumed that women with breast cancer had normal cognitive functioning before treatment. Second, chemotherapy was believed to be the sole agent responsible for cognitive changes, as supported by neuropsychological testing and imaging studies (Ahles et al., 2012). This perspective was formed by reports from people with cancer about diminished cognitive abilities typically emerging during or shortly after chemotherapy (Kanaskie & Loeb, 2015; Munir et al., 2010, 2011; Von Ah, Habermann, et al., 2013). Consequently, terms like ‘chemo brain’ and ‘chemo fog’ gained popularity (The Cancer Council Australia, 2023; Vardy & Dhillon, 2010; Wefel et al., 2011).

Collecting data about cognitive performance post-breast cancer diagnosis but pre-treatment presents ethical challenges. Delaying treatment for the sake of cognitive assessment

data could be considered harmful. Additionally, receiving a life-threatening diagnosis like breast cancer can evoke psychological and emotional responses which may impact cognitive function and confuse the cognitive assessment results. Despite this, some studies have successfully assessed cognition before any cancer treatment or surgery. These studies revealed that 20–30% of women demonstrated lower-than-expected cognitive performance, relative to age and education, and these impairments were not attributable to psychological factors (Ahles et al., 2008; Tager et al., 2010; Wefel et al., 2004), prompting researchers to consider other biological and genetic contributing factors. As research has advanced, it has become clear that cognitive changes in women with breast cancer are multifactorial in origin (Ahles et al., 2012; Janelsins et al., 2014; Oliva et al., 2024). Consequently, there is a growing consensus to move beyond the narrow framing of 'chemo brain' and 'chemo fog' in favour of more inclusive terminology, such as 'cancer-related cognitive changes.

3.7 Aetiology of cognitive changes in women with breast cancer

Teasing apart the impact of various cancer and treatment-related agents on cognition is not easy. The causes of cognitive changes after breast cancer are complex and often interconnected. This section describes the possible underlying causes of cognitive changes after breast cancer, linked to drug therapy, biological factors, and affective disorders.

While there is growing evidence that cognitive changes after cancer can impact individuals with hormone-based cancers, especially women, there are additional drug and biological factors linked to changes in cognition. This may explain why women have been vocal in expressing the challenges they experience, as they are known by the medical profession to frequently report cognitive symptoms (Smidt et al., 2016). Women are also the studied population regarding cognitive changes after cancer.

3.7.1 Drug therapy factors

3.7.1.1 Chemotherapy

Altered cognitive function has been associated with adjuvant chemotherapy. Studies have shown that chemotherapy can impact cognitive function due to a complex interplay of direct and indirect biological mechanisms affecting the central nervous system in three ways. Firstly, chemotherapy triggers an inflammation response in the body, increasing cytokines (e.g. tumour necrosis factor), C-reactive protein and lymphocytes (Fleming et al., 2023). Through blood tests, research has shown an association between these inflammatory markers and reduced cognitive performance at the end of chemotherapy treatment (Janelsins et al., 2022; van der Willik et al., 2018). Secondly, although the blood-brain barrier is designed to filter foreign chemicals and agents to prevent entry into the brain structure, animal studies have shown that some chemotherapy drugs have crossed the blood-brain barrier and caused cellular changes (Vardy & Tannock, 2007). It is thought that the neurotoxicity of chemotherapy causes direct injury to neurons and neurotransmitter levels. Thirdly, it is also believed that chemotherapy could cause blood clotting in the small vessels of the CNS. This microvascular damage leads to reduced oxygen to the CNS, culminating in cognitive impairment (Seigers & Fardell, 2011).

In a recent French study (Lange et al., 2023), researchers assessed cognitive functioning in women with breast cancer and healthy age and education-matched women. Neuro-psychological tests and self-report questionnaires were administered before treatment, one year and two years after diagnosis. After adjustment, women with breast cancer had lower baseline scores in working memory, processing speed, and attention compared to healthy controls, and these differences remained statistically significant over follow-up for working memory and processing speed. Executive function scores were similar between groups at baseline but decreased at year one among breast cancer patients. Self-reported difficulties

also increased in the breast cancer group at one year (Lange et al., 2023). The study shows that cognitive changes in women with breast cancer are measurable and can begin before treatment, implying an aetiology other than chemotherapy and persisting over time. The study also highlights persistent deficits in working memory and processing speed, indicating that certain cognitive functions are more vulnerable and may continue to be impaired over time. The decline in executive function also suggests that changes could worsen, possibly because of additional treatment, ongoing stress, or biological changes related to cancer. More severe cognitive impairments have been linked with chemotherapy that has higher doses and more cycles. It has also been linked with certain chemotherapy regimens, particularly cyclophosphamide, methotrexate and 5-fluorouracil (CMF). However, Vardy & Dhillon (2010) have indicated that current chemotherapy treatments are considered less toxic and, as such, more recent studies report a lower incidence of impairment with the CMF regimen.

3.7.1.2 Endocrine (hormone) therapy

Research has found a possible causal link between cognitive decline and anti-hormonal drugs used to reduce oestrogen in women with oestrogen-positive receptor breast cancers. Oestrogen has a positive impact on biological systems and supports cognitive function. Oestrogen receptors provide neuroprotection in the brain. Oestradiol is known to enhance neuroplasticity. However, aromatase inhibitors (e.g. Exemestane) used with post-menopausal women and selective oestrogen receptor modulators/agonists (e.g. Tamoxifen) can cross the blood-brain barrier, impacting oestrogen receptor expression and reducing neuroprotection, leading to a possible decline in cognition. Women are prescribed these medications for 5 -10 years after diagnosis, but many women choose to stop this medication due to side effects, including decreased cognitive function (Fardell, et al., 2023). Recent evidence shows that endocrine therapies may predominantly affect verbal memory and processing speed (Oliva et al., 2024). However, establishing a direct causal link between oestrogen-reducing drugs and

cognitive impairment is difficult, as most women receive hormone treatment after other treatments (surgery, chemotherapy, and radiation therapy).

The Tamoxifen and Exemestane Adjuvant Multinational Trial (Lee Meeuw Kjoe et al., 2023; Schilder et al., 2010) included women with breast cancer who had received chemotherapy. Survivors were then treated with Exemestane for 5 years (n = 114) or received sequential treatment consisting of 2.5 years of Tamoxifen followed by 2.5 years of Exemestane (n = 92). Neuropsychological performance was evaluated before starting endocrine therapy, after one year (short-term follow-up), and at five years (long-term follow-up). A control group of 120 healthy individuals was assessed at the same intervals. After adjusting for age, IQ, attrition, menopausal symptoms, anxiety/depression, and fatigue, at one year, Schilder et al. (2010) found that the women who received Tamoxifen experienced more cognitive problems than those who received aromatase inhibitors, when compared with healthy controls (Schilder et al., 2010). A further study at five years (Lee Meeuw Kjoe et al., 2023) showed the sequential treatment group had declines in verbal memory compared to the control group. Additionally, compared to the Exemestane-only group, the sequential group showed short-term declines in information processing speed, executive function and verbal memory. The Exemestane group did not exhibit cognitive decline compared to the control participants. The reduced cognitive function measured in those who had Tamoxifen, both alone and after switching to Exemestane, suggests that Tamoxifen may have lingering cognitive effects. These findings, if validated, indicate that Tamoxifen may have more detrimental cognitive effects than Exemestane (Lee Meeuw Kjoe et al., 2023).

3.7.1.3 Effects of anaesthesia (surgery)

While a healthy human brain is resilient to the effects of general anaesthesia and surgery, postoperative cognitive dysfunction (POCD) can be a major perioperative complication for some individuals (Guran et al., 2022). There is substantial research supporting a link

between cognitive impairment and those who undergo cardiovascular and other extensive surgical procedures (Belrose & Noppens, 2019; Berger et al., 2018). The causal links between general anaesthetics and cognitive decline are complex and still contested, but there are indications that changes to Tau protein, inflammation, calcium dysregulation, and mitochondrial dysfunction are possible causes (Belrose & Noppens, 2019).

POCD is associated with poor postoperative outcomes, including delayed recovery, prolonged hospital stays, loss of work, and increased medical expenses. Risk factors for POCD include general anaesthesia, surgical stress, advanced age, pre-existing cerebral, cardiac, or vascular diseases, preoperative mild cognitive impairment, low educational level, and a history of alcohol abuse (Guran et al., 2022).

Three studies show that approximately 20% of breast cancer patients who have undergone surgery but have not yet commenced chemotherapy or other drug therapy already have cognitive impairment (Ahles et al., 2008; Jansen et al., 2011; Wefel et al., 2010). This could indicate that POCD is revealed through neuropsychological tests, or there could be other aetiologies contributing to cognitive impairments. Guran et al. (2022) raises concerns about women with breast cancer who undergo surgery as part of their cancer treatment regimen, but already have cognitive impairments before surgery, particularly due to chemotherapy. This could be relevant for women undergoing surgery, both before other treatments and for reconstructive purposes later in the survivorship stage. The studies show that perioperative mild cognitive impairment is a risk factor for developing POCD and thereby could be linked to worsening cognitive symptoms for some women with breast cancer (Guran et al., 2022).

3.7.1.4 Radiation therapy

Radiation therapy as a causal factor for cognitive changes in women with breast cancer is rarely discussed. Shibayama et al. (2014) found that breast cancer patients who received local radiotherapy (having already undergone surgery) and were seven months post-diagnosis

had lower cognitive function, specifically in immediate verbal memory and delayed recall, as assessed using the neuropsychological test Wechsler Memory Scale-Revised (WMS-R), compared to women with breast cancer who had not received radiotherapy. The cognitive impairment was partially mediated by higher plasma interleukin (IL)-6 levels. These findings suggest that radiotherapy may indirectly affect cognitive function through increased proinflammatory cytokines, particularly IL-6 levels. In 2019, these authors furthered their study with this breast cancer group and found that after 3 years, IL-6 levels had reduced and scores on verbal memory and delayed recall had improved (Shibayama et al., 2019). The recent study did not indicate whether women were on endocrine therapy at the follow-up assessments. Although this suggests that radiation therapy may be linked to cognitive decline for a short period during and after treatment, there are other possibilities linked to other therapies.

3.7.2 Biological factors

3.7.2.1 Inflammation markers

Biological markers in breast cancer patients, particularly serum inflammation, can be measured through blood tests. As previously outlined, research has linked increased inflammation markers during and after chemotherapy to reduced cognitive function in women with breast cancer (Fleming et al., 2023). This could be due to the chemotherapy increasing the inflammatory response in the body, altering the blood-brain barrier, and allowing the toxicity of the chemotherapy to affect brain function. However, biological and cognitive assessments conducted before chemotherapy and other treatments have provided significant insight into cancer-related cognitive changes. commence. Booth et al. (2006) found that various cytokine levels were elevated in women with breast cancer before chemotherapy commenced and then two years after treatment (Booth et al., 2006). Researchers measured inflammatory markers like C-reactive protein (CRP) and interleukin-6 (IL-6) at diagnosis, before any treatment, and found that high levels of these markers were associated with cognitive impairments, such as memory

and processing speed issues, two years later. This suggests that elevated inflammation levels prior to any treatment starting could be a predictor of long-term cognitive problems (Duivon et al., 2024).

3.7.2.2 Genetic indicators

Genetic risk factors for cancer-related cognitive changes after breast cancer have been explored based on their involvement in other neurodegenerative diseases. The ε-4 allele of the apolipoprotein E (APOE) gene is the strongest and most well-established genetic risk factor for Alzheimer's disease (Fleming et al., 2023). The APOE gene assists with neuronal repair and plasticity after injury (Ahles et al 2012). Various studies have shown that people with the APOE gene appear more vulnerable to cognitive impairment through head injury, cardiac bypass surgery and dementia (Vardy & Tannock, 2007). A study by Ahles et al. (2003) found that women with breast cancer who had chemotherapy and carried the APOE gene had lower cognitive function than those without the gene (Ahles et al., 2003). It is possible that a genetic disposition could explain why there is only a subgroup of women who experience cognitive changes after breast cancer.

3.7.2.3 Menopause

Chemotherapy treatment for breast cancer often induces early menopause, which reduces levels of oestrogen in the body. Oestrogen serves as a neuroprotective agent. Studies have been inconclusive about the relationship between chemotherapy–induced menopause and cognitive impairment. Some studies show a decline in cognitive capacity in those who had chemotherapy-induced menopause (Hermelink et al., 2007), whereas others show no link (Vardy & Dhillon, 2010). The influence of a woman's hormonal status before chemotherapy treatment may be significant to cognition. Sudden changes in circulating oestradiol, such as those caused by chemotherapy-induced amenorrhea in premenopausal women, can exacerbate the cognitive effects of subsequent endocrine therapy (Ganz & Van Dyk, 2020). In

postmenopausal women who start endocrine therapy with already low levels of circulating oestradiol, the effects are likely to be different but may be confounded by age-related cognitive decline, which could also be worsened by chemotherapy (Wagner et al., 2020).

3.7.2.4 Ageing process

Older adults diagnosed with cancer frequently have lower cognitive reserve, frailty, and comorbidities, including neurodegenerative disorders such as dementia (Ahles et al., 2012; Magnuson et al., 2021). A recent study (Root et al., 2023) examined cognitive functioning in older female breast cancer survivors compared to women without a history of cancer, focusing on how these abilities change with age. Women aged 60 to 89 at the time of diagnosis were assessed over two years. Cognitive performance declined with age in both groups. However, women less than 75 years old demonstrated significantly lower performance in areas such as memory, attention, processing speed, and executive functioning when compared to controls. These differences were not observed among women aged 75 and older. The study also found that greater accumulation of age-related health deficits was associated with poorer cognitive outcomes in survivors, particularly in the under 75 years subgroup. These findings suggest that age-related health decline may contribute to cognitive impairment in breast cancer survivors (Root et al., 2023).

3.7.3 Affective factors

3.7.3.1 Anxiety and depression

Questions have been asked about whether cognitive impairments are the result of affective disorders, such as anxiety and depression. Distress is a broad construct, covering a wide range of emotions related to symptoms of depression, anxiety and adjustment disorder (Dinapoli et al., 2021), which women may experience throughout their breast cancer experience. Learning of a cancer diagnosis could certainly alter mood, which could affect sleep

and other physiological functions. Worry and concern about mortality, the future, and treatment could bring about anxiety and depression. The rate of anxiety and depression in women with breast cancer is estimated at between 10 and 30%, depending on the study population, study design, and choice of measures (Dinapoli et al., 2021). These psychological conditions could be present individually or cumulatively at any time during a breast cancer experience and therefore exacerbate cognitive impairments (Park et al., 2023). However, studies have shown that self-reported distress, anxiety and depression only correlate with self-reported cognitive impairments, but not with neuropsychological test results (Jansen et al., 2011; Tager et al., 2010; Vardy & Tannock, 2007). A recent study also found that increased symptoms of depression and anxiety were associated with worsened self-reported cognitive function scores, suggesting a direct link between emotional distress and cognitive decline in this population (Liu et al., 2024). Overall, research consistently finds that higher levels of depression and anxiety correlate with greater perceived cognitive dysfunction in breast cancer patients.

3.7.3.2 Fatigue

Research has indicated that fatigue and cognitive changes are not mutually exclusive side effects of breast cancer, but rather interrelated, with fatigue being a possible causal factor of cognitive changes (Joly et al., 2019). In fact, fatigue has been described as the most troublesome side effect of breast cancer. Although it has been described here under ‘affective factors’, its origin can be multifactorial, but it is not the focus of this thesis. In summary, the cause of fatigue has been linked with side effects of all breast cancer treatments (i.e., chemotherapy, radiation therapy, hormone therapy) due to a range of biological changes, including cancer-related anaemia (Joly et al., 2019), which reduces haemoglobin levels.

Cancer-related fatigue is different from normal fatigue in that it persists despite adequate rest or sleep (Miura et al., 2016). Like depression and anxiety, fatigue is a subjective phenomenon

that must be evaluated using self-report measures. Similar to anxiety and depression, there is a strong association between self-reported increased fatigue and cognitive problems, but no correlation with objective neuropsychological test results (Castellon et al., 2004; Vardy & Tannock, 2007).

Fatigue is recognised as a multidimensional concept, manifesting in various forms: physically (e.g., reduced physical performance), affectively (e.g., decreased interest), and cognitively (e.g., impaired concentration or attention). This classification differentiates expressions of tiredness based on physical functioning and sensations, emotional states, and cognitive difficulties (Miura et al., 2016). Research has now recognised that the presentation of groups of symptoms may contribute to fatigue and cognitive changes and is now being evaluated as a 'symptom cluster'.

3.7.3.3 Symptom clusters

The above literature has highlighted that, in addition to cognitive changes, women with breast cancer could experience other side effects from breast cancer and its treatment. The co-occurrence of two or more related symptoms in cancer survivors is known as a 'symptom cluster'. Previous research has documented symptom clusters, particularly for sleep, fatigue, and mood disturbances. Many of these symptoms exist independently or secondarily to cognitive changes.

Symptom clusters in breast cancer patients could arise from shared biological mechanisms, including inflammatory processes, elevated cytokine levels, immune responses, and the activation of the sympathetic nervous system and the hypothalamic-pituitary-adrenal axis (So et al., 2021). Identifying a single causal pathway is challenging due to variability in symptom cluster inclusions across studies (e.g., fatigue, pain, and depression versus fatigue, pain, depression, and sleep (So et al., 2021).

Depression and anxiety significantly impact cognitive function, overall well-being, and treatment adherence in breast cancer patients. These psychological factors can lead to a higher symptom burden and poorer quality of life outcomes. Notably, depression and anxiety may persist long after cancer treatment, continuing to affect cognitive function during survivorship. This highlights the importance of early identification and management of psychological distress to mitigate long-term cognitive effects (Fardell et al., 2023).

3.8 Neuroanatomical imaging evidence of cognitive changes

Magnetic resonance imaging (MRI) and positron emission tomography (PET) studies have shown specific functional and structural changes in the brain that could help explain cognitive changes in women with breast cancer. Breast cancer survivors report frustration at the lack of acknowledgment they receive from many health professionals when they report cognitive difficulties (Becker et al., 2015; Player et al., 2014; Smidt et al., 2016). Functional MRI (fMRI) scans the brain while the subject performs a task (usually as part of a standardised neuropsychological test), such as a memory task. The images from the fMRI studies provide a potential explanation for why cognitive symptoms may exist (Ferguson et al., 2007).

A study by Silverman et al. (2007) compared two groups of women who had breast cancer 5-10 years earlier; one group had chemotherapy and the other had not. Some of the women treated with chemotherapy had also taken Tamoxifen. PET scans were taken during short-term memory and verbal recall tasks. For the non-chemotherapy group, scans showed brain activation in the parietal and occipital cortex. In comparison, the chemotherapy group showed atypical and increased activation of the inferior frontal cortex and posterior cerebellum area. This demonstrates that it may be possible for women breast cancer survivors to recruit alternate or

additional brain areas to perform a specific task, thereby compensating for subtle changes in cognitive ability.

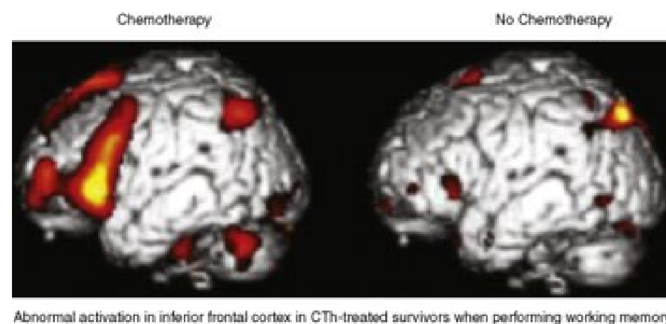

Figure 3.2: Activation associated with short-term recall in chemotherapy-treated (left) and untreated (right) subjects. (Image used with permission of Professor Daniel Silverman, UCLA.)

Ferguson et al. (2007) conducted a study using fMRI images of 60-year-old monozygotic twins during a working memory task with incrementally increasing levels of difficulty. Twin A had breast cancer and had undergone chemotherapy, while Twin B had neither breast cancer nor any chemotherapy exposure. Although the twins did not differ in task performance accuracy, the fMRI revealed stark differences in brain activity. Twin A exhibited an expanded spatial extent of brain activation in the cortical regions but decreased activation in the mid-frontal regions compared to Twin B.

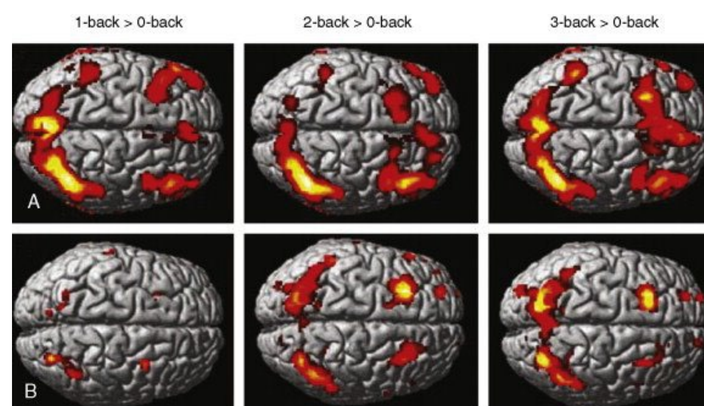

Figure 3.3: A - Twin treated with chemotherapy. B - Twin who did not receive chemotherapy. (Image used with permission of Robert Ferguson, Andrew Saykin, and Tim Ahles, Memorial-Sloan Kettering, NY, as advised by Dr Haryana Dhillon)

Like Silverman et al. (2007), this increase in the recruitment of different areas of the brain to complete a task could be viewed as a compensatory strategy for neural dysfunction. Additionally, Twin A had more white matter hyperintensities (indicating possible damage to blood vessels or myelin sheaths) compared to Twin B. Notably, Twin A was a carrier of the APOE gene and had also taken Tamoxifen. Therefore, the extent to which these neuroanatomical changes are purely due to chemotherapy is unknown, as other causal factors such as aging and genetics may play a role.

Inagaki et al. (2007) used MRI scans to compare the brains of healthy women and those who had various regimes/combinations of chemotherapy treatment for breast cancer. This study found that there was decreased brain volume in the grey and white matter of women who had had breast cancer one year after chemotherapy treatment, but not after three years. The areas of the brain affected were the superior and frontal gyri, parahippocampal gyrus, cingulated gyrus and precuneus. These areas are associated with attention, visuospatial and memory function, which coincide with the cognitive problems self-reported by women with breast cancer after treatment and measured on neuropsychological tests.

Vardy et al. (2019) performed an increasingly difficult graded neuropsychological test under fMRI conditions. The study found that women who received chemotherapy and had self-reported cognitive impairment demonstrated increased frontal activation compared to those who did not report cognitive impairment. However, this difference was only apparent in the most challenging task condition (Vardy et al., 2019). This study by Vardy et al. (2019), along with other fMRI studies, helps validate the experiences of women who report cognitive changes and challenges the studies that do not show a correlation between 'objective' neuropsychological test results and 'subjective' self-reported measures.

3.9 Considering cognitive changes and impact on function: ICF model

This chapter has so far focused on the possible aetiology and personal risk factors contributing to cognitive changes after breast cancer, along with the resulting neuroanatomical changes. While this does not directly address work performance and participation, a thorough understanding of the body systems and structures affected by breast cancer and its treatment is essential to grasp the impact on cognitive function and the capacity to work. Using the International Classification of Functioning, Disability and Health (ICF) model (World Health Organization, 2001) as a guiding framework, breast cancer and its treatments can be seen to cause impairments in body structures and functions, which are further influenced by personal factors. As such, Figure 3.4 presents the ICF model with the research reviewed thus far (i.e. body systems / structures, and personal factors) only. The ICF model helps clinicians understand the pathophysiology of breast cancer and supports the selection of appropriate assessments and interventions. As this chapter continues with a published scoping review on cognitive changes and their impact on women's work ability, performance, and participation, further components of the ICF model will be explored and presented. This will highlight the multifaceted nature of cognitive impairment and its real-world implications for women with breast cancer.

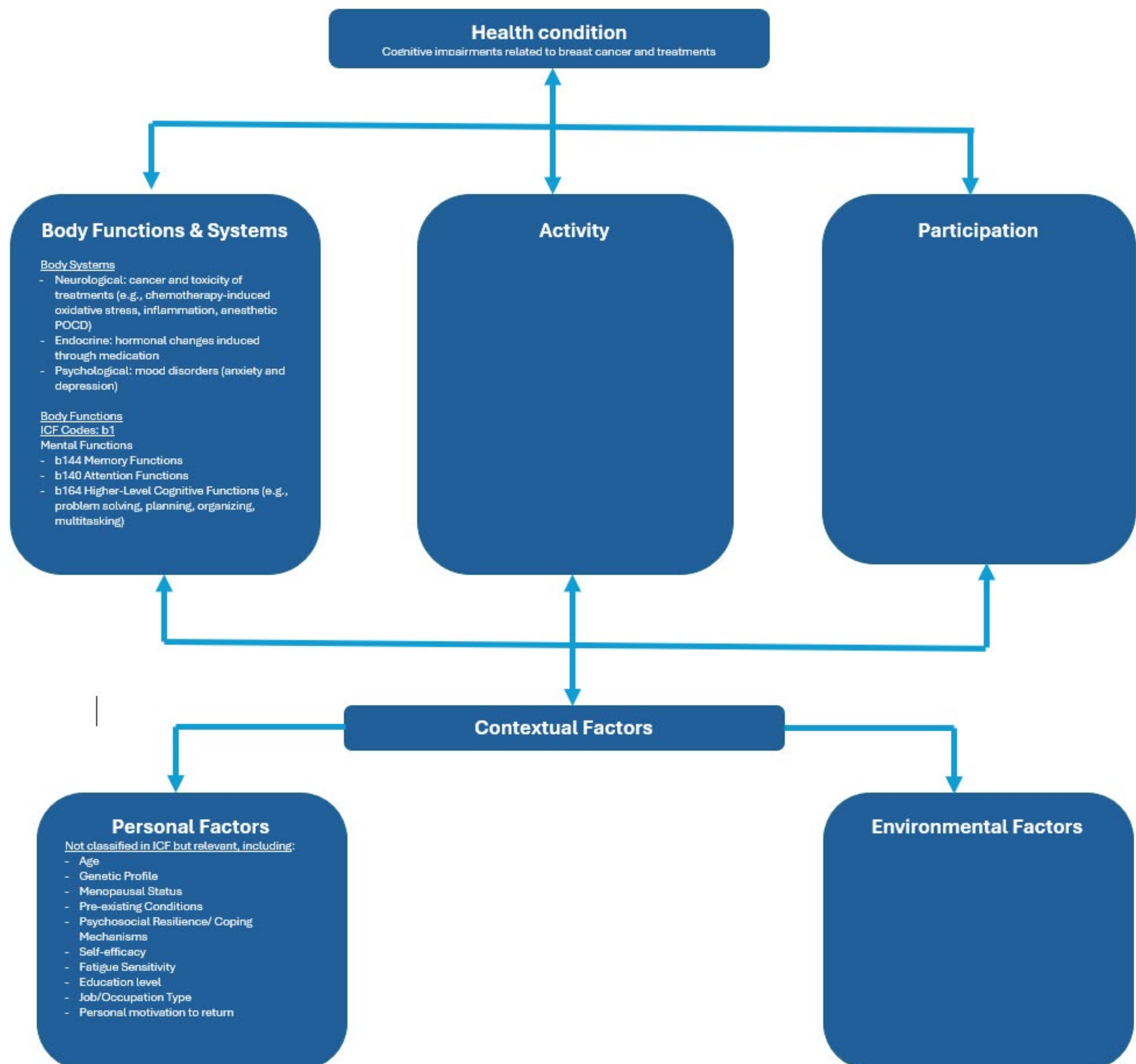

Figure 3.1: ICF model applied to breast cancer and cognitive changes, including impairments in body structures and functions and personal factors.

3.10 Paper: Cognitive changes after breast cancer: a scoping review to identify problems encountered by women when returning to work

At the time of writing this thesis, the following paper, published in 2021, is the first scoping review that describes cognitive changes and their impact on work performance for women with breast cancer. The scoping review provides evidence to build on the 'activity' and 'participation' components, as well as 'environmental' factors depicted in the ICF model. Each of the research papers which was included in the scoping review has undergone a critical review, thereby providing a reliable investigation to answer the question: How do cognitive changes affect the work performance and participation of women with breast cancer?

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REVIEW ARTICLE

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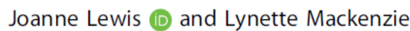
Cognitive changes after breast cancer: a scoping review to identify problems encountered by women when returning to work

Joanne Lewis and Lynette Mackenzie



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ABSTRACT

Purpose: A scoping review of international literature was conducted to identify the various problems encountered by women with breast cancer associated with cognitive deficits, and the relationship to work roles and tasks.

Method: This scoping review was conducted using the structure recommended by Arksey & O'Malley in consideration of the PRISMA extension for Scoping Reviews checklist and reviewed for quality, inclusion criteria and key findings related to cognitive changes after breast and impact on work. Searches were conducted in five databases from January 2000 to December 2020.

Results: A total of 34 studies met the inclusion criteria. There were 20 quantitative studies, 11 qualitative studies, one mixed method and two case study reports. Findings related to the type of cognitive changes that impact work performance and participation, how these are measured in a work context and the types of interventions directed towards improving cognitive function at work after breast cancer. An absence of ecologically valid assessments and interventions with a coherent approach to early identification and management of cognitive changes after breast cancer was apparent.

Conclusion: Breast cancer survivors can experience challenges in their employment due to cognitive deficits, which may lead to the loss of their employment. Health professionals need to explore breast cancer survivors work role and consider appropriate referrals to ensure women receive the necessary support and rehabilitation to address cognitive problems impacting work performance. Further research is needed to develop workplace-based cognitive assessments and interventions to improve the work performance and participation of women with breast cancer experiencing cognitive deficits.

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➤ IMPLICATIONS FOR REHABILITATION

- Work participation can be negatively impacted by unacknowledged cognitive changes that are not assessed and managed throughout the cancer survivorship journey.
- Health professionals in health care systems, particularly occupational therapists need to consider appropriate referrals to workplace rehabilitation providers to ensure necessary support and rehabilitation to address cognitive problems impacting on work performance.
- Occupational therapists performing workplace assessments for women with breast cancer, should assesses cognitive function in accordance with the cognitive demands of the job and work environment, and involve the employer and client in workplace based cognitive interventions.

Introduction

In Australia, 90% of women with breast cancer are anticipated to survive for at least five years due to better early screening and effective treatment [1]. More than 69% of breast cancers diagnosed are in those aged 40–69 years old [1] and women in this age group are likely to be in paid work when they are diagnosed. However, international studies have estimated that up to approximately 40% of women with breast cancer will not return to work, have to change employment or reduce work hours or demands [2]. After medical treatment (surgery, chemotherapy, radiation), breast cancer survivors have reported long-term functional difficulties such as ongoing fatigue, pain, lymphoedema, anxiety/depression and cognitive deficits, which may become chronic and therefore affect participation in everyday roles and activities, such as work. Some women report cognitive deficits to be more troublesome than physical side effects [3]. There is a large variance in the estimation of women experiencing cognitive changes after breast cancer across the literature due to the timing and types of assessments conducted [4]. However, assessments conducted pre and post-treatment as well as in longitudinal studies (three years post-treatment) indicate that approximately 30% of breast cancer survivors experience ongoing cognitive difficulties to some degree, following treatment [5,6].

Cognitive deficits after breast cancer are a side effect that has raised many questions in the literature, particularly around causation. Originally chemotherapy was thought to be the key causal agent for cognitive changes, hence the term 'chemo-brain' developed. However, studies have raised the possibility of other

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contributing factors, including age, genetics, cellular (cytokines) and hormone drug therapies [4]. The co-occurrence of depression, fatigue, and sleep disorders may also affect cognition [4]. Whatever the cause of cognitive changes, women have reported that cognitive deficits negatively impact their performance of everyday activities [3]. Despite objective and standardized neuropsychological testing providing mixed results about the presence of cognitive deficits [7], women have self-reported changes in their memory, executive functioning verbal ability and information processing. Functional magnetic resonance imaging and positron emission tomography studies carried out during the performance of selected neuropsychological tests have added credence to women's subjective reports of cognitive changes [8–10]. Functional magnetic resonance imaging and positron emission tomography studies have shown specific functional and structural changes of the brain that occur for women with cognitive changes after breast cancer [8–10]. Decreased neural function in frontal [8–10], hippocampal [10], and cerebellar structures [9] contributed to language, planning, memory, and coordination problems. Also, breast cancer survivors had wider recruitment of neural activity during simple cognitive tasks when compared to those without breast cancer [8]. Recruitment of additional brain regions to perform specific cognitive tasks to compensate for subtle changes in cognitive ability appear to increase cognitive load for even simple everyday tasks.

Participation in work is seen as an important milestone in the survivorship phase of breast cancer [11]. Women report that returning to work brings positive psychological, emotional and financial benefits to promote their recovery [12]. However, many women report that cognitive changes have impacted their ability to return to work or maintain their employment [13]. Work is now generally considered good for the health and wellbeing of all people, regardless of the type or nature of injury or disability [14]. Literature has shown that continued participation in complex cognitive activities, such as work, helps promote cognition through the establishment of habits and routines as well as skill acquisition [15]. Therefore, if cognitive changes are affecting women's performance or participation in work after breast cancer, there needs to be appropriate assessment, intervention [16] and service delivery to assist the return to work process. In one study, where all participants reported cognitive difficulties approximately 30% left the workforce due to cognitive difficulties impacting work performance [13]. Cognitive deficits can cause diminished quantity and quality of work and possibly lead to absenteeism, presenteeism, performance management, termination of employment or early retirement [17].

There is a paucity of research on the impact cognitive changes have on return to work for women with breast cancer in Australia. International research lacks applicability due to the segregated health care rehabilitation system and social/employment services sector in Australia [18]. This is now an imperative, as government policy has initiated a rising age of retirement [19]. So together with the increasing survival rate of breast cancer, more women will be managing the chronic side effects of their cancer and treatment at work for an extended period. It is therefore important that we understand how cognitive changes impact the work performance of women with breast cancer, to help in developing appropriate assessments and interventions to preserve employment. This scoping review aimed to identify what is known about how cognitive changes impact work ability or performance for women with breast cancer and consider how this relates to practice in Australia, with a unique health and employment system.

Research question

What is known about how cognitive changes impact on work ability or performance of women with breast cancer?

Secondary objectives

Specifically, this scoping review also aimed to address the following questions:

1. What is the impact of cognitive deficits on work performance and ability following breast cancer?
2. How is the impact of cognitive deficits on work performance measured for women with breast cancer?
3. What strategies or interventions are used to address cognitive deficits impacting work performance for women with breast cancer?

Methods

This scoping review was conducted using the structure recommended by Arksey & O'Malley (2005) [20], together with enhancements provided by Levac, Colquhoun, & O'Brien (2010) [21] and in consideration of the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [22,23] The steps taken were:

1. Identifying the research question
2. Identifying relevant studies
3. Selecting appropriate studies
4. Charting the data
5. Collating and analysing results

A critical appraisal of individual sources of evidence was also conducted following the PRISMA-ScR [22]. Although the PRISMA-ScR states that this is an optional step for scoping reviews [22], the critical appraisal enabled a review of the methodological challenges faced by researchers in this field. This scoping review did not include the optional sixth step of consultation [21] due to the solid number of qualitative, mixed methods and case studies retrieved through the search, that gave voice to many women with breast cancer experiencing cognitive difficulties.

Developing the research question

The impact cognitive changes have on work performance or the ability of women with breast cancer is a complex issue that crosses over health and employment issues. A scoping review is the examination of a broad area to identify gaps in research knowledge, clarify main concepts and report on the range of evidence that underpins practice in a particular field [20] and as such, is beneficial for complex questions.

Identifying relevant studies

A systematic search was conducted using Medline, CINAHL, Web of Science, Scopus and Cochrane Library from the year 2000 to May 2020. This time limit was applied due to cognitive changes after cancer becoming recognized from 2000 onwards. Search terms used were: "breast cancer" OR "breast neoplasm" AND "cogniti*" OR "cognition" OR "cognitive" OR "cognition disorder" AND "work" OR "work performance" OR" return to work" OR "work capacity evaluation" OR "work environment" OR "work tolerance schedule" OR "employ*" OR "supported employment" OR "job performance" OR "job accommodation". Reference lists of key articles relating to cognitive problems and work for women with

breast cancer were reviewed for other potential studies. The results were imported into Mendeley to store citations and track the abstract and article review process.

Study selection

Studies were selected that met the following eligibility criteria: (i) research published in peer-reviewed journals, (ii) written in English, (iii) involve qualitative or quantitative or mixed method research methods, (iv) included the search terms listed above either in the title or abstract and (v) only included cohorts of breast cancer survivors, or where the results included other cancers, the breast cancer cohort results were mutually exclusive.

Charting and summarizing the data

All articles were read and re-read to identify emerging themes and domains within the results and discussion sections. Descriptive data about each study (authors, country, setting, study aims, outcome measures used, and main findings) were charted in an excel spreadsheet.

Critical appraisal

Critical appraisals were conducted when there was an appropriate tool to use for the study design. To keep the appraisals consistent, the Joanna Briggs Institute (JBI) Critical Appraisal Tools Studies [24] were utilized. These require a 'yes, 'no' and 'unclear' marking options against each checklist item. A scoring system was created, where 'yes = 2', 'no = 0' and 'unclear = 1'. This helped quantify the appraisal. Cross sectional studies were appraised using the JBI Critical Appraisal Tool for Cross Sectional Studies [24], which is an eight item checklist. Cohort studies were appraised using the JBI Critical Appraisal Tool for Cohort Studies, which is an 11 item checklist [24]. Qualitative studies were appraised using the JBI Critical Appraisal Tool for Qualitative Studies, which is a 10 item checklist [24]. Case studies were appraised using the JBI Critical Appraisal Tool for Case Report Studies, which is an eight item checklist [24]. There were no JBI Critical Appraisal Checklists for mixed method studies, as such the Mixed Methods Appraisal Tool (MMAT) [25], a 13 item checklist was used.

Results

Selection of sources of evidence

Results of the literature search and review process are summarized in Figure 1. The results yielded 34 studies. From a total of 779 references, 448 duplicate articles were removed. 125 full-text papers were retrieved and reviewed in full by one reviewer. 95 did not meet the study inclusion criteria. Finally, there were 34 articles in the review (Figure 1).

Study characteristics

Key characteristics of the studies are summarized in Table 1–3. Publication dates ranged from 2004 to 2019. Nineteen studies were conducted in the USA, four studies conducted in China, two studies each in Australia, Germany and United Kingdom. There were single studies from Hong Kong, Japan, France, Brazil and Sweden. There were 20 quantitative studies, of which twelve were analytical cross-sectional studies (six with comparison groups), two longitudinal prospective trials (one randomized) and one cohort study. Two studies used secondary analysis of longitudinal data, two studies developed, and validated assessment tools and one was a descriptive cross-sectional study. There were 11 qualitative studies, two case study reports and one mixed methods design.

Quality assessment

A quality assessment was conducted using critical appraisal tools that were appropriate for the study design. Six studies had a methodological design that did match a critical appraisal tool design and could not be scored. The cross-sectional studies scores ranged from 71% to 100%. The cohort study scored 73%. The qualitative studies ranged from 50% to 90%. The case study reports scored from 63% to 94% and the mixed methods study scored 81%.

Data analysis and synthesis

The findings from the data analysis and synthesis will be considered considering the objectives of this scoping review, with quantitative and qualitative results being presented separately due to their epistemological differences.

Cognitive Difficulties impacting on work performance and participation

impact of cognitive changes on work performance. Eight studies [3,13,26–31] used qualitative methods to describe the impact cognitive changes had on the quantity and quality of work performance of women with breast cancer. Women most commonly reported reduced memory, difficulty concentrating, slow reaction time and cognitive errors with their work tasks [3,27,29]. Women in the Munir et al. (2010) study described poor concentration, confusion, lack of clear thinking, an inability to divide their attention, difficulty communicating with work colleagues and a reduced ability to deal with everyday problems in the workplace. Three studies [26–28] highlighted the particular difficulties with executive functioning experienced by women with breast cancer when performing work tasks. In the Lewis et al. (2016) study difficulties were experienced with 'attending', 'programming' (flexible thinking strategies in response to changing contexts) and 'continuing' with work tasks [28]. Women reported an impaired ability to multitask or sequence activities at work [26] and difficulty organising and prioritising their work [27].

Women in three studies [27–29] reported that physically they may have looked well after breast cancer treatment, but cognitive changes were like 'invisible symptoms' [29] or a 'hidden disability'[28] that was hard to explain, difficult for employers and colleagues to understand [27] and felt the need to conceal these from their employer [3,27]. In two studies, women with breast cancer reported that their employer was closely scrutinizing their performance because of their cognitive dysfunction affecting performance [26,31]. When women with breast cancer believe they are unable to meet the cognitive demands of the job, they report feeling stressed, inadequate, not confident [32] embarrassed [27,31], frustrated, upset [3,30,31] and distressed [31]. Women with breast cancer described how cognitive impairments required them to work longer [3] and harder [28,31], or apply more "cognitive effort" to achieve their pre-cancer work output [28,33] and as a result, cause mental fatigue. Women attempted to describe mental or cognitive fatigue, caused by cognitive changes after breast cancer and treatment, being different to physical fatigue at the end of a workday [27,28].

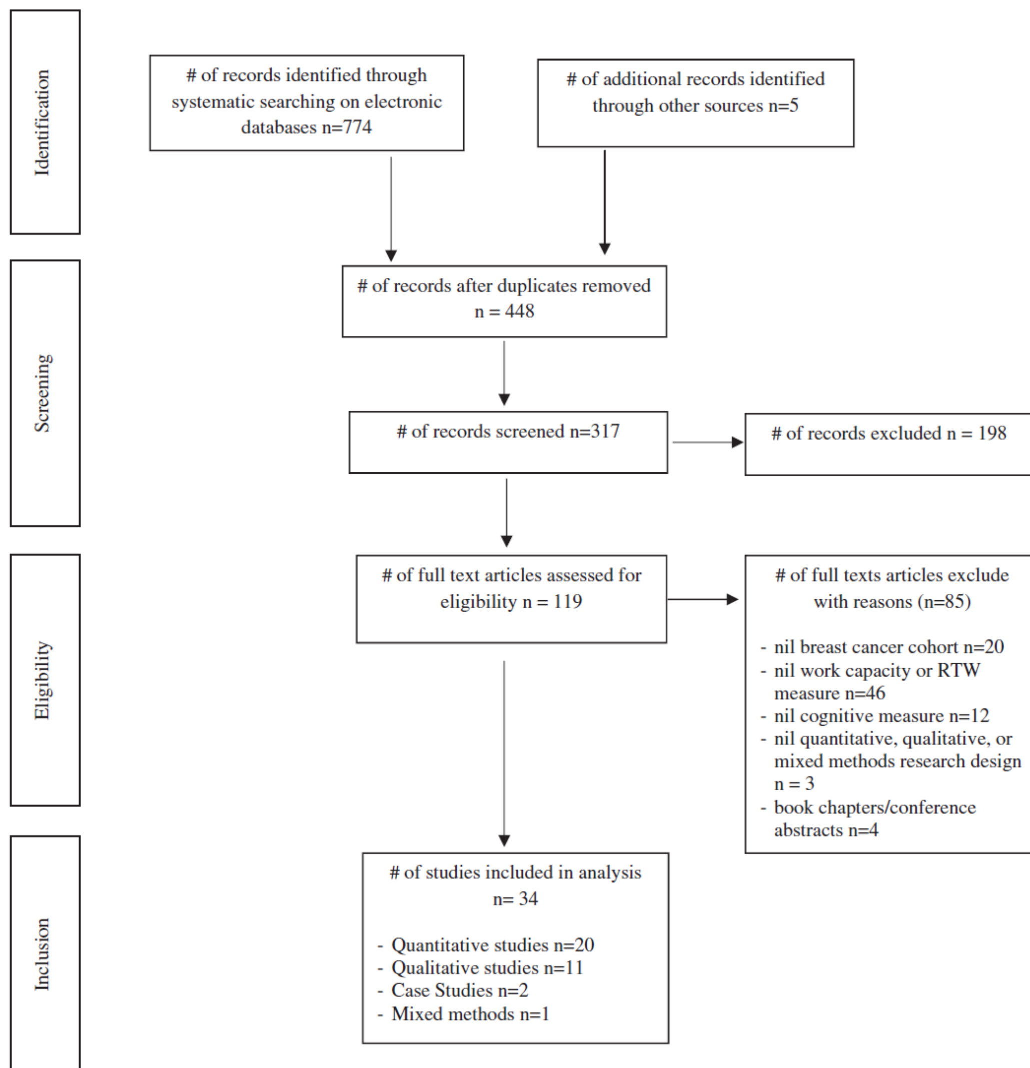

Figure 1. Study selection procedure.

In the only mixed-method study by Schmalenberger et al. (2012), the specific impact of cognitive changes on female musicians with breast cancer was described. Changes in memory impacted the ability to remember lyrics of songs, reduced speed of thinking impacted ability to sight-read music and reduced concentration impacted attention during concert performances [34].

Ten studies used a quantitative approach to examine the relationship between cognitive changes after breast cancer and the impact on work performance. The Work Limitations Questionnaire (WLQ), a self-reported work performance measure was used in seven of the studies in this scoping review [7,35–40]. Using the WLQ, women with breast cancer were found to have higher levels of cognitive impairments which reduced their work output or pace of work, compared to healthy women or a comparative group [7,35,37,40,41]. In the Brick et al. (2019) study, the breast cancer group had a significantly higher work-related disability at the time of diagnosis compared to the healthy group which was significantly related to cognitive challenges ($p = 0.011$). Breckenridge et al. [42] found that endocrine therapy was moderately related to perceived attentional problems at work for women with breast cancer. Von Ah et al. (2017) found that attentional fatigue was significant ($p < 0.001$) for predicting self-reported work ability [43]. A later study by Von Ah et al. (2018) study found that employed breast cancer survivors with perceived low cognitive functioning reported poorer workability, work performance and work productivity, whereas those with higher perceived cognitive functioning had improved work performance [38]. Similarly, Barnes et al. (2014) found that women who

Table 1. Quantitative studies included in scoping review ($n = 20$).

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
Barnes et al. (2014) USA [44]	Analytical Cross Sectional	Determine the effect of job tasks and satisfaction on mental and physical health 9 months post-treatment initiation.	Setting: Hospital and outpatient clinics Tools: Surveys and Measures (SF36 and CESD −10)	$N = 493$ Mean age = 49 years 2 months and 9 months post-diagnosis Employed at the time of diagnosis	• Pre-post design, but 'pre' diagnoses score was collected via recall at 2 months after initiating treatment. • Employment in cognitively demanding and less satisfying jobs was associated with decreases in mental health and increases in problems with work or daily activities 9 months post-treatment initiation ($p < 0.05$) • Women in cognitively demanding jobs before diagnosis who had prolonged chemotherapy had a decline in physical and mental health leading to problems at work. • They reported difficulties with intense concentration or attention, analysing data or information, keeping up with the pace set by others and learning new things.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 81%
Breckenridge et al. (2012) USA [42]	Analytical Cross-Sectional	To assess whether occupationally active breast cancer survivors with a history of endocrine therapy differ from occupationally active breast cancer survivors with no history of endocrine therapy exposure on measures of perceived and performance-based cognitive function.	Setting: Community outpatient and wellness clinics. Tools: Hospital Anxiety and Depression Scale (HADS); Multidimensional Fatigue Symptom Inventory – Short Form (MFSI – SF); Visual Analogue Scale of Pain (VASP); Functional Assessment of Cancer Therapy Cognitive Scale Version Two (FACT Cog); Cognitive Symptom Checklist – Work 59 (CSC-W59); CNS Vital Signs (CHSVS)	$N = 133$ Mean Age = 45 years 3 years post-treatment	• n = 77 breast cancer survivors used endocrine therapy (Tamoxifen or aromatase inhibitor), n = 56 breast cancer survivors had no endocrine therapy. • Endocrine therapy was not related to objective neuropsychological test outcomes. • Endocrine therapy was moderately related to perceived attentional problems at work and perceived cognitive function in overall life above what could be explained by symptom burden measures.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 81%
Brick et al. (2019) USA [39]	Secondary analysis of longitudinal cohort	Examine the magnitude of work-related disability and the demographics and clinical correlates in post-menopausal women with breast cancer compared with healthy controls.	Setting: Community Tools: Work Limitations Questionnaire (WLQ); Beck Depression Inventory II; Profile of Mood States2: Tension/ Anxiety Subscale; Patient Assessment of Own Functioning Inventory (physical and cognitive functioning); Epworth Sleepiness Scale)	$N = 45$ $n = 24$ BC Mean age BC = 61.1 years Initial and 6 months post-diagnosis	• Breast cancer group had a significantly higher work-related disability at baseline and 6 months compared to the healthy group. • Breast cancer group also had a significantly higher work-related disability at baseline compared to 6 months. • At baseline, work-related disability for the breast cancer group was strongly associated with emotional-based symptoms and cognitive challenges ($p = 0.011$). At 6 months, work-related disability was strongly related to physical limitation (hand use) ($p = 0.031$) and sensory/ perceptual impairments ($p = 0.001$).	JBI Critical Appraisal Checklist for Cohort Studies 73%
Calvio et al. (2010) USA [7]	Analytical Cross-Sectional (with comparison group)	To investigate the relationship between perceived cognitive function at work and performance-based neuropsychological measures and work output in occupationally active breast cancer survivors.	Setting: Non-clinical Tools: Hospital Anxiety and Depression Scale, Multidimensional Fatigue Symptom Inventory – Short Form Physical Fatigue, VAS of Fatigue at Work, Job Stress (Behavioural Risk Factor Survey), Cognitive Symptom Checklist – Work 59 (CSC-W59) (3 sub-areas), Central Nervous System Vital Signs, Work Limitations Questionnaire (WLQ	$N = 235$ $n = 122$ BC Mean Age = 45 years 3 years post-treatment	• Women with breast cancer reporting higher levels of cognitive limitation, anxiety, and depression compared with the healthy control group. • In the healthy group, neuropsychological testing was related to work output (self-reported), however, in the breast cancer group, self-reported cognitive function was more closely related to work output (self-reported).	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 93%
Cheng et al. (2018) China [40]	Analytical Cross-Sectional (with comparison group)	To determine whether work output was related to cognitive limitations while at work in occupationally active breast cancer survivors	Behavioral Risk Factor Surveillance System, Hospital Anxiety and Depression Scale (HADS), European Organization for Research and Treatment of Cancer's (EORTC) Quality of Life Questionnaire (QLQ-	$N = 534$ $n = 267$ BC Mean Age = not provided (age categorized) Average 3.2 years post- treatment	• The BC group reported higher levels of fatigue, general distress, and lower levels of work output ($p < 0.05$). • Cognitive symptoms at work were related to lower levels of quantity, quality, and timeliness of completed work in BC group.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 88%

(continued)

Table 1. Continued.

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
		employed in a rapidly evolving economy.	30) Cognitive Symptom Checklist-W21 (CSC-21 Chinese version), Work Limitations Questionnaire (WLQ)			
Cheng et al. (2016) Hong Kong [36]	Analytical Cross-Sectional (with comparison group)	To explore the symptom burden (cognitive limitation and psychological distress) of employed breast cancer survivors in Hong Kong and if these factors are related to work productivity and quality of life.	Setting: Outpatient clinic Tools: Hospital Anxiety and Depression Scale, Cognitive Symptom Checklist – Work 21 (CSC-W21), Work Limitation Questionnaire, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire	$N = 90$ $n = 30$ BC Mean Age = not provided (categorized) Average 2.87 years post-diagnosis	• The self-perceived cognitive limitation at work was significantly higher ($p < 0.05$) in the breast cancer group than in the healthy control group. • No differences in anxiety and depression between groups, so cognitive limitations not associated with psychological symptoms. • No relationship between cognitive limitation and lost productivity, which is different from other studies.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 100%
Cheng et al. (2015) China [53]	Psychometric testing of the assessment tool	To translate the Cognitive Symptom Checklist – Work 21, into Chinese and culturally adapt and validate the Chinese version, a measure of work-related cognitive limitations in occupationally active breast cancer survivors.	Setting: Community Tools: Cognitive Symptom Checklist – Work 21 (CSC-W21).	$N = 22$ Mean Age = not provided (age categorized) Average 33.87 months post-diagnosis	• CSC – W21 was translated into Chinese and culturally adapted. Internal consistency of factors, item – and scale – level content validity, and test-retest reliability established. • Construct validity was determined through convergent validity and relationship with subscales of the Work Limitations Questionnaire (WLQ). • The CSC-W21-C has sound measurement properties so that it can be used to identify cognitive limitations related to specific work tasks in breast cancer survivors.	Nil appropriate quality assessment tools available for this research design
Hansen et al. (2008) USA [35]	Analytical Cross-Sectional (with comparison group)	Examine the individual contribution of symptom burden (physical fatigue, depression, anxiety and cognitive limitations) were differentially associated with work limitations in breast cancer survivors.	Setting; Web-based Tools: Web-based Questionnaires: Behavioural Risk Factor survey, Multidimensional Fatigue, Symptom Inventory – Short Form, Hospital Anxiety and Depression Scale (HADS), Cognitive Symptom Checklist - Work (CSC-W59), Work Limitations Questionnaire	$N = 203$ $n = 100$ BC Mean Age = 49.5 years 3.8 years post-diagnosis	• 3.8 years post-diagnosis, fatigue was more strongly related to work limitations in the breast cancer group than cognition. • Women with breast cancer reported higher levels of self-reported cognitive limitations than healthy age-matched women ($p = 0.001$). • Women with breast cancer reported higher levels of age-adjusted work limitations ($p < 0.001$).	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 93%
Hedayati et al. (2012) Sweden [54]	Secondary analysis of a longitudinal study	To identify the associations between cognitive, psychosocial, somatic and treatment factors with RTW among women treated for breast cancer.	Cognitive Stability Index (CSI) European Organization for Research and Treatment of Cancer's (EORTC) Quality of Life Questionnaire (QLQ-30) and Breast Cancer Module	$N = 44$ Mean age of RTW group = 54 years of Average age of no RTW group = 53 years old. 8 months and 11 months post-diagnosis.	• At 8 months after diagnosis (baseline) 64% had return to work. • At 11 months 37% no working and had more advanced breast cancer (OR = 3.64, 95%CI 2.01-7.31), lymph-node involvement (OR = 18.80, 95% CI 5.32-90.69), and HER2+ (OR = 10.42, 95% CI 2.19-65.32) than did working women. • Most women had returned to work by 18 months. • There was no significant change in cognitive function scores between 8 and 11 months and cognitive function was not related to return to work.,	Nil appropriate quality assessment tools available for this research design
Miura et al. (2016) Japan [50]	Analytical Cross-Sectional	To evaluate the level of cognitive fatigue in ambulatory breast cancer patients and investigate the associations between cognitive fatigue, QOL and physical/psychosocial factors.	Setting: Hospital Outpatients Tools: Cancer Fatigue Scale, Functional Assessment of Cancer Therapy – Breast (FACT-B), Simplified Menopausal Index (SMI) Self-Rating Questionnaire for Depression	$N = 93$ Mean Age = 53 years 4 years post-diagnosis	• Low (L-Cog-F) and high cognitive (H-CogF) groups established based on the score on the fatigue subscale of the Cancer Fatigue Scale. • Breast cancer patients with high cognitive fatigue suffer from severe menopause and depressive symptoms, and deteriorating QOL.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 71%

(continued)

Table 1. Continued.

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
					• Patients with high cognitive fatigue were concerned about keeping their jobs.	
Moskowitz, et al. (2013) USA [49]	Analytical Cross-Sectional (with comparison group)	Whether employed breast cancer survivors in the years after treatment for breast cancer and a non-cancer comparison group experience clustering of symptoms; Whether cluster assignment differs between breast cancer survivors and working women without breast cancer; Whether work-related and health-protective factors are associated with such clusters.	Setting: Community (online) Tools: Web-based questionnaires, Multidimensional Fatigue, Symptom Inventory – Short Form, Hospital Anxiety and Depression Scale (HADS), Cognitive Symptom Checklist - Work (CSC-W59), Job-related questions, Behavioural Risk Factor survey,	$N = 194$ $n = 94$ BC Mean age = 49.5 years Average 2 years post-diagnosis	• High level of symptom burden [OR = 2.46; 1.22-4.93] through elevated levels of cognitive limitations, fatigue and distress 12 months after diagnosis in employed breast cancer survivors, compared to those with no breast cancer diagnosis. • Fatigue, anxiety, depression, and cognitive limitations combine to form a cluster of 'high' symptoms in employed women with breast cancer 2 years after diagnosis. • Job stress and work limitations was related in both non-cancer and breast cancer groups, but the breast cancer group had a steeper decline in work output, associated with increased job stress and fatigue.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 86%
Oberst et al. (2010) USA [48]	Descriptive Cross Sectional	To describe work-related physical and cognitive disability estimates 12 and 18 months after diagnosis and treatment in a sample of the employed breast can prostate cancer patients.	Setting: Community Tools: Interviews / Questionnaires	$N = 704$ $n = 447$ BC Mean age = 50 years 12- and 18-months post-diagnosis	• Cognitive disability was reported by 34 % of women at 12 months and 22% after 18 months of diagnosis/treatment. • Although physical disability was more problematic regarding work tasks, a significantly higher proportion of women with a cognitive disability (14% v 4.2%) left the workforce, compared with women with breast cancer without a cognitive disability.	Nil appropriate quality assessment tools available for this research design
Ottati et al. (2013) USA [52]	Assessment tool development	To develop a brief, reliable self-report measure of work-related cognitive limitations in occupationally active breast cancer survivors.	Setting: A pooled dataset from previously collected data. Tools: Cognitive Symptom Checklist – Work 59 (CSC-W59); Functional Assessment of Cancer Therapy – Cognition Version 2 (FACT-Cog).	$N = 228$ $n = 114$ BC Average age = 46.55 years 1-10 years post-diagnosis	• A brief self-report measure was developed (Cognitive Symptom Checklist – Work 21 (CSC-W21) and found to be internally reliable and have construct validity. It can be used for quickly assessing work-related cognitive problems for breast cancer survivors at work. It helps identify tasks that present as problems for breast cancer survivors at work.	Nil appropriate quality assessment tools available for this research design
Porro et al. (2019) France [46]	Longitudinal Prospective	To evaluate the quality of life, multidimensional cancer-related fatigue and changes in these variables as determinants of RTW during breast cancer treatment.	Setting: Community Tools: European Organization for Research and Treatment of Cancer's (EORTC) Quality of Life Questionnaire (QLQ-30) Multidimensional Fatigue Inventory (MFI-20).	$N = 68$ Mean age = 46.97 years Start of adjuvant treatment	• Women were assessed at the start of adjuvant treatment (baseline), 3 months and 6 months. • At 3 months, 50% had RTW, at 6 months 60.7% had RTW. • At 6 months, the likelihood of having RTW was increased by having higher scores for cognitive functioning OR = 1.10 [1.03-1.17] and lower mental fatigue OR = 0.29 [0.11-0.81].	Nil appropriate quality assessment tools available for this research design
Schmidt et al. (2019) Germany [47]	Secondary analysis of a longitudinal study	To provide data on the current RTW situation of disease breast cancer survivors up to 5 years after a cancer diagnosis in Germy. To investigate the association of treatment-related side effects with the long-term working status after breast cancer. To explore the relationship of RTW with QoL aspects.	Setting: Community Tools: European Organization for Research and Treatment of Cancer's (EORTC) Quality of Life Questionnaire (QLQ-30) and the QLQ-BR-23. Questionnaire; Fatigue Assessment Questionnaire; Centre for Epidemiological Studies Depression Scale.	$N = 135$ Mean age = 50.5 years (at time of surgery) 1 year and 5 years post-surgery	• One year after surgery 56% had RTW same hours, 22% were working reduced hours, 22% had not RTW or ceased, mainly due to joint occurrence of fatigue and cognitive problems, such as memory and attention. • 5 years after surgery, women who had not RTW generally had worse QoL functions and symptoms compared to those who were at work. The working group had significantly better scores on cognitive function OR = 18 [0-37].	Nil appropriate quality assessment tools available for this research design
Todd et al. (2011) USA [41]	Analytical Cross-Sectional (with comparison group)	To determine whether fatigue and depressive symptoms, which can co-occur with one	Setting: Community Tools: Hospital Anxiety and Depression Scale (HADS), Rotterdam Symptom	$N = 255$ $n = 133$ BC	• 3 years post-treatment employed breast cancer survivors reported higher levels of fatigue ($p = 0.001$), depression ($p = 0.001$)	JBI Critical Appraisal Checklist for Analytical

(continued)

Table 1. Continued.

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
		another, are independently and/or interactively related to cognitive limitations at work.	Checklist (RSCL), Cognitive Symptom Checklist – Work 59 (CSC-W59)	Mean Age BC = 45 years 3 years post-treatment	and cognitive limitations ($p = 0.001$) compared to those without breast cancer.	Cross-Sectional Studies 93%
Wefel et al. (2004) USA [5]	Prospective, Randomized longitudinal trial	To determine to what extent cognitive dysfunction is attributable to chemotherapy in patients with breast carcinoma.	Setting: Outpatients Tools: WAIS-R, Trail Making Test, VSRT, NVSRT, COWAT, Grooved Pegboard, MMPI (Depression, Anxiety), FACT-Breast Module (includes questions about work)	$N = 18$ Mean age = 45.4 years Before the start of chemotherapy (baseline), 3 weeks post-chemotherapy, 6 months post-baseline, 1year post-chemotherapy and 18 months post-baseline	• Neuropsychological testing is done before the start of chemotherapy (baseline), 3 weeks post-chemotherapy, 6 months post-baseline, 1year post-chemotherapy and 18 months post-baseline. • Impaired cognitive function was found in 33% of women before chemotherapy • 61% of women had a decline in cognitive function 3 months after the first round of chemotherapy. The most affected domains were attention, learning and processing speed • Declines were quite subtle and associated with a performance that fell within the average range compared to healthy control individuals. • Declines correlated with functional decline, including a decreased ability to work. • 12 months after chemotherapy, 50% who had cognitive impairment improved, whereas 50% did not.	Nil appropriate quality assessment tools available for this research design
Von Ah et al. (2018) USA [38]	Analytical Cross-sectional	Examine the relationship between perceived cognitive function including perceived cognitive impairment and perceived cognitive ability and workability, work performance, work productivity and intention to leave employment in cancer survivors.	Setting: Community Tools: Work Limitation Questionnaire (WLQ); Functional Assessment of Cancer Therapy – Cognition Version 3 (FACT-Cog); Self-Focused Emotional Labor Scale; Work Ability Index (WAI)	$N = 68$ Mean age = 52 years old Average of 3.8 years post-treatment	• Employed breast cancer survivors with negative perceptions of cognitive function reported poorer workability, work performance and work productivity. Whereas a positive view of cognitive abilities was related to improved ratings of work outcomes.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 79%
Von Ah et al. (2017) USA [43]	Analytical Cross Sectional	Examine the relationship between attentional fatigue and perceived work ability in breast cancer survivors, controlling for known covariates.	Attentional Function Index; Work ability Index	$N = 68$ Mean Age = 52.1 years old Average 4.97 years post-treatment	• 26.5% of the breast cancer patients reported poor to moderate perceived work ability. • Attentional fatigue was significant ($P < 0.001$) for predicting self-reported work ability, explaining 40% of the variance of work ability. • Age, education, household income and time post treatment were not found to have a significant relationship with perceived work ability in this study.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 81%
Zeng et al. (2016) China [37]	Analytical Cross-sectional (with comparison group)	To determine whether levels of distress (anxiety and depression) and cognitive symptoms at work are related to work productivity and quality of life in breast cancer survivors compared with women without cancer, but with musculoskeletal injuries.	Setting: Community outpatient Tools: Hospital Anxiety and Depression Scales (HADS), Cognitive Symptom Checklist – Work 21 (CSC – W21); Work Limitation Questionnaire (WLQ)	$N = 412$ $n = 159$ BC Mean age not provided Average 3.81 years post-diagnosis	• Employed breast cancer survivors had finished treatment at least 2 years ago. • The comparison group had musculoskeletal injuries. • The breast cancer group reported higher levels of cognitive limitations and anxiety at work, and lower levels of work productivity and QOL than the musculoskeletal group. • Cognitive limitations at work were associated with work limitations.	JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies 79%

Table 2. Qualitative studies included in scoping review ($n = 11$).

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
Becker et al. (2015) USA [26]	Qualitative	To explore survivors' perceptions of their cognitive functioning.	Setting: Community oncology setting Tools: Interviews Focus Groups	$N = 10$ Mean age = 55 years Average 4.6 years post-diagnosis	• Six themes identified: cognitive problems, effects on employment, emotional response to having cognitive dysfunction, search for answers to why cognitive changes, used coping mechanisms, the provider's role (lack of information). • Nine out of ten working full time before diagnosis. At the time of research three were full time, one part-time. Others had left the workplace due to the inability to function at pre-illness level or meet demands of work.	JBI Critical Appraisal Checklist for Qualitative Research 60%
Boykoff et al. (2009) USA [3]	Qualitative	To explore in-depth the effects that cognitive impairment has on women's personal and professional lives.	Setting: Community based centres Tools: In-depth interviews and focus groups	$N = 74$ Mean Age = not provided 1 year post-treatment	• Women in the study reported the following: • Chemo brain is 'frustrating' and 'upsetting', resulting in reduced independence. • Lack of acknowledgement from medical community. • Chemo brain affected job performance, quit job and take less demanding job that pays less, so retired early. • Coping strategies included: using a journal, using calendars, post it notes, keeping mind active by doing problems, crosswords and puzzles, curtailing work and social activities, taking lower paid and less demanding jobs,	JBI Critical Appraisal Checklist for Qualitative Research 80%
Kanaskie et al. (2015) USA [27]	Qualitative	To uncover the meaning of cognitive change in women with breast cancer, how symptoms are experienced and become evident, how symptoms impact roles in personal and professional lives and how women cope with these changes.	Setting: Outpatient cancer support groups Tools: Interviews and journals	$N = 7$ Median Age = 52 years old 1 year post-treatment	• Five themes were identified: noticing the difference, experiencing cognitive changes, interacting socially, coping and looking forward. • Cognitive changes have an impact on employment, which then influence financial and social wellbeing.	JBI Critical Appraisal Checklist for Qualitative Research90%
Lewis et al. (2016) Australia [28]	Qualitative	To identify difficulties in work-related cognitive strategy use experienced by women with breast cancer, using the Perceive, Recall, Plan and Perform System of Task Analysis.	Setting: Community Tools: Interviews, Perceive, Recall, Plan and Perform System of Task Analysis	$N = 10$ Mean Age = 50 years old Up to 2 years post-treatment	• Perceive Recall Plan and Perform (PRPP) System of Task Analysis was able to identify problems areas in cognitive strategies that may be vulnerable in breast cancer survivors: 'programming', continuing' and 'attending'. • Difficulty with flexible thinking strategies to enable rapid change in response to changing context. • These cognitive limitations had an impact on quality and quantity of work performance. • Cognitive changes like a 'hidden disability, were experienced by the individual but difficult to explain and observable to others by slow performance.	JBI Critical Appraisal Checklist for Qualitative Research 75%
Luo et al. (2019) China [29]	Qualitative	To determine whether breast cancer survivors at work following the diagnosis and/or treatment of breast cancer, in a rapidly developing country such as China experience similar return to work challenges as reported in nations with established RTW policy and procedures with employees with cancer.	Setting: Community Tools: Semi-structured interviews	$N = 16$ Average age of 42.8years old Average time since diagnosis not provided. Average 18 months been at work	• Interpretative phenomenological analysis used to investigate responses. • The 3 main themes were: • Experiencing work-related challenges: Physical limitations (fatigue, lack of stamina, menopause symptoms and upper limb discomfort) and cognitive limitations (reduced memory, slow reactions, difficulty concentrating, cognitive errors) • Responses from employers/supervisors: Positive support or negative reactions (including an abrupt return to pre-cancer expectations, which some women found difficult with invisible symptoms such as fatigue, cognitive problems). • Responses from co-workers: Positive support or negative reactions	JBI Critical Appraisal Checklist for Qualitative Research 85%

(continued)

Table 2. Continued.

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
Munir et al. (2010) United Kingdom [13]	Qualitative	To investigate awareness of cognitive changes following chemotherapy treatment; Explore perceptions of cognitive ability and subsequent confidence in carrying out daily tasks; Identify the impact of perceptions inability to return to work decisions and workability.	Setting: Community Tools: Focus groups	$N = 13$ Mean age = 48.8 years Approximately 5 years post-diagnosis	• Of the 13 women, two had reduced their hours of work and four took early retirement or left work because of cognitive problems. • Women became aware of cognitive changes during and following chemotherapy. • Poor concentration, confusion, lack of clear thinking, unable to contrite and divide attention affected ability to communicate with others. Reduced ability to deal with everyday problems that arose. • Cognitive changes negatively affected their self-confidence and cognitive ability, irrespective of manual or non-manual job. Worried about appearing slow or incapable or not meeting the employer's expectations. • Having a supportive employer made the RTW process less stressful.	JBI Critical Appraisal Checklist for Qualitative Research 75%
Munir et al. (2011) United Kingdom [32]	Qualitative	Explore what health care information and support are available to help women understand the effects of chemotherapy on daily functioning at home and work.	Setting: Outpatient clinic Tools: Interviews; Cognitive Failures Questionnaire, Beck Depression Inventory, Fatigue Severity Scale.	$n = 31$ BC, $n = 5$ HP Average age = 47 years old 4 months post-treatment	• Problem with remembering tasks at work most reported problem. • Patients request more information on cognitive changes and various interventions to assist. • Interventions are suggested: cognitive activity (crossword/puzzle); information for family, friends and colleagues and employer; compensatory techniques; HPS recommends that work itself could be an intervention.	JBI Critical Appraisal Checklist for Qualitative Research 75%
Player et al. (2014) Australia [30]	Qualitative	To describe changes in cognitive function experienced by women who had undergone chemotherapy and the strategies used to overcome the associated challenges.	Setting: Community Tools: Interviews	$N = 9$ Mean Age = 50 years old Up to 2 years post-treatment	• Themes identified: uncertainty about chemo brain, symptoms are persistent but inconsistent and impact on work performance of tasks; things that were previously simple now complex – like driving, high levels of fatigue from extensive concentration and thinking required to do everyday simple tasks, but economic imperative to RTW, and increased time spent on work tasks impacts on family life. Self-generated strategies including taking notes, reminders, diaries, structuring day, seeking emotional support from others, exercising relaxation, rely on others for help, avoid stressful situations, leisure pursuit, puzzles. • Employer views them as 'fully recovered' – they don't feel this way.	JBI Critical Appraisal Checklist for Qualitative Research 85%
Sandberg et al. (2014) USA [56]	Qualitative	To delineate the broad range of adjustments women breast cancer survivors, draw upon to minimize cancer-related limitations in the workplace.	Setting: Community Tools: Interviews	$N = 14$ Age between 45 and 55 years old. 6-24 months post-diagnosis	• Discusses a range of formal and informal strategies to help manage work performance. • Strategies to address cognitive problems at work include receiving cognitive prompts from others or providing cognitive prompts to self.	JBI Critical Appraisal Checklist for Qualitative Research 70%
Von Ah et al. (2013) USA [31]	Qualitative	To obtain a better understanding of breast cancer survivors perceived cognitive impairment its trajectory and its impact on relationships, daily function and work ability.	Setting: Community Tools: Interview	$N = 22$ Mean Age = 56 years old 5.6 years post-treatment	• Six main themes emerged: specific type of cognitive changes (eg, memory, attention and concentration), trajectory of cognitive changes (most noticeable after adjuvant treatment ended), cognitive changes impacted on self-perception and relationships, impacted on daily functioning and work and needed to develop strategies to cope, impact on quality of life and varying response from health care providers to support cognitive changes.	JBI Critical Appraisal Checklist for Qualitative Research 80%

(continued)

Table 2. Continued.

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
Zomkowski et al. (2019) Brazil [45]	Qualitative	To assess the barriers and facilitators experienced and the coping strategies adopted by Brazilian women 30 days after return to work following breast cancer treatment.	Setting: Community Tools: Interviews	$N = 12$ Age between 44 and 63 years old. 18 months post-surgery	• Women took 583 days to RTW. Main themes were: • Barriers to return to work included physical symptoms such as fatigue and arm pain impacting work performance as well as discrimination from employer. • Facilitators to RTW included social and emotional support from employer and others, as well as the cognitive demands of a job. • Coping strategies included job role adjustments and reducing work tasks, work hours and working from home.	JBI Critical Appraisal Checklist for Qualitative Research 50%

perceived themselves to be in a cognitively demanding job before breast cancer reported increased problems at work 9 months after treatment ($p < 0.05$) [44]. Cheng et al. (2016) was the only study that found that there was no relationship between cognitive limitation and lost productivity in women with breast cancer, despite self-perceived cognitive limitations at work being significantly higher ($p < 0.05$) than the healthy control group [36].

Impact of cognitive changes on work participation. Six qualitative studies [3,13,26–28,45] reported on how reduced cognitive performance impacted women's ability to participate in the workforce after breast cancer. Inability to meet the cognitive demands of work tasks led women to resign or take early retirement [3,26,28,31]. In two studies, women reported making changes to their employment status to match their cognitive abilities despite being financially or personally undesirable, resulting in reduced salary and income [3,27]. Women linked their inability to maintain the quality and quantity of pre-cancer work performance with reduced opportunities for promotion and advancement [3]. Contrary to this, Zomkowski *et al.* (2019) found that non-manual work with higher mental demands was a facilitator of return to work, as opposed to physically demanding work [45].

Cognitive difficulties may also affect work performance for an extended period after being diagnosed with breast cancer. Porro et al. (2019) found that at 6 months post-diagnosis, the likelihood of having returned to work was increased by having higher scores for cognitive functioning OR = 1.10 [1.03-1.17] [46]. The study by Schmidt et al. (2019) found that one year after breast cancer surgery, 22% of women had not returned to work due to joint occurrence of fatigue and cognitive problems [47]. Further, five years after a breast cancer diagnosis, women who had returned to work had significantly better scores on cognitive function OR = 18 [0–37] compared to those who had not returned to work [47]. Supporting this, Obserst et al. (2010) ($n = 447$) found that a significantly higher number of women left the workforce after breast cancer due to cognitive difficulties (14%), compared with physical difficulties (4.2%) [48].

The experience of cognitive changes, fatigue and work. Four qualitative studies [3,28,30,32] reported on women with breast cancer attempting to describe the cognitive fatigue they were experiencing at work, which was different to physical fatigue and how this impacted work performance. In the Boykoff et al. (2009) study, a participant states, 'So I leave at the end of the day, I am spent, when before I was energetic. And it's not a physical spent, it is a mental spent that I didn't have before' (p 229). In Player *et al.* (2014), participants indicated that cognitive fatigue was due to a high level of focused concentration with work tasks, together with organising and attending medical appointments. Lewis et al. (2016) used the Perceive, Recall, Plan and Performance System of Task Analysis to explain the difficulty women with breast cancer had with 'continuing' tasks due to cognitive fatigue. Women in this study reported the cognitive fatigue coming from having to think harder or longer about work tasks, with one woman stating 'she would last about half an hour (at work) then fall off the mental perch' and then 'fatigue from having to think about everything and then takes one or two days to recover' (p.329). In the Boykoff et al. (2008) study, a participant reported that 'every two hours I was going somewhere to sit down and relax because I could not think well' (p.229).

There were seven quantitative based studies [35,41,42,46,47,49,50] that examined the relationship between cognitive impairments and fatigue and the impact on work

Table 3. Other studies (mixed methods, case study reports) included in scoping review ($n = 3$).

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
Newman (2013) USA [55]	Case Study	To highlight the unique role that occupational therapy played in assisting a breast cancer survivor with chemotherapy related cognitive dysfunction explore her narrative and sense of self 2 years post treatment.	Setting: outpatient / community clinic Tools Intervention 'Take Action' program	$N = 1$ Age = 56 years 2 years post treatment	• Occupational therapy intervention in clinic focusses on improving daily cognitive (work) performance. • 6x group sessions: 1) Assessment and goal setting 2) client centred symptom 3) intervention: self-care 4) intervention: work 5) intervention: social and leisure 6) future planning and discharge methods • Instruction on problem solving.	JBI Checklist for Case Reports 63%
Ryan et al. (2011) USA [33]	Case Studies	To describe a tailored occupational therapy program to rehabilitate chemotherapy-related side effects.	Setting: Community, out patient Tools: Montreal Cognitive Assessment (MOCA); 21 neuropsychological tests.	$N = 2$ Average age = 30 years 1-2 months post-treatment	• Occupational therapy program occurred in outpatient clinical not workplace, with two women having difficulty working in a fast-paced multiskilling work environment. • Difficult to determine effectiveness of intervention due to small sample size and poor patient attendance and engagement. • Intervention was based on a range of compensatory techniques addressing memory, organizational strategies, functional organization, relaxation / visualization techniques, remediation of divided attention and set-shifting. Taking notes during meetings, using post it notes, marking highlighting items that needed attention. Better utilizing PowerPoint and excel to synthesize and communicate information at work, computer based games used to help shift attention, rehearsing presentations, developing and practicing compensatory strategies to	JBI Checklist for Case Reports 94%

(continued)

Table 3. Continued.

Author, year, country	Study Design	Study Aim	Setting / Tools	Participants	Major Findings from Results	Quality Assessment
Schmalenberger et al. (2012) Germany [34]	Mixed Methods	To determine the extent to which breast cancer and its treatments affect the physical, mental and emotional conditions conducive to maintaining a musical career.	Setting: Community Tools: Web-based surveys and interviews	$N = 90$ Average age = 53 years old 1-5 years post-treatment	synthesize and present information, • 53% reported cognitive symptoms and more than half of these reported it to be ongoing and moderate to extreme in intensity. Women reported forgetting words to songs, concentrating through long pieces of music, difficulty sight reading.	McGill Mixed Methods Appraisal Tool 81%

performance. Porro et al. (2019) found that the greater the increase in mental fatigue during treatment, the less likely the patient was to have returned to work 6 months after the start of chemotherapy [OR = 0.29; 0.11-0.81]. Moskowitz et al. (2013) reported 24 months (median) post-diagnosis employed breast cancer survivors had higher levels [OR = 2.46; 1.22-4.93] of symptom burden (cognitive, limitations, fatigue and distress) than those without breast cancer [49]. Miura et al. (2016) used the subscale of the Cancer Fatigue Scale (developed in Japan by Okuyama et al. 2000) to examine cognitive fatigue [50,51]. Based on the scores, they divided a cohort into low cognitive fatigue and high cognitive fatigue groups. They found that breast cancer patients with high cognitive fatigue also had higher levels of depression and lower Quality of Life scores. Todd et al. (2011) found that three years post-treatment, breast cancer survivors reported higher levels of fatigue ($p = 0.001$), cognitive limitations ($p = 0.001$) and depression ($p = 0.001$) than those without cancer [41]. Schmidt et al. (2019) found that one year after breast cancer surgery 22% had not returned to work, with the main reason being the joint occurrence of cognitive complaints and fatigue [47]. Contrary to this, the study by Hansen et al. (2008) found that four years post-diagnosis, although women with breast cancer were more likely to report cognitive limitations compared to healthy age-matched women, it was fatigue rather than the cognitive difficulties that were more strongly related to work limitations.

Measurement of cognitive changes and impact on work

Self-report measures and neuropsychological cognitive assessments are used to assess changes in cognition after breast cancer to determine the impact on work.

Self-Report measures. All 20 studies that used a quantitative-based methodology used self-report assessments to identify or measure changes in cognition that were impacting work performance. The Functional Assessment of Cancer Therapy – Cognitive (FACT-Cog) was used by three quantitative based studies in this scoping review [38,42,52]. The FACT-Cog is a self-reported questionnaire evaluating global cognitive problems at work and in everyday life. Von Ah et al. (2018) used the FACT-Cog to demonstrate that employed breast cancer survivors, 5 years post-treatment with negative perceptions of cognitive function was significantly related to reported poorer workability, work performance and work productivity. Whereas a positive view of cognitive abilities was significantly related to improved ratings of work outcomes [38].

The Cognitive Symptom Checklist – Work (CSC-W) was used in ten quantitative based studies in this scoping review. Ottati and Feuerstein (2013) reduced the CSC-W59 to 21 items (CSC-W21) and consider the tool to have adequate internal reliability and construct validity to quickly assess work-related cognitive problems for breast cancer survivors at work [52]. The study by Cheng et al. (2015) translated and culturally adapted the CSC-W21 for a Chinese population and reported on psychometric testing to validate the assessment tool [53]. Six studies used the CSC-W59 [7,35,41,42,49,52]. Using the CSC-W59 with employed breast cancer survivors and a non-cancer comparative group, Todd et al. (2011) found that three years post-treatment, women with breast cancer reported significantly higher levels of cognitive limitations ($p = 0.001$) compared to those without breast cancer [41]. Four studies used the CSC-W21 [36,37,40,53] for women to self-report cognitive symptoms related to work tasks. Using the CSC-W21 with employed breast cancer

survivors and a comparative group with musculoskeletal disorders, Zeng et al. (2016) found that approximately four years post-diagnosis, cognitive limitations at work were significantly associated with work productivity loss in the breast cancer group but not the comparative group. In this study, women in the breast cancer group were in mostly 'white collar' occupations, compared to the musculoskeletal injury group, who were in predominately 'blue collar' occupations [37]. The CSC-W21 (Chinese version) was used in Cheng et al. (2018), which had similar findings of women approximately three years post treatment self-reporting cognitive limitations that were reducing work output, but not in the healthy control group [40].

Neuropsychological testing. Five quantitative based studies used formal neuropsychological testing in addition to self-report measures. Two quantitative based studies that utilised the same population of breast cancer patients [7,42] used the Central Nervous System Vital Signs (CNSVS), a battery of computerised neuropsychological tests, to formally measure cognitive impairment. Calvio et al. (2010) found that in a healthy comparison group, neuropsychological testing was related to self-reported work output, however, in the breast cancer group, self-reported cognitive function was more closely related to self-related work output. Hedayati et al. (2013), using the Headminder computerized neurocognitive tool to obtain a Cognitive Stability Index (CSI) found that objective measures of cognitive function (memory, attention, response speed and processing speed) were not related to return to work [54].

Wefel et al. (2004) used a range of standardised neuropsychological tests including the Wechsler Adult Intelligence Scale-Revised (WAIS-R), Trail Making Test (TMT), Verbal Selective Reminding Test (VSRT), Non-Verbal Select Reminding Test (NVSRT), Controlled Oral Word Association (COWAT), Grooved Pegboard and Minnesota Multiphasic Personality Inventory (MMPI) before any breast cancer treatment had commenced and again three weeks, six months, 12 months, and 18 months [5]. Wefel et al. (2004) found that 33% of women with breast cancer had cognitive impairment before treatment started. Three months after the first round of chemotherapy started, 61% of women had a decline in cognitive function and the most commonly affected domains were attention, learning and processing speed [5]. Declines were quite subtle and associated with a performance that fell within the average range compared to healthy control individuals [5]. Cognitive declines correlated with functional decline (self-reported), including decreased ability to work [5].

A case study report [33] used a range of standardised neuropsychological tests (WAIS-R, Trail Making Test, VSRT, NVSRT, COWAT, Grooved Pegboard, MMPI and Montreal Cognitive Assessment) and self-report measures to provide pre and post-intervention scores for the cognitive function of two women with breast cancer, with the results of this intervention presented below.

Other measures. A qualitative study by Lewis et al. (2016) used the Perceive, Recall, Plan and Perform (PRPP) System of Task Analysis to assesses cognitive strategy problems in women with breast cancer, conducted *via* therapist interview and/or observation [28]. This criterion-referenced assessment uses task analysis methods to identify problems with cognitive information processing. Lewis et al. (2016) identified women with breast cancer have difficulties with cognitive strategies of attention, programming and continuing or persisting with work-related tasks [28].

Interventions Addressing cognitive difficulties at work

Several qualitative studies in this scoping review discussed formal cognitive interventions and informal strategies to assist in managing cognitive difficulties at work. There were no studies that provided workplace-based interventions with allied health professionals.

Formal interventions. Two case report studies involved formal occupational therapy treatment in a clinic scenario [33,55]. The formal occupational therapy interventions were both provided in an outpatient clinic environment but had different approaches to helping women with breast cancer address cognitive difficulties at work. Ryan et al. (2011) provided a case study report on individual treatment sessions (one hour per week, four to eight-week duration) with two young breast cancer survivors who reported difficulty managing their high cognitive level functioning jobs, which required multiple cognitive skills at a high pace [33]. Treatment was aimed at ameliorating attention and executive functioning deficits, and to return to work or improve performance. The following strategies were used: education in a "5 step process" to guide thinking, imagery/visualization, external cues and self-check education, as well as better use of basic computer-based packages, and computer-based games to apply in the work environment when performing work tasks. Ryan et al. (2011) reported that patients showed some resistance to the compensatory cognitive strategies. Although there were some improvements in one participant, the authors stated outcomes were impacted by poor treatment adherence, presumably because it occurred external to the workplace, but not during work hours [33]. Newman (2013) described the outcome of a single participant from a five-week group occupational therapy intervention program called 'Take Action'. This intervention was designed for breast cancer survivors who reported cognitive difficulties. This program also used a compensatory approach by training participants in problem-solving and action planning strategies to manage cognitive difficulties impacting work performance and was successful in helping this patient redefine her occupational role [55].

Informal strategies. Nine studies discussed a range of informal workplace-based coping strategies [3,13,26,27,30–32,45,56] that aimed to provide women with strategies to use in the workplace. Informal strategies used by, or suggested by women included: Modifying work schedules e.g. reduce work hours [45,56]; Reduce overall workload [56]; Receive assistance from others [13,56]; Change/modify work environment e.g.; work at home [45,56]; Use technology e.g. calendar and checklists on a computer or other apps on phone as reminders and bring structure [26,27,30,56]; Increase handwritten note-taking, journaling and diary entries [3,26,30]; Receive cognitive prompts from others [56]; Provide cognitive prompts to self [56]; Post-it notes in the environment [3]; Activities external to work including exercise, relaxation and artistic pursuits [30]; Doing puzzles [3,26,30]. Health professionals in the Munir et al. (2011) study indicated that participation in work itself is likely to be a form of cognitive intervention [32].

An intervention suggested in six of the studies [3,13,26,30–32] was increased education and support from health professionals on cognitive changes after chemotherapy and how it may impact return to work. Although this is not a direct intervention related to cognitive difficulties at work, women in these studies believed that if increased recognition and information was provided, they would be more informed about how and why cognitive changes occur after cancer, thereby helping them prepare for work. The need for this intervention was further validated by Munir et al.

(2011) ($n = 33$) where 58% of participants believed more information and help was required to help women manage cognitive changes after breast cancer [32].

Discussion

This scoping review used standard scoping review methods to identify, select and analyse findings from 34 studies to establish what is known about how cognitive changes impact work ability or performance for women with breast cancer, and consider how this relates to practice in Australia, with its unique health and employment system. We documented the international peer-reviewed literature by synthesizing the country of origin, study design, setting, assessment tools, the quality of the study and main results to establish the i) impact of cognitive deficits on work performance and ability ii) forms of measurement and iii) strategies or interventions used to address cognitive deficits impacting on work. The implications of the findings and the gaps that emerged from the results of this review that can be relevant for health professionals and policymakers are now discussed.

A need for comprehensive workplace-based assessments of cognition

This scoping review presented results from quantitative studies, that were supported by reflective qualitative studies to provide evidence that many women with breast cancer have deficits in their cognitive capacity following breast cancer [57] that impact work performance and participation. This evidence has been further validated through functional magnetic radiation imaging studies [8,9]. However, as described in this review, there continues to be a discrepancy between results from neuropsychological testing and self-report measures when determining the impact on work ability and performance. Self-report measures continue to show a relationship between poor work performance and outcomes whereas formal neuropsychological testing does not [5,7,52]. Likely explanations for this are that complex problems with cognitive function in work occupations are not being evaluated in standardized neurophysiological assessments which tend to assess limited components of cognition and these tend to be conducted in clinical settings. As such, a dynamic assessment of the cognitive demands of a women's pre-illness work role is needed followed by an evaluation of the woman's ability to integrate various cognitive domains to construct real-life and real-time cognitive strategies to perform the work tasks [28]. Health professionals must understand the nuances of the work situation that the patient needs to return to, as well as the complexity of the work environment such as those described by Schmalenberger et al. (2012) when describing the specific needs of women musicians with cognitive changes after breast cancer [34]. Ecologically valid assessments can then lead to interventions that target improve task performance at work, rather than only focusing on cognitive deficit symptoms and prescribing general cognitive remedial strategies. This could help reduce workplace problems.

All 20 of the quantitative studies in the scoping review used self-reported measures to evaluate cognitive functioning at work [7,42,52]. Whilst these were able to identify general cognitive difficulties in the workplace, the measures were not job-specific and were self-reported. Funding bodies (e.g. insurance companies) may require more impartial information about a person's cognitive function and cognitive work demands before paying for services. In these circumstances, there is a need to understand the difference between pre-illness cognitive function and how this has changed after an illness. The Kitahata et al. (2017) study used family members to help validate how breast cancer survivors' cognitive function had changed pre and post-diagnosis and treatment [58]. For work performance, an employer representative, such as the woman's manager or supervisor would be best positioned to provide feedback about the pre-and post-cancer cognitive function. None of the scoping review studies sought the employer's perspective on the quality or quantity of the employee's work performance [49]. If women with breast cancer report being performance managed by their employer, then gaining the input of the employer, who will be the ultimate judge of an employee's work performance, needs to be incorporated. A workplace assessment by an occupational therapist could use an ecologically valid cognitive assessment tool, that considers the cognitive demands of the specific work tasks and assess the women's cognitive function in relation to this, also incorporating feedback from the employer.

A need for workplace-based interventions to address cognitive difficulties

A Cochrane Review by de Boer et al. (2015) that states that there is 'moderate-quality evidence' that multidisciplinary interventions involving physical, psychological and vocational components doubled the return to work rates, compared to usual care [59]. Interventions included: education, guidance, advocacy and support to optimize workplace accommodations and job retention. The review stated that there should be an increased focus on return to work within rehabilitation programs and coordination with existing return to work programs and resources [59], but there was no specific focus on cognitive interventions. In this scoping review, several studies briefly described informal intervention strategies to address cognitive difficulties directly at work, but only two studies describe a formal intervention that was targeted at improving cognitive function at work [33,60]. But again, neither of these studies were conducted in the workplace to provide specific occupational based strategies to improve job and task outcomes. Ryan et al. (2011) indicate that there is likely to be a poor transfer of cognitive rehabilitation strategies when the intervention does not take place in the work environment [33]. A stronger ecological approach to intervention should be considered by clinicians and researchers.

Whilst there are growing numbers of studies evaluating web-based cognitive rehabilitation programs [61], even in Australia [62,63], these are not specifically targeted at improving work performance. A protocol for a randomised control trial to evaluate the effect of exercise on cognitive function on work performance has been provided by Witlox et al. (2019), which may provide results that are useful for considering as a more holistic approach to workplace rehabilitation for women with breast cancer [64].

This scoping review also highlighted how other factors may intertwine with cognitive symptoms to have an impact on work ability and participation. Firstly, the lack of recognition of cognitive changes by health professionals could add to emotional distress and contribute further to cognitive impairment [65]. Acknowledgment, support [27] and education [66] regarding cognitive changes have been indicated as an early intervention strategy. Understanding why and how cognitive changes occur can help survivors accept the condition and to move forward in the recovery journey [27]. This understanding may then give women the ability and confidence to explain their cognitive deficits to family, friends, and their employer. Secondly, the intertwined

nature of cognitive difficulties, with fatigue and psychological symptoms post breast cancer can have an impact on work ability. Breckenridge et al. (2012) state that symptoms of depression, anxiety and fatigue should be screened for and treated in breast cancer survivors as an approach to reducing perceived cognitive limitations [42]. A more systematic approach to assessment and appropriate intervention for cognitive changes early in the treatment process may prevent some of the 'flow on' effect to work participation.

A need for continuity of care to address cognitive changes after breast cancer

From the discussion on assessment and intervention, it is evident that there are many gaps in service delivery to address cognitive changes impacting work for women with breast cancer. Most of the research on the impact of cognitive changes on work capacity was conducted in North America and Europe. Although limited, research in Australia is steadily increasing. The models of health care and employment-based rehabilitation services differ between countries, therefore making comparisons difficult. In Australia, health-related services for oncology are provided in a state-funded hospital system, whereas, employment-based rehabilitation services are funded through private insurance schemes or federally funded rehabilitation programs [18]. This makes integration of vocational based services into "usual" or "standard" oncology care [59], a challenging task. In Australia, there needs to be more cohesion across health care and workplace rehabilitation services, with early acknowledgement, identification, assessment, intervention, and referral to minimize the impact of cognitive changes on work participation. Routine cognitive screening during treatment could provide early identification of those with cognitive difficulties. A simple screen, using the FACT – Cog might be worthwhile used in the early stages of treatment to screen for cognitive problems. Information and education should be provided to advise on what to expect from changes to thinking [67]. In the Australian health care system, this could be performed by an oncologist, clinical nurse, or occupational therapist during outpatients' visits for treatment and reviews. If concerns are noted through the brief screening process, or the patient expresses difficulties with work performance, a referral for workplace rehabilitation services should be considered, as the issue of cognition and work performance is complex and requires a more integrated approach.

Difficulties conducting workplace-based research in cognitive dysfunction after breast cancer

The quality assessments of both the qualitative and quantitative studies in this scoping review could be considered medium to high. Several of the studies did not have a methodological design that could be evaluated using a quality assessment tool, possibly indicating the opportunistic nature of research in this area because of ethical issues in the timing and location of data collection. There has been a call for more research to develop interventions to address cognitive impairments and return to work [41,66,68,69]. Richardson et al. (2011) indicated that many of the gaps in knowledge about cancer survivorship interventions may be due to areas that are difficult to research or issues with working out how to implement solutions in everyday practice [69]. All studies in this scoping review were conducted through surveys, databases, interviews, or face to face training in hospitals, outpatient clinics or community settings. There were no studies that conducted assessments or interventions in the workplace. This may indicate that research on workplace-based assessments and interventions for cognitive dysfunction may be one of these areas of difficulty for researchers. Conducting ecologically valid research in workplaces is challenging, as women with breast cancer may not have disclosed their illness or cognitive difficulties, therefore the employer cannot play an active part in the assessment or intervention strategies. Workplace rehabilitation can make a significant impact on injured or ill worker's quality and quantity of work however, it must be in collaboration with the client, employer and allied health professional [70]. Even if women with breast cancer have disclosed their illness and cognitive dysfunction to their employer, a research program evaluating cognitive assessment and rehabilitation program at work may highlight hidden problems and raise an employer's concern about work performance, placing employment in jeopardy. As such, research around women's cognitive deficits impacting work performance after breast cancer needs to be carefully designed with a strong ethical framework to minimize any effect on employment.

Strengths and limitations

Using a systematic approach to this scoping review, this study brought together findings from epistemologically different research designs to present an in-depth summary of what is known about cognitive changes after breast and the impact on work as well as provide clinically relevant information to challenge health professionals in their practice. Although a thorough and focused strategy was utilised, it is possible that more studies exist, including those in other languages, but were not identified by the search criteria.

Conclusion

Growing evidence on the health benefits of work for injured and ill workers is reflected in the practice of most occupational health professionals by encouraging workers to stay involved with work during treatment [15,70,71] rather than taking a prolonged absence [18]. For women with cognitive dysfunction after breast cancer, returning to work may provide a form of therapy whilst participating in a meaningful and productive occupation [15,32]. This scoping review has found that a combination of strategies across the breast cancer survivorship journey needs to be implemented to address cognitive changes after breast cancer and to maximize the chances of improving their work capacity and returning to work. This is an ethically challenging area of research that requires collaboration across multiple stakeholders and systems to develop evidence for more ecologically valid assessments and interventions to improve women's cognitive performance in the workplace following breast cancer.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent

Informed consent was not necessary as no human subjects were involved in the study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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3.11 Update on evidence from scoping review

Since the scoping review was released, there have been 16 citations of this scoping review (Lewis & Mackenzie, 2022) since it was published in 2022, indicating the growing interest in cognitive changes for women with breast cancer and the impact on work ability.

The updated data included in this chapter, which extended the findings of the original scoping review, employed the same search strategy and inclusion criteria, which covers literature from January 2021 to May 2025, and identified 11 further studies that examined the intersection of breast cancer, cognitive impairment, and return to work. This represents a substantial increase in studies, given that there were 34 studies over 20 years in the original published scoping review. Additionally, publications from various countries indicate that this topic is gaining international recognition. The largest number of studies came from China, with three separate investigations contributing to the evidence base. The United Kingdom followed with two studies, both of which provided insights into the lived experiences and workplace challenges of breast cancer survivors. Single studies were conducted in several other countries, including the United States, Spain, Finland, France, Canada, Norway, and Italy. This increased number of studies and international distribution demonstrates the widespread acknowledgment of the importance of supporting breast cancer survivors in their efforts to return to and maintain employment, while also highlighting the diverse healthcare systems, cultural contexts, and workplace environments in which these challenges are navigated.

Quantitative research predominantly explored the relationship between cognitive function and work outcomes among breast cancer survivors. There continues to be a strong use of self-reported questionnaires to evaluate the cognitive function of women with breast cancer and work limitations. Although in this period, since the scoping review was published, there have been different measures utilised. Overall, there is a consistent finding with the previous

scoping review that self-reported cognitive impairments are related to reduced work performance and participation.

Von Ah & Crouch (2021) used the Everyday Cognition (ECog) scale, which is a 39-question measure that assesses cognitively mediated functional ability across six domains, as well as one global total overall everyday function. Work engagement was measured using the 17-item Utrecht Work Engagement Scale (UWES-17) and includes three domains of work engagement, including vigour, dedication, and absorption. The study found that at least one year after treatment 12% of the breast cancer survivors identified that they had consistently ("a little" to "much") worse cognitive performance since their diagnosis and treatment for breast cancer. Poorer everyday cognitive function as assessed using the ECog, was significantly associated with reduced work engagement (Von Ah & Crouch, 2021).

Liu et al. (2021) reported that two years after treatment had been completed, women with breast cancer experienced greater work limitations and lower quality of life compared to non-cancer controls, with productivity loss due to presenteeism reaching 8%. The primary outcomes assessed were productivity loss, evaluated using the Work Limitations Questionnaire, and overall quality of life, measured by the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30). Additional measures included psychological distress, assessed via the Hospital Anxiety and Depression Scale (HADS), and cognitive difficulties in the workplace, evaluated using the Cognitive Symptom Checklist (CSC-W21). Although the breast cancer group had higher cognitive limitations at work than the healthy control group, as indicated by the CSC-W21 total score, the difference was not significant.

Lange et al. (2024) evaluated the cognitive impairment and relationship with work participation in breast cancer patients using nine paper-based standardised neuropsychological tests (Hopkins Verbal Learning Test Revised, d2, Verbal fluency, Trail Making

Test, Stroop test, Spatial span, Digit span, Letter Number Sequencing, and Symbol search) and the FACT-Cog. Of the 178 women with breast cancer, 37 (20.8%) did not return to work at the two-year mark. Patients who returned to work had a higher occupational class (e.g., professional) and were less likely to have had a mastectomy. Two years after breast cancer, return to work was significantly linked to lower levels of overall cognitive impairment and perceived cognitive abilities as well as higher scores in working memory, processing speed and attention. These findings highlight the importance of cognitive assessment at various times after breast cancer and in facilitating successful reintegration into the workforce following breast cancer treatment.

Corbière et al. (2024) explored the self-efficacy of women with breast cancer who were on sick leave from their employment, as a way of determining how this may be an obstacle to their planning and decision making about return to work. The Return-to-Work Obstacles and Self-Efficacy Scale (ROSES) was utilised with women on sick leave due to breast cancer to validate the use of this measure in this specific population. There are 10 dimensions to the ROSES, one being cognitive difficulties. There were 153 women with breast cancer in the study, which validated the ROSES-BC and found that chemotherapy and cognitive difficulties dimensions were the only key predictors of return to work.

In Chapman et al. (2023), 88 women living with metastatic breast cancer completed online questionnaires assessing their global health status, perceived cognitive and emotional vulnerability and their experience of employers following diagnosis. Women working at the time of the study also reported on their quality of working life. Participants completed online questionnaires including the Functional Assessment of Cancer Therapy-Cognitive Scale (FACT-Cog), Hospital Anxiety and Depression Scale (HADS), European Organisation for Research and Treatment of Cancer Quality of Life (EORTC-QLQ-Q30, Version 3), Quality of Working Life for Cancer Survivors (QWLQ-CS) and Work Productivity and Activity Impairment

Questionnaire: Specific Health Problem (WPAI: SHP, Workplace Experience Questions (WPEQ). The study found that a higher quality of working life was associated with better perceived cognitive function and lower depression in women with metastatic breast cancer.

Bøhn et al. (2024) found that 63% of BCSs maintained their work status eight years post-diagnosis, with reduced work status linked to chemotherapy, comorbidities, cognitive impairment, and fatigue. A range of tools was used to explore factors linked to return to work status, with the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30) v3 being used to explore cognitive function, pain, and fatigue.

The qualitative studies provided deeper insights into the lived experiences of women with breast cancer.

Through interviews with women with breast cancer, employers and health professionals, Marinas-Sanz et al. (2023) identified a range of return-to-work barriers for women with breast cancer. Overall, the barriers included physical and cognitive symptoms, psychosocial challenges, lack of coordination among stakeholders, legal ambiguities, and unsupportive work environments. It was women with breast cancer who reported that cognitive barriers of lack of concentration and memory secondary to chemotherapy or hormone therapy both increased insecurity in the performance of their tasks. One woman stated: “It’s not enough that I recovered from cancer, but I came back to the company, and they told me: you’re out and you’re going to start from scratch”. (Worker with breast cancer, p.7, Marinas-Sanz et al., 2023).

Chapman et al. (2022) examined the long-term effects of cognitive impairment following breast cancer on work performance and participation through interviews with women who had breast cancer. Women had completed treatment on average two years prior, but up to five years prior. At the time of the interview, most women (65%) reported working full-time, and six women (15%) had changed their job role and/or employer since their diagnosis. The study found that cognitive changes provoke emotional distress, fatigue, and reduced confidence, adversely

impacting work on a long-term basis, up to five years in this study. The study highlights some self-management strategies utilised by women, mostly related to addressing memory deficits. However, notably, some women reported that their cognitive deficits prevented them from remembering to implement the strategies. This study has indicated that cognitive changes can lead to ongoing and sustained suboptimal workability and the implementation of common self-management coping strategies. Women often feared how they would be viewed by their employers or co-workers when it came to their cognitive challenges and the long-term implications for their employment (Chapman et al., 2022).

Mao et al. (2025) conducted interviews with Chinese health professionals who had breast cancer about their experiences with returning to work. One of the major themes was 'Physical and Mental Re-Awareness'. Gradual improvements in cognitive abilities, attention, and emotional resilience fostered confidence in their return to work. Within this theme, nine of the 20 participants reported decreased memory, thinking, and energy, leading to stress, poor concentration, memory loss, intolerance of crowded spaces, and depression. Some quotes from this study articulate the difficulties women with breast cancer experience with cognitive changes and their work demands:

- "Despite my love for my previous job, I couldn't keep up with the demands, necessitating a shift to a support role. It's disheartening that my professional skills aren't being fully utilised" (p. 1943).
- "I invested more effort into becoming a doctor than most people, but now I feel like a broken machine" (p. 1943).
- "I find myself irritable, depressed, unable to concentrate, and my work efficiency has declined. Direct patient care is no longer a suitable role for me, leaving me disappointed in myself" (p. 1943).

In this study, Mao et al. (2025) also notes that all 20 participants with breast cancer had returned to their jobs within 120 days post-surgery, with the majority returning within one to two months post-surgery. This return-to-work rate is much higher than that found in other studies with heterogeneous occupation types.

Magnavita et al. (2023) was an Italian study that used mixed methods to examine barriers to returning to work for women with breast cancer, to find better support strategies. The qualitative study included a healthy control group. The breast cancer group reported that their working capacity was reduced by 50% compared to their level before the disease. This could be considered evidence of presenteeism. The qualitative component revealed that return to work was influenced by person, company and societal factors. Cognitive and neuropsychological problems (reduced concentration, decreased performance, and apathy) were considered person-related barriers to returning to work.

Hou et al. (2021) conducted a mixed-methods study with women who had completed primary treatment for breast cancer. Only 21.35% of 192 breast cancer patients returned to work after completing treatment. The Patient Health Questionnaire-9 (PHQ-9), the Brief Fatigue Inventory (BFI), the Cognitive Symptom Checklist (CSC) Chinese version, the Work Ability Index (WAI), and the Lam Assessment of Employment Readiness (LASER) were completed. Results identified cancer stage, cognitive limitations, depression, fatigue, and work ability as significant predictors of employment readiness, or otherwise, preventing a return to work. Qualitative data found that higher skill levels, better social support, and a flexible work schedule facilitated RTW; stress, lack of confidence in one's work skills, depression, and fatigue are all possible barriers to return to work (Hou et al., 2021).

Improvement in cognitive functioning following breast cancer treatment shows mixed outcomes. Some women recover gradually, while others experience persistent difficulties with memory, attention, and processing speed. Although intervention effectiveness was

not the focus of this thesis, evidence indicates that cognitive deficits can improve or be compensated for over time. Non-pharmacological interventions such as cognitive rehabilitation, mindfulness-based stress reduction, and physical activity can improve certain cognitive domains and overall well-being, although effects are generally modest and vary by intervention type. Systematic reviews highlight cognitive rehabilitation and exercise as particularly promising for enhancing attention, executive function, and processing speed in breast cancer survivors (Park et al., 2023). Yang et al. (2025) found psychological interventions most effective for improving subjective outcomes, cognitive training for working memory and executive function, cognitive rehabilitation for learning and memory, and mindfulness-based stress reduction for processing speed. However, there is limited research on workplace-specific strategies to address cognitive challenges, which has been identified as an area for future investigation.

3.12 Considering cognitive changes and impact on work performance and participation: ICF model

Earlier, the ICF model was presented considering the possible aetiology, neuroanatomic and personal risk factors causing cognitive changes after breast cancer, as well as the resultant neuroanatomic changes. After this, the scoping review provided broader contextual considerations on how cognitive changes impact the work performance and participation of women with breast cancer. Quantitative studies have helped understand the extent of the changes, but qualitative studies bring a deeper understanding of the everyday work challenges, what women experience in the workplace environment and how they manage these challenges. The scoping review enables a further expansion of the ICF model application that will now be presented to summarise the literature thus far (Figure 3.5).

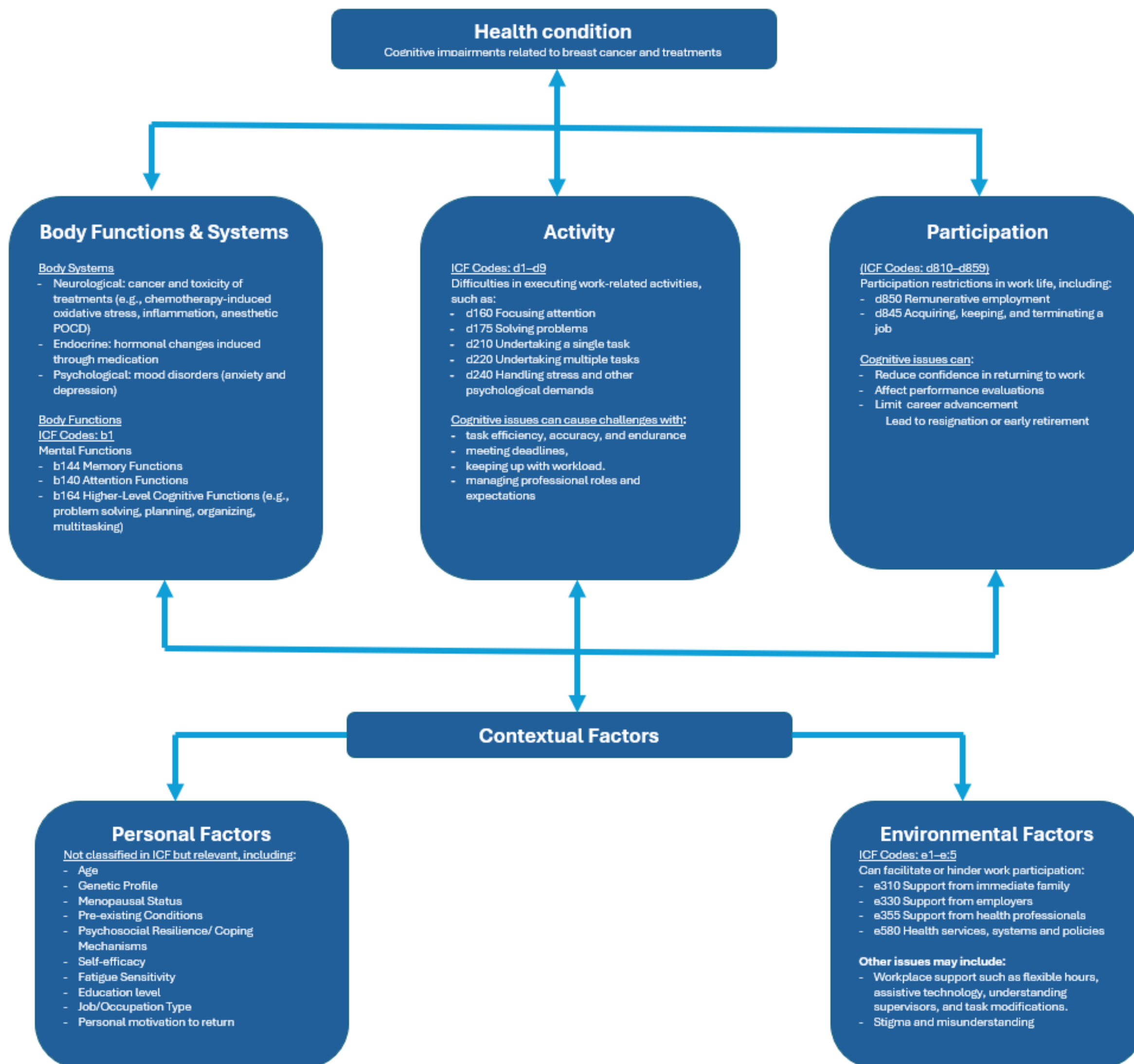

Figure 3.2: ICF model applied to breast cancer and cognitive changes, including body structures and functions, activity and participation limitations, personal and environmental factors.

3.13 Key findings

This chapter examined the multifaceted nature of cognitive changes in women with breast cancer and their impact on work participation and performance. It confirmed that impairments were common and influenced by treatment types, biological and genetic factors, and affective conditions such as anxiety, depression, and fatigue. Neuroimaging studies provided evidence of brain changes and compensatory mechanisms, validating women's self-reported experiences. Findings from our published scoping review (Lewis & Mackenzie, 2022) showed that cognitive impairments significantly affected work ability, with updated literature reinforcing this across diverse international contexts. Quantitative studies linked deficits in memory, attention, and processing speed to reduced work performance, while qualitative research revealed emotional distress, reduced confidence, and long-term workplace challenges. The chapter applied the ICF model to illustrate how cognitive changes intersect with personal and environmental factors, influencing activity and participation. It highlighted the need for targeted interventions, better assessment tools, and workplace support to help women manage cognitive impairments and maintain employment.

CHAPTER 4: PILOT STUDY USING THE PRPP-A

4.1 Introduction

This chapter investigates the reasons why women may have difficulty returning to work after breast cancer, focusing specifically on impaired cognition. Cognition underpins all human activity, allowing individuals to interpret information, make decisions, and perform tasks essential for personal, social, and occupational functioning. From simple routines to complex problem-solving, cognitive processes form the foundation of how we operate and engage in meaningful activities. Although cognitive changes after breast cancer are often subtle, they can significantly impact work performance. The chapter seeks to answer the question: *What specific cognitive domains are affected in women with breast cancer in their worker roles?* To address this, it begins with a discussion of three approaches to cognitive assessment (neuropsychological, International Classification of Functioning, Disability and Health, and Diagnostic and Statistical Manual of Mental Disorders) and some of the challenges and opportunities that may arise from considering alternative approaches. It examines the most common neuropsychological testing and self-reported assessments used for evaluating cognition in women with breast cancer, along with the limitations related to work-related cognitive assessments. An alternative approach of functional cognition, using the Perceive, Recall, Plan, and Perform System of Task Analysis (PRPP-A), is proposed as an option for assessing the cognition of women with breast cancer concerning work tasks, as it addresses the shortcomings of traditional assessments in this area and meets the requirements of third-party providers. This is followed by a pilot study that was published, using the PRPP-A to identify specific cognitive strategy difficulties faced by women with breast cancer in their worker roles.

Lewis, J., Chapparo, C., Mackenzie, L., & Ranka, J. (2016). Work after breast cancer: Identification of cognitive difficulties using the Perceive, Recall, Plan, and Perform

(PRPP) system of task analysis. *British Journal of Occupational Therapy*, *79*(5), 323–332. https://doi.org/10.1177/0308022616639983

4.2 Cognitive domains and areas of the brain affected by breast cancer

Cognitive ability domains can be conceptualised in several ways. One approach groups cognitive domains by general functions such as memory, attention, language, or executive function. Another framework is based on brain regions, informed by lesion studies, linking abilities to areas like the frontal or temporal lobes, parietal lobe, or hippocampus. The hierarchical model presents simpler sensory-perceptual processes as foundational domains, progressing to complex executive functions, which require the coordination of multiple lower-level processes (Harvey, 2019). However, cognitive functions are not isolated. Although they are part of a general hierarchical model, they are interconnected. For example, effective executive functions depend on the ability to accurately perceive and remember information, as well as the capacity to execute motor actions (Alsaedi, 2025). The cognitive domains impacted by breast cancer and related treatments are generally assessed through neuropsychological testing, which examines cognitive abilities like memory, attention, processing speed, reasoning, judgment, problem-solving, spatial, and language functions in isolation (Argyriou et al., 2011). Table 2 defines the cognitive domains, and the corresponding numbers are marked on the brain diagram in Figure 6 to show their general neurofunctional locations. In a review by Fleming et al. (2023), studies in women with breast cancer showed that even ten years after chemotherapy, survivors still experience cognitive deficits in verbal memory, working memory, processing speed, and executive function compared to healthy controls.

Table 4.2: Descriptors for cognitive domains (numbers correspond to Figure 4.6).

Cognitive Abilities		Descriptors
1	Visual-spatial ability	The capacity to perceive, generate, and mentally manipulate visual patterns or spatial relationships.
2	Attention	The ability to focus on specific stimuli or tasks while filtering out distractions.
3	Concentration	Sustained mental focus on a particular task or object.
4	Reaction time	The speed at which an individual responds to a stimulus or makes a decision.
5	Processing speed	The efficiency with which the brain can complete simple or routine cognitive tasks.
6	Working memory	The capacity to hold and manipulate information in mind for short periods during tasks.
7	Verbal memory	The ability to remember spoken or written language-based information for a certain period.
8	Visual memory	The skill of recalling visual details or images from past experiences.
9	Language ability	Verbal fluency, the ability to access semantic knowledge
10	Executive function	A set of mental processes that manage and regulate other cognitive skills and behaviours.

(Argyriou et al., 2011; Barnhill & Dickerman, 2015; Gaynor et al., 2021)

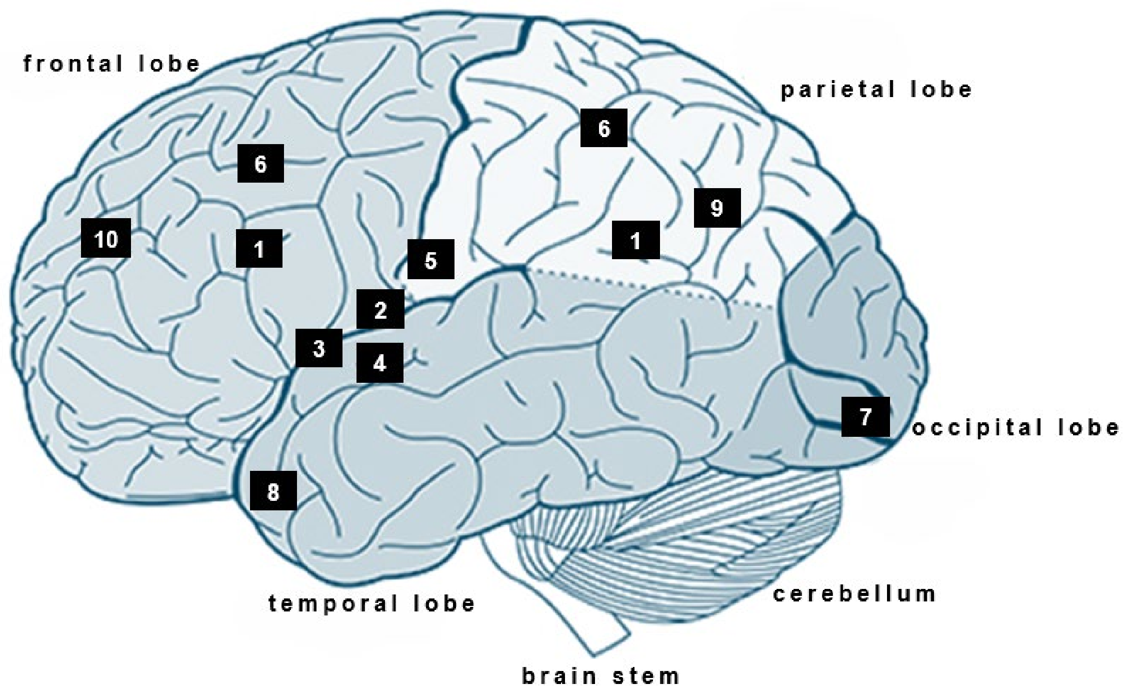

Figure 4.3: General neurofunctional locations of cognitive domains

4.3 Approaches to cognitive assessment

There is no consistent terminology used to describe cognitive domains in the literature. As noted above, most cancer-related cognitive impairment research adopts a neuropsychological approach. In contrast, patient self-report questionnaires often use more functional language, aligning with terminology from the ICF Model (World Health Organization, 2001). This section outlines three different approaches to cognitive assessment for consideration, including a neuropsychological approach, the ICF Model (World Health Organization, 2001), and the Diagnostic and Statistical Manual of Mental Disorders, 5th edition Text Revision (DSM-5-TR) (American Psychiatric Association, 2022a).

4.3.1 Neuropsychological

Neuropsychological assessment involves a standardised evaluation of cognitive abilities using a performance-based battery of tests across multiple domains, often including more than one test per domain. Common areas assessed include memory, attention, processing speed, reasoning, judgment, problem-solving, spatial skills, and language functions. These tests require active demonstration of specific skills in a controlled setting with an examiner present. Neuropsychological assessments are standalone evaluations for diagnostic and capacity purposes, not for guiding interventions. Neuropsychological testing in Australia is conducted by clinical neuropsychologists, who are registered psychologists with specialist postgraduate training in brain disorders related to cognitive, emotional and behavioural factors. (Australian Psychological Society, 2025).

A key element of neuropsychological testing is the use of normative comparisons to determine if an individual's performance aligns with expectations based on their educational and life experiences. Deviations from expected levels can be measured and interpreted in context. Despite structured approaches, defining a universal threshold of cognitive impairment

that correlates directly with functional limitations is challenging. Establishing clear links between specific cognitive deficits and everyday functioning is complex, except in well-defined conditions like traumatic brain injury. Self-reported and observed behaviours during the assessment may offer valuable insights, but self-reported symptoms are considered less reliable than objective performance testing due to psychological influences (Harvey, 2012).

The International Cognition and Cancer Task Force (ICCTF) (Wefel et al., 2011) and several systematic reviews (Argyriou et al., 2011; Jung et al., 2023; Olson et al., 2016) have identified attention, memory, processing speed, language, executive function, and visual-spatial ability as the cognitive domains most affected by cancer and its treatments. Although these reviews include individuals with various cancer types, women with breast cancer represent a significant proportion of study participants. For women with breast cancer, neuropsychological testing is primarily used in research settings to explore the causal factors of cognitive impairment. In practice, particularly in Australia, few women undergo such testing for cognitive concerns due to limited access, a shortage of neuropsychologists, and high costs, which are rarely covered by Medicare or private health insurance. In some cases, women with an insurance claim related to breast cancer may be referred for neuropsychological testing by the insurer to obtain an objective evaluation of cognitive function and its impact on work. The results may influence the outcome of the claim and access to financial benefits. It remains uncertain whether neuropsychological tests are the most effective tools for assessing cognitive abilities in the workplace.

4.3.2 International Classification of Functioning, Disability and Health (ICF) model

Women with breast cancer need reliable and valid cognitive function assessments to support their rehabilitation. Currently, no standardised neuropsychological tools specifically assess functional disability in these women. The World Health Organization's International

Classification of Functioning, Disability and Health (ICF) (World Health Organization, 2001) provides a universal language and framework for describing health and disability, and it is freely available internationally. Combined with clinical diagnoses from the International Classification of Diseases (ICD-11), the ICF offers a comprehensive understanding of health by incorporating how medical conditions impact daily function, leading to more targeted interventions to improve everyday activities and promote participation.

In the ICF model, "mental functions" describe cognitive functions, with each function corresponding to a cognitive domain. While there is some overlap with neuropsychological approaches, ICF descriptors are generally broader. The ICF framework extends beyond cognitive function to include the impact of health conditions on activity and participation, addressing limitations of a purely neuropsychological approach. The ICF codes and descriptors related to cognition in work-related activities and participation are detailed in Table 4.3. A key advantage of the ICF is its potential as a low-cost, standardised tool for epidemiological research, enabling the collection and comparison of global data on how cognitive impairment affects work function and participation in women with breast cancer.

Table 4.3: ICF codes and descriptors for cognition, work tasks and participation

ICF Code	Descriptor	Definition
b1 Mental Functions		
b110	Consciousness functions	Functions related to the state of awareness and alertness, including the clarity and continuity of the wakeful state.
b114	Orientation functions	Awareness of oneself in relation to time, place, and person.
b117	Intellectual functions	General mental functions required to understand and constructively integrate information, including reasoning, problem-solving, and abstract thinking.
b122	Global psychosocial functions	Functions related to the integration of psychological and social aspects, such as interpersonal relationships, motivation, and self-regulation.
b126	Temperament and personality functions	Stable characteristics of a person’s behaviour, such as emotional stability, openness, agreeableness, and self-control.

b130	Energy and drive functions	Mental functions that produce vigour and motivation, including impulse control, appetite, and sleep-wake cycle regulation.
b134	Sleep functions	Functions related to the quality, timing, and amount of sleep.
b140	Attention functions	Mental functions that focus on specific stimuli or thoughts and manage competing demands on attention.
b144	Memory functions	Mental functions involved in registering, storing, and retrieving information. Includes short-term, long-term, and working memory.
b147	Psychomotor functions	Mental functions that control voluntary movement, including initiation, coordination, and regulation.
b152	Emotional functions	Mental functions related to the experience and regulation of emotions, such as happiness, sadness, fear, and anger.
b156	Perceptual functions	Mental functions that interpret sensory stimuli, including recognition and discrimination of auditory, visual, tactile, and other sensory input.
b160	Thought functions	Mental functions related to ideation, sequencing, abstraction, and organisation of ideas.
b164	Higher-level cognitive functions	Complex goal-directed mental activities such as decision-making, planning, judgment, and cognitive flexibility.
b167	Mental functions of language	Functions involved in the reception and expression of spoken, written, and other forms of language.
b172	Calculation functions	Mental functions related to performing arithmetic operations.
b176	Mental functions sequencing complex movements	Planning, coordinating, and executing sequences of movements required for complex tasks.
b180	Experience of self and time functions	Awareness of one's identity, body image, and the passage of time.
Activity and Participation		
d1 Learning and applying knowledge		
d110	Watching	Using the sense of vision intentionally to experience visual stimuli.
d115	Listening	Using the sense of hearing intentionally to experience auditory stimuli.
d160	Focusing attention	Intentionally focusing on specific stimuli or tasks.
d163	Thinking	Using thought functions for reasoning, problem-solving, and decision-making.
d166	Reading	Activities involved in decoding symbols and interpreting meaning (letters, words, sentences).
d172	Calculating	
d175	Solving problems	
d177	Making decisions	
d2 General tasks and requirements		
d220	Undertaking multiple tasks simultaneously (multi-tasking)	Carrying out more than one task at the same time.

d230	Carrying out daily routine	Performing coordinated actions and tasks that are part of daily life.
d3 Communication		
d310	Communicating with – receiving – spoken messages	Understanding spoken language conveyed by others.
d330	Speaking	Producing spoken messages using appropriate language.
d345	Writing messages	Producing symbols or letters to communicate messages by hand or device.
d8 Major Life Areas		
d840-d859	Work and Employment	

(World Health Organization, 2001)

The ICF Model can be applied in clinical settings through the ICF Checklist (Version 2.1a, Clinician Form) (World Health Organization, 2001). This practical tool outlines the major categories of the ICF and is used to record and summarise information on an individual's functioning and disability. The checklist can be completed using various sources, including written records, direct observation, client self-report, or information provided by a carer or other informants.

The self-report aspect of the ICF approach provides a more holistic view of functioning compared to traditional neuropsychological assessments. However, no published studies could be found applying the ICF model specifically to women with breast cancer. Pilarska et al. (2023) advocated for using the ICF framework to assess cognitive function in people with brain cancer, where cognitive impairments are often more direct and severe than those experienced by women with breast cancer, to guide rehabilitation and improve quality of life and participation.

In women with breast cancer, the Functional Assessment of Cancer Therapy – Cognitive Function (FACT-Cog) (FACIT.org, 2025) is commonly used in both research and clinical practice to assess women's own perception of their cognitive function. The FACT-Cog uses function-based questions aligned with the ICF framework. For example:

- The item *"I have had trouble concentrating"* corresponds to the ICF Body Functions domain – Mental functions.

- The item *“I have used the wrong word when referring to an object”* aligns with the ICF domain of Activities and Participation – Communication.
- The item *“I have trouble shifting back and forth between different activities that require thinking”* relates to Activities and Participation – General tasks and demands.

4.3.3 Diagnostic and Statistical Manual of Mental Disorders 5th Edition, Text Revised (DSM-5-TR)

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR) provides a standardised system for diagnosing and classifying mental disorders, ensuring consistency across clinical settings. It supports treatment planning, provides a common language for communication among health professionals, and assists with health policy and insurance claims (American Psychiatric Association, 2022a). Cognitive changes in people with cancer are not commonly assessed using the DSM-5-TR, even though it was updated in 2013 to include a new category: Neurocognitive Disorders (Barnhill & Dickerman, 2015). This category includes disorders where the primary clinical deficit is cognitive function, generally acquired rather than developed over time, representing a decline from a previously attained level of functioning. The neurocognitive disorder category emphasises diagnosed conditions such as delirium, Alzheimer’s Disease, Lewy Body Dementia, and traumatic brain injury with a defined aetiology. It also includes classifications like “Major or Mild Neurocognitive Disorder Due to Unknown Aetiology” and “Unspecified Neurocognitive Disorder.” The former is used when there is evidence of a medical cause, with or without substance involvement, but insufficient information for a specific diagnosis. Interestingly, the presence of the ε4 variant of apolipoprotein E is a risk factor for Alzheimer’s Disease but not a diagnostic marker (Sachdev et al., 2014). This genetic factor also increases the risk of cognitive impairment in women with breast cancer. Other factors, such as the cancer itself or its treatments, could also be responsible (Whittaker et al., 2022).

The DSM-5-TR notes that the "Unspecified Neurocognitive Disorder" category should be used when an individual shows symptoms characteristic of a neurocognitive disorder but does not meet the full diagnostic criteria for any specific condition, yet experiences clinically significant distress or impairment in social, occupational, or other important areas of functioning. This classification acknowledges the impact of cognitive symptoms on everyday functioning, aligning well with the ICF framework discussed earlier. This category may be especially relevant for women with breast cancer who report cognitive impairments affecting their ability to work or participate in employment, particularly when a clear etiological link cannot be established. Within the "Unspecified Neurocognitive Disorder" category, clinicians assess which of the six cognitive domains are affected, using definitions outlined in Figure 4.7. Cognitive impairment is considered diagnosable when there is impairment in at least one cognitive domain (American Psychiatric Association, 2022a).

Unspecified Neurocognitive Disorder (R41.9)

This category applies to presentations in which symptoms characteristic of a neurocognitive disorder that cause clinically significant distress or impairment in social, occupational, or other important areas of functioning predominate but do not meet the full criteria for any of the disorders in the neurocognitive disorders diagnostic class.

Cognitive domain:

1. Complex attention: sustained attention, divided attention, selective attention, processing speed
2. Executive function: planning, decision-making, working memory, responding to feedback/error correction, overriding habits/inhibition, mental flexibility.
3. Learning and memory: immediate memory, recent memory, including free recall, cued recall, and recognition memory, very-long-term memory, semantic; autobiographical, implicit learning.
4. Language: expressive language, including naming, word finding, fluency, and grammar, and syntax and receptive language
5. Perceptual–motor includes abilities subsumed under the terms visual perception, visuo-constructional, perceptual–motor, praxis, and gnosis
6. Social cognition: recognition of emotions, theory of mind

Figure 4.4: DSM-5-TR Cognitive domains for assessing and diagnosing neurocognitive impairments.

(American Psychiatric Association, 2022a).

Clinicians consider their observations, symptoms reported by the patient or caregiver, and necessary assessments to determine whether neurocognitive impairment is major or mild. In mild neurocognitive disorders, cognitive impairments do not prevent independence in daily life but often require extra effort and compensatory strategies. The ability to remain functionally independent distinguishes mild from major neurocognitive disorders, relying on input from the individual, their family, and the clinician's judgment. Assessments are broken down into subcomponents of each cognitive domain. To avoid copyright issues, only two cognitive domains, with examples of symptoms or observations and corresponding assessments, are included in Table 4.4.

Table 4.4: DSM-5-TR Examples of cognitive domains and related symptoms, observations, and assessments.

Cognitive domain	Examples of symptoms or observations	Examples of assessments
Complex attention (sustained attention, divided attention, selective attention, processing speed)	Major: Has increased difficulty in environments with multiple stimuli (TV, radio, conversation); is easily distracted by competing events in the environment. Is unable to attend unless input is restricted and simplified. Has difficulty holding new information in mind, such as recalling phone numbers or addresses just given, or reporting what was just said. Is unable to perform mental calculations. All thinking takes longer than usual, and components to be processed must be simplified to one or a few. Mild: Normal tasks take longer than previously. Begins to find errors in routine tasks; finds work needs more double-checking than previously. Thinking is easier when not competing	Sustained attention: Maintenance of attention over time (e.g., pressing a button every time a tone is heard, and over a period). Selective attention: Maintenance of attention despite competing stimuli and/or distractors: hearing numbers and letters read and asked to count only letters. Divided attention: Attending to two tasks at the same time: rapidly tapping while learning a story being read. Processing speed can be quantified on any task by timing it (e.g., time to put together a design of blocks; time to match symbols with numbers; speed in responding, such as counting speed or serial 3 speed).

	with other things (radio, TV, other conversations, cell phone, driving).	
Executive function (planning, decision making, working memory, responding to feedback/error correction, overriding habits/inhibition, mental flexibility)	*Major:* Abandons complex projects. Needs to focus on one task at a time. Needs to rely on others to plan instrumental activities of daily living or make decisions. *Mild:* Increased effort required to complete multistage projects. Has increased difficulty multitasking or difficulty resuming a task interrupted by a visitor or phone call. May complain of increased fatigue from the extra effort required to organise, plan, and make decisions. May report that large social gatherings are more taxing or less enjoyable because of increased effort required to follow shifting conversations.	*Planning:* Ability to find the exit to a maze; interpret a sequential picture or object arrangement. *Decision making:* Performance of tasks that assess process of deciding in the face of competing alternatives (e.g., simulated gambling). *Working memory:* Ability to hold information for a brief period and to manipulate it (e.g., adding up a list of numbers or repeating a series of numbers or words backward). *Feedback/error utilisation:* Ability to benefit from feedback to infer the rules for solving a problem. *Overriding habits/inhibition:* Ability to choose a more complex and effortful solution to be correct (e.g., looking away from the direction indicated by an arrow; naming the colour of a word's font rather than naming the word). *Mental/cognitive flexibility:* Ability to shift between two concepts, tasks, or response rules (e.g., from number to letter, from verbal to key-press response, from adding numbers to ordering numbers, from ordering objects by size to ordering by colour).

(American Psychiatric Association, 2022a)

Reading the descriptors of mild neurocognitive impairments closely resembles qualitative research on women with cognitive changes after breast cancer. For example, Table 4.4 describes mild cognitive impairment in complex attention as difficulties with dividing attention and concentrating on tasks like driving. Breast cancer research participants report

similar experiences: “Hard, really hard. I can't concentrate, I get easily distracted, things take me hours and hours, whereas it wouldn't have before. Something that might have taken an hour before can now take me all day because I can't concentrate. My brain doesn't work the same anymore” (Chapman et al., 2022, p.608) and “I get lost a lot easier driving…I have a GPS and one on my phone and I typically take printed directions with me now. I couldn't find where I was going to a meeting this morning. 45 minutes later I finally figured out where I was supposed to be. And at that point I had missed the meeting” (Myers, 2010, p.74). Mild cognitive impairment in executive functioning is described as difficulty multitasking or resuming a task, with increased fatigue from the extra effort required to organise, plan, and make decisions. A breast cancer research participant states a similar experience: “I find myself getting daydreamy. I am like the ADD kid: [I] can hyper-focus as long as [I am] doing one thing, but if something walks by down the hall, [and] I see it…I am gone. It makes my job a lot harder because, as a teacher, you have to do everything all at once. So, when I leave at the end of the day, I am spent, when before I was energetic. And it’s not a physical spent; it is a mental spent that I didn’t use to have”(Boykoff et al., 2009, p.229).

The DSM-5-TR does not specify which assessments, or how many, should be administered per cognitive domain. However, in the executive functioning domain, an example of an assessment is “naming the colour of a word’s font rather than naming the word” (see Table 4.4). This describes the Stroop Test (Stroop, 1935). Diagnosing a neurocognitive impairment using the DSM-5-TR blends subjective reporting by the client or caregivers, clinician assessment, and, if needed, neuropsychological assessments. The DSM-5-TR indicates that when neuropsychological assessment is unavailable, clinicians may rely on informal assessments, but objective demonstration of cognitive deficits is essential to distinguish mild neurocognitive disorder from normal cognitive aging and major neurocognitive disorder (or dementia)(Ganguli et al., 2011). Mild neurocognitive disorder should fall in the range of 1–2 SD

below the normative mean, or between the third and 16th percentiles, on tests with appropriate norms (American Psychiatric Association, 2022a).

Using the DSM-5-TR approach to assess women with cognitive changes after breast cancer seems positive, as it includes recognition of functional deficits reported by patients and significant others, along with clinician assessment and, where needed, neuropsychological or other testing. However, there is limited discussion on using DSM-5-TR for cancer-related cognitive changes, and it does not appear to have much support. Barnhill & Dickerman (2015) in the book 'Psycho-oncology' briefly mentioned the inclusion of neuropsychological disorders in the DSM-5-TR for assessing cognitive impairments in people with cancer. However, later editions did not further develop this topic. The DSM-5-TR is discussed for use with psychological and emotional disorders (e.g., depressive disorders and post-traumatic stress) related to cancer and treatment. Overall, there is resistance to adopting the DSM-5-TR approach routinely in oncology clinical practice and research, partly due to concerns that using psychiatric diagnostic criteria could pathologise subtle, temporary, or treatment-related cognitive difficulties (Barnhill & Dickerman, 2015; Ganguli et al., 2011) that could also be related to stress, anxiety, or low mood (Bender & Merriman, 2014). Nonetheless, the holistic approach to assessment, accessible nature, and standard categorisation of neuropsychological disorders in the DSM-5-TR could support cognitive assessments for women with breast cancer and possibly assist them with accessing insurance claims where clinically based and formal assessment is required (Phan, 2022).

4.4 Measurement of cognitive changes in women with breast cancer

Much of the research on cognitive changes in cancer patients aims to establish if cognitive impairments exist and their causality. These assessments have generally used neuropsychological tests and self-reported measures. Generally, neuropsychological tests have

been labelled ‘objective’ assessments and self-report measures as ‘subjective’ assessments. Over time, there has been an increase in linking cognitive changes to employment challenges, often through return-to-work status, with more work-specific self-reported measures having been developed. Overall, studies exploring cognitive changes and their impact on work have used both objective and subjective measures, each with its ‘pros’ and ‘cons’.

4.4.1 Objective vs subjective assessments

Health professionals use objective data and subjective patient reports to diagnose conditions and establish treatment plans. Objective data can be obtained through observation, measurement, or standardised assessments. Subjective assessments rely on patients' perspectives, reporting symptoms, experiences, or feelings. Pain and fatigue are examples of self-reported symptoms without objective assessments to quantify or validate them. However, further exploration of these symptoms could lead to a diagnosis explaining the fatigue or pain patients experience. Dismissing patients and their carers' subjective reporting of symptoms could be catastrophic (Queensland Government, 2025). Hence, there needs to be an understanding that both objective and subjective assessments, together with health professionals' interpretation and clinical reasoning, are all important parts of a thorough health assessment (Australian Commission on Safety and Quality in Health Care, 2020).

Assessing cognitive changes following breast cancer is an area where clinicians must rely on patients' self-reported symptoms. The literature often uses terms such as ‘self-report,’ ‘perceived,’ or ‘subjective’ assessments interchangeably (Oliveira et al., 2022), but essentially refer to forms of assessment that do not involve neuropsychological testing. Women with breast cancer often first notice cognitive changes during chemotherapy treatment (Kanaskie & Loeb, 2015; The Cancer Council Australia, 2023). They report these changes to various health professionals, receiving mixed responses (Hamilton et al., 2024; Smidt et al., 2016). A study by Smidt et al. (2016) interviewed oncologists about their perceptions of cognitive changes in

cancer patients. The study found that some oncologists did not inquire about cognitive changes because they were unsure of effective evaluation and intervention options. Interestingly, the study revealed that some oncologists believed women with breast cancer were more likely to report cognitive changes due to 'priming' compared to patients with other types of cancers. These oncologists cited that breast cancer survivors have greater access to supportive care and information, which likely influenced their perceptions of cognition (Smidt et al., 2016). If some oncologists have these implicit biases, there may be an effect on the quality of the dialogue with a woman with breast cancer when she first reports cognitive changes, and the level of support provided. Oncologists doubting a woman's subjective experience of memory, attention, and concentration changes are likely to ignore these symptoms or superficially explain them as 'just stress' (Smidt et al., 2016). Clinicians may also use patient self-reported questionnaires to evaluate cognitive changes. However, these questionnaires can contain ‘leading’ statements, asking patients about their symptoms in a negatively worded way (Australian Bureau of Statistics, 2023c). For example, “I have had trouble concentrating.” This may prime the patient by drawing their attention to certain symptoms, potentially influencing both their awareness and reporting of those symptoms (Phan, 2022). This could lead the woman to feel confused and doubtful about her cognitive changes, in turn, leading to other psychological issues. This is like experiences that people with chronic illness describe, when clinicians invalidate their emotional and behavioural symptoms (Bontempo et al., 2025), which may then lead to patients experiencing shame, healthcare anxiety, healthcare system avoidance, and diagnostic delay (Bontempo et al., 2025). For women with breast cancer, a lack of support or early evaluation of cognitive changes may lead to worsening cognitive functioning and contribute to their reduced work abilities and participation (Joly et al., 2019).

Due to the subjective nature of patient reporting and questionnaires, there is a tendency to favour objective reporting. Some clinicians believe that neuropsychological testing, often described as the objective form of testing, is the best option for validating cognitive changes

reported by women with breast cancer. This view is somewhat supported by the International Cognition and Cancer Task Force (ICCTF), which advocates for neuropsychological battery tests before treatment begins (Wefel et al., 2011). Although the ICCTF has made these recommendations to further research in this area, they do little to promote the use of more Patient-Reported Outcomes (PROs) in cancer care (Mazariego et al., 2025) and lack a client-centred approach. Research has shown that neuropsychological results do not correlate well with self-reported cognitive changes. This may lead to 'average' neuropsychological test results for a woman (Whittaker et al., 2022), further contributing to the dismissal of symptoms by some health professionals. Additionally, insurers have indicated suspicion about deliberate poor performance on neuropsychological tests to skew results (Phan, 2022). Yet, insurers and other third parties still rely on neuropsychological testing to make judgments (Phan, 2022). Apart from fMRI, there is no true objective way of identifying and validating women's reports of cognitive changes after breast cancer. However, fMRIs are an expensive and somewhat invasive procedure for all women to undertake. The shortcomings of these approaches need to be explored, and alternative evaluation methods considered.

4.4.2 Neuropsychological tests

A wide range of standardised neuropsychological tests have been used to evaluate both the type and severity of cognitive impairment in breast cancer survivors. Table 4.5 presents the most common neuropsychological assessments used to assess cognitive changes in women with breast cancer. Neuropsychological tests usually assess one cognitive domain or ability per test. These standardised neuropsychological tests are administered under controlled conditions, such as a quiet room with minimal distractions, to elicit the individual's 'best' performance (Vardy & Dhillon, 2010). Most comprehensive neuropsychological assessments can take up to four hours to complete. They also require trained professionals to administer, which limits their practicality in general clinical settings (Argyriou et al., 2011). Tests can be

performed using traditional "pencil and paper" or computerised/automated platforms (Cheung et al., 2012). There has been an increase in computerised neuropsychological assessments as they offer several advantages over traditional methods, such as minimal training for administrators, precise control over test delivery, improved consistency, and reduced practice effects. Computerised neuropsychological assessments minimise examiner administration, involvement and bias. The nonverbal nature of computerised neuropsychological tests increases their usability, somewhat removing language and cultural barriers (Fray & Robbins, 1996). Some computerised neuropsychological assessments can be conducted remotely and asynchronously by clinicians, improving accessibility to those in rural and remote areas or who have difficulty accessing clinic-based services. However, to ensure reliable and valid data, remotely conducted computerised neuropsychological assessments require appropriate hardware, software, and compatibility (Cheung et al., 2012). Although there are substantial benefits with remote computer-based testing, there are limitations due to the lack of synchronous assistance from a clinician. These include the participant needing adequate computer literacy and cognitive ability to follow instructions and the inability to conduct standardised motor function (e.g., Grooved Pegboard test) (Vardy & Dhillon, 2010) or verbal fluency tests.

A meta-analysis by Lindner et al. (2014) found that breast cancer survivors tend to perform worse on neuropsychological cognitive tests compared to healthy, age- and education-matched controls. However, neuropsychological tests are developed for populations with moderate to severe impairments (e.g., traumatic brain injury, stroke, dementia) and may lack sensitivity to detect the more subtle cognitive changes experienced by breast cancer survivors (Pullens et al., 2010). Standardised neuropsychological tests often fail to identify clinically meaningful cognitive changes that can significantly affect day-to-day functioning. For example, Ferguson et al. (2007) studied a pair of monozygotic twins: Twin A, a breast cancer survivor, performed within normal limits on neuropsychological testing but reported significant cognitive complaints

and showed notable differences in MRI findings compared to Twin B (Figure 3.3). This suggests that neuroimaging and self-report measures may be more sensitive to real-world cognitive changes than standardised tests. Ferguson et al. (2007) point out that neuropsychological standardised assessments often fail to show significant results, even when women with breast cancer report cognitive issues, which questions their validity. One explanation is that the artificial testing environment fails to replicate real-life demands. Breast cancer survivors often report difficulties with complex tasks such as driving or multitasking at work, activities that require the dynamic integration of multiple cognitive domains. Yet, neuropsychological tests tend to isolate and assess domains individually. This may explain why a woman might perform well on 'pen and paper' tasks in a clinic, but struggle to reverse-park her manual car in a crowded parking lot (Calvio et al., 2010).

Research design issues have also been identified. A major limitation is the lack of baseline cognitive assessments conducted before cancer treatment. Ideally, to assess cognitive change, neuropsychological testing should occur both pre- and post-treatment. However, as previously stated in chapter 3, performing cognitive assessments at diagnosis presents ethical and practical challenges. At that point, patients are often overwhelmed by surgery, multiple medical procedures, and emotional stress, all of which could confound baseline results. Yet without these data, clinicians may overlook cognitive decline in individuals who were previously high functioning, as they may still score within average norms post-treatment (Nelson et al., 2014; Vardy & Tannock, 2007). Even mild impairments can have significant impacts, especially in the workplace.

In response to these challenges, the ICCTF has established guidelines for neuropsychological testing in adults with cancer (Wefel et al., 2011). To improve research consistency and comparability, the ICCTF recommends:

- Conducting longitudinal studies that include both pre- and post-chemotherapy assessments.
- Using appropriate control groups.
- Applying a brief, standardised test battery that has demonstrated sensitivity to post-chemotherapy changes, such as:
    - Controlled Oral Word Association Test (COWAT) – measures verbal fluency.
    - Trail Making Test – assesses attention and executive function.
    - Hopkins Verbal Learning Test-Revised (HVLT-R) – assesses verbal memory.
    - Brief Visuospatial Memory Test-Revised (BVMT-R) – measures visual memory.

These guidelines aim to standardise study design and improve data quality, helping researchers better identify affected cognitive domains and their extent. However, they do not address the core issue: the lack of ecological validity in standardised neuropsychological testing. Despite improved methods, current assessments still fail to capture how cognitive impairments influence real-world functioning in breast cancer survivors. There are no neuropsychological tests that directly evaluate specific work-related tasks. Instead, clinicians must infer work performance capacity from test results, often without a first-hand knowledge of the occupational and work environment in which the patient performs their work (Newman, 2013; Ryan et al., 2011). Common neuropsychological tests used in studies examining cognitive changes in women with breast cancer are listed in Table 4.5.

Table 4.5: Common neuropsychological tests used for assessing cognition in women with breast cancer.

Test Name	Description	Domains Assessed	Interpretation of Score
California Verbal Learning Test (CVLT)	Participants learn and recall a list of words over repeated trials, followed	Verbal learning, memory, recall, recognition, interference effects.	Impairments suggest difficulties with verbal learning and memory encoding or retrieval.

	by delayed recall and recognition tasks.		
Hopkins Verbal Learning Test–Revised (HVLT-R)	Participants are read 12 words and asked to recall them across multiple trials, with delayed recall and recognition.	Verbal learning, immediate/delayed memory.	Lower recall/recognition scores may indicate verbal memory impairment.
Rey Auditory Verbal Learning Test (RAVLT)	A list of 15 words is presented over five trials, followed by interference, delayed recall, and recognition.	Verbal memory, learning rate, attention, susceptibility to interference.	Performance across trials provides insight into memory processes and retention.
Rey–Osterrieth Complex Figure	Participants copy a complex geometric figure, then reproduce it from memory after a delay.	Visual spatial memory, planning, attention.	Impaired recall or organisation may indicate deficits in visuospatial and executive functions.
CNS Vital Signs	A computerised battery assessing multiple domains using interactive cognitive tasks.	Memory, executive function, psychomotor speed, reaction time, attention.	Norm-referenced scores provide a broad profile of cognitive strengths and weaknesses.
Wechsler Adult Intelligence Scale (WAIS)	Multi-subtest battery measuring verbal comprehension, working memory, perceptual reasoning, and processing speed.	General intelligence, executive functioning, memory, processing speed.	Standard scores (mean = 100, SD = 15); variations indicate domain-specific strengths/weaknesses.
Wechsler Memory Scale (WMS)	Assesses auditory, visual, immediate, and delayed memory via various subtests.	Working memory, short-term and long-term memory, visual/auditory memory.	Standardised scores help detect memory impairments and track changes over time.
Trail Making Test (TMT A & B)	Part A: connect numbered dots; Part B: alternate between numbers and letters.	Processing speed, attention, cognitive flexibility.	Longer times suggest executive function or attention deficits.

Controlled Oral Word Association (COWAT)	Generate words beginning with specific letters (e.g., F, A, S) in 60 seconds.	Verbal fluency, language production, executive function.	Lower scores may reflect impaired frontal lobe functioning or language deficits.
Grooved Pegboard	Timed task involving placing grooved pegs into matching holes with each hand.	Fine motor skills, visuomotor coordination, psychomotor speed.	Longer completion time suggests motor or coordination deficits.
Headminder CSI	Computer-based test tracking changes in cognitive functioning over time.	Attention, processing speed, memory, reaction time.	Variability in scores across assessments may indicate cognitive instability or decline.
Stroop Test	Requires naming ink colours of printed words with conflicting semantic content.	Inhibition, attention, cognitive control.	Difficulty with incongruent trials may indicate executive dysfunction.
Wisconsin Card Sorting Test (WCST)	Cards must be matched according to changing rules without instruction.	Abstract reasoning, set-shifting, problem-solving.	Perseverative errors may reflect frontal lobe dysfunction.
CANTAB	Computer-based cognitive battery using visual and memory-based tasks.	Attention, memory, planning, executive function, decision-making.	Results compared to normative data to identify specific deficits.
Symbol Digit Modalities Test (SDMT)	Match symbols with numbers under timed conditions.	Processing speed, visual scanning, attention.	Lower scores suggest processing or attentional impairments.
Rivermead Behavioural Memory Test	Simulates real-life memory tasks (e.g., remembering appointments, names).	Functional memory, prospective memory.	Helps identify daily-life memory challenges and severity.
Brief Visuospatial Memory Test-Revised (BVMT-R)	Copy geometrical shapes and locations over repeated trials.	Visual memory	Performance across trials indicates the ability to visually learn.

4.4.3 Self-reported cognitive measures

A variety of self-reported measures are used with women breast cancer survivors to assess their perceived cognitive limitations and abilities, as presented in Table 4.6. The measures listed are validated tools. Self-reported cognitive assessments are practical, accessible for health practitioners, low-cost, and quick to administer. These tools typically use "I" statements written in negative or deficit-focused language to describe what the individual may be experiencing in terms of everyday cognitive functioning or performance of daily activities. This format can help individuals articulate their experiences. However, it also presents challenges for people with language or literacy difficulties, and the cultural sensitivity of some questionnaires may introduce bias. To address language and cultural concerns, several self-report measures have been translated into other languages and evaluated in diverse populations, reflecting cultural nuances. For example, the Functional Assessment of Cancer Therapy–Cognitive Function (FACT-Cog) is now available and validated in Chinese, French, Korean, Japanese, Turkish, and Portuguese (Oliveira et al., 2022).

The potential for individuals to become more aware of or focused on symptoms through negatively worded, deficit-oriented questions, known as a priming effect, has also been partially addressed in the FACT-Cog. The tool includes multiple subscales: perceived cognitive impairments (CogPCI), comments from others (CogOth), perceived cognitive abilities (CogPCA), and impact on quality of life (CogQoL). Notably, the CogPCA includes positively worded statements, reflecting a strengths-based approach. The CogOth subscale asks patients to consider feedback from others regarding their cognitive function (FACIT.org, 2025).

Vardy & Tannock (2007) suggest that self-reported questionnaires may lead individuals to misattribute pre-existing cognitive difficulties to cancer or its treatment, when these issues may instead be related to heightened emotional distress or anxiety associated with a cancer diagnosis. Higher scores on self-report cognitive measures have been shown to correlate with

depression, anxiety, poor quality of life, and fatigue (Whittaker et al., 2022), but regularly show limited correlation with objective neuropsychological assessments (Pullens et al., 2010).

Despite these limitations, self-reported assessments remain clinically useful. They offer valuable insights into patient distress, perceptions of cognitive functioning, and can help identify individuals with subtle cognitive issues who may benefit from further evaluation, neuropsychological testing, or additional support services (Oliveira, 2022).

Table 4.6: Common self-reported measures for assessing cognition in women with breast cancer.

Tool Name	**Description**	**Domains Assessed**	**Notes/Use in Breast Cancer**
Functional Assessment of Cancer Therapy – Cognitive Function (FACT-Cog)	37-item scale (Version 3) assessing perceived cognitive impairments, abilities, impact on quality of life, and others' perceptions.	Memory, attention, concentration, multitasking, quality of life	Most used self-report tool in breast cancer CRCI research. Validated in survivors; correlates with fatigue, depression.
Cognitive Failures Questionnaire (CFQ)	25-item scale measuring frequency of cognitive lapses in daily life (e.g., forgetfulness, distractibility).	Attention, memory, action slips, perception	Frequently used in cancer populations; sensitive to subjective cognitive change.
Patient Assessment of Own Functioning Inventory (PAOFI)	33-item tool measuring perceived difficulties in memory, language, motor skills, and higher-level cognition.	Working memory, executive function, and communication	Used in early studies of CRCI; aligns with objective findings in some populations.
PROMIS Cognitive Function Short Form	NIH-developed item bank with flexible short forms (e.g., 4, 8, 10-item versions).	Cognitive concerns and abilities	Used in clinical and research settings. Available in Computer Adaptive Testing (CAT)

			format. Increasingly used in cancer trials.
EORTC QLQ-C30 – Cognitive Functioning Subscale	Two items in the QLQ-C30 assess concentration and memory.	Global cognitive functioning	Part of the larger EORTC Quality of Life Questionnaire. Often used in trials but lacks cognitive depth.
Attentional Function Index (AFI)	16-item self-report of ability to direct attention in daily life, often used with cancer patients.	Attentional capacity, working memory, executive control	Used primarily with breast cancer survivors; sensitive to treatment effects.
Neuro-QoL Cognitive Function	Measures perceived cognitive functioning and its impact on social roles and daily activities.	Memory, attention, executive function	Developed by NIH; increasingly used in cancer survivorship research.

4.4.3.1 Cognitive screens

Cognitive screening tools have been used in research involving women with breast cancer who report cognitive changes. The Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) (Gaynor et al., 2021) are used for this purpose and presented in Table 4.7. These screens are clinically administered, involving the clinician asking the patient a range of questions to assess various cognitive domains. One limitation of these tools is that they rely on the patient having adequate vision and hearing for the assessment to be valid. However, unlike pen-and-paper self-report questionnaires, which patients complete themselves, cognitive screening tools are administered by clinicians. This allows for additional clinical observations to be made during the process.

While MMSE and MoCA are easy to access and administer, they are primarily sensitive to moderate and severe cognitive impairments (Cheung et al., 2012) and are most often used in older populations to screen for dementia (Magnuson et al., 2021). The American Society of

Clinical Oncology (ASCO) Guidelines for Geriatric Oncology recommend using either tool to detect cognitive impairment in older adults with cancer. As such, the MMSE and MoCA are unlikely to be effective in detecting mild cognitive deficits among women with breast cancer. These tools are not comprehensive and are designed to distinguish between moderate-to-severe impairment and normal functioning. Nevertheless, they may still serve as a basic or "blunt" screening tool to assess baseline cognitive status (Cheung et al., 2012).

The NSW Agency for Clinical Innovation, (2021) provides healthcare professionals with a range of screening and assessment tools for older people. However, there are currently no comparable resources or standardised cognitive screening tools available in the healthcare system specifically for people with cancer. Furthermore, there are no cognitive screening tools designed to identify work-related cognitive problems.

Table 4.7: Cognitive screens used for women with breast cancer reporting cognitive changes.

Test Name	Description	Domains Assessed	Interpretation of Score
Mini-Mental State Exam (MMSE)	Brief bedside assessment of orientation, memory, attention, language, and visuospatial skills.	Global cognitive functioning, dementia screening.	Scores below 24/30 suggest possible cognitive impairment.
Montreal Cognitive Assessment (MoCA)	Quick screening covering memory, executive function, language, visuospatial ability, and attention.	Mild cognitive impairment detection, global cognition.	Scores below 26/30 may indicate cognitive deficits, even in high-functioning individuals.

4.4.3.2 Self-reported cognitive measures about work

A common criticism of self-reported cognitive measures (e.g., FACT-Cog) is their generic nature and lack of specificity to everyday functioning (Haywood et al., 2023). However, two self-reported questionnaires include items that focus on cognitive functioning at work, as outlined in Table 4.8. Ottati & Feuerstein (2013) reported on the development of a targeted self-report tool for women with breast cancer experiencing cognitive difficulties in the workplace, the Cognitive Symptom Checklist–Work (CSW-C21). The CSW-C21 assesses occupational limitations related to cancer-related cognitive impairment across three domains: working memory, executive function, and task completion. Although not solely a cognitive assessment, the Work Limitations Questionnaire (WLQ) includes a Mental-Interpersonal Demands subscale that addresses cognitive challenges such as attention, memory, multitasking, and problem-solving at work (Von Ah et al., 2017, 2018). While these tools are useful for identifying work-related cognitive issues, they primarily focus on task-specific performance rather than broader participation or functional capacity. Additional assessments are needed to directly evaluate occupational difficulties related to specific tasks and work environments (Haywood et al., 2023).

Table 4.8: Self-report cognitive measures about work

Tool Name	How Administered	Work-Related Domains Assessed	Breast Cancer Findings
Cognitive Symptom Checklist–Work-21 (CSC-W21)	21-item self-report on on-the-job cognitive challenges (e.g., memory slips, multitasking difficulty).	Working memory, executive function, and task completion.	Developed and validated specifically for breast cancer survivors, showing strong reliability (α = 0.88) and valid correlations with job stress and cancer stage.

Work Limitations Questionnaire (WLQ)	25-item measure of how health issues affect work performance across four subscales (e.g., time mgmt., mental demands).	Subscale on mental-interpersonal tasks, output demands, attention, concentration, and memory	Used with breast cancer survivors; captured job performance impacts due to cognitive symptoms.

4.5 Alternative approach to assessing cognition and work function in women with cancer

Up to this point, the criticisms and challenges of the neuropsychological approach, using neuropsychological testing, as well as the ICF model with self-reported methods, have been described. In summary, neuropsychological testing is considered insufficient for evaluating cognitive functioning in women with breast cancer at work due to its lack of ecological validity. Such testing takes place in clinical environments without distractions and focuses on individual cognitive domains, which contributes to poor ecological validity. This approach fails to account for the complexities of a work environment with multitasking and work demands. Many self-reported cognitive questionnaires assessed within the ICF Model focus on the functional performance of cognitive domains; however, they lack relevance to a work setting. The CSC-W21 is the most relevant questionnaire because it directly relates to cognitive functioning at work. Nevertheless, self-reported measures are not supported by the ICCTF and are not considered reliable assessments by third-party stakeholders such as insurers, mainly because they do not correlate well with neuropsychological tests (Phan, 2022). Using the DSM-5-TR approach, which involves a clinically mediated assessment focusing on real-world and life functioning, appears to have the most merit. The Perceive, Recall, Plan, and Perform System of Task Analysis is a clinician-administered performance assessment (Ranka et

al., 2025) used to evaluate the effectiveness of cognitive strategy use during occupational participation. This uses a functional cognitive approach to assessment and intervention as opposed to a cognitive deficit approach.

4.5.1 The Perceive, Recall, Plan and Perform System of Task Analysis

The Perceive, Recall, Plan and Perform System of Task Analysis (Chapparo & Ranka, 2014) uses a functional cognition approach to assessment and intervention for people with cognitive challenges (Ranka et al., 2025) and is grounded in the Occupational Performance Model of Australia (OPM(A). The OPM(A) is built on two key theories pragmatism and dynamical systems theory. Pragmatism focuses on doing what works in real-life situations, valuing practical knowledge, context, and the lived experience of individuals. Dynamical systems theory sees occupational performance as a self-organising system shaped by internal (person) and external (environmental) contexts (Chapparo & Ranka, 2025). The dynamic assessment measures a person's occupational performance skill and cognitive strategy application strengths and these results guide interventions that focus on improving occupational participation by simultaneously addressing occupational performance mastery and cognitive strategy application requirements. It has been used in populations of children with autism and developmental delay (Challita et al., 2018) and adults with stroke (Smith et al., 2023; White et al., 2020), traumatic brain injury (Nott & Chapparo, 2008; Smith et al., 2023), schizophrenia (Aubin et al., 2009), HIV (Ranka & Chapparo, 2010) and dementia (Steultjens et al., 2012). It has not been used in a cancer population to date. The PRPP System of Task Analysis has been used to assess cognitive strategy use in everyday activities, including handwriting (Mathwin et al., 2023), meal preparation (Aubin et al., 2009), socialising (Challita et al., 2018), grocery shopping (Ranka & Chapparo, 2010) and other various activities of personal and instrumental daily living (Nott & Chapparo, 2008; Steultjens et al., 2012; White et al., 2020). Bootes & Chapparo, (2010) have used the PRPP System of Task Analysis to assess work occupations. The cultural

applicability of this assessment tool has also been considered in Indigenous Aboriginal populations in Australia (Smith et al., 2023).

4.5.2 Functional Cognition

Functional cognition refers to the "cognitive ability to perform daily life tasks, incorporating metacognition, executive function, other domains of cognitive functioning, motor performance skills and performance patterns" (Giles et al., 2020, p.2). Evaluations that use a functional cognition approach have ecologically validity, because the assessments have a strong 'representativeness' of a task, meaning the extent to which an assessment corresponds in everyday occupations and environments, and 'generalisability' of test results, which is the degree to which poor performance predicts everyday problems (Ranka et al., 2025). These assessments are classified as performance assessments (World Health Organization, 2001). They provide information about what a person does or perceives they do in everyday life contexts, measuring performance against specific criteria rather than a pre-determined norm (Ranka et al., 2025). This approach rejects notions of 'typical' and 'normal' in favour of 'specific' and 'particular' in relation to the client and their environment (Smith et al., 2023).-This approach is core to occupational therapy, as assessment of cognition is embedded in the performance of everyday activities, which are client-specific, nuanced, and context-specific interventions to be developed to promote occupational participation (Ranka et al., 2025). Expenditure on occupational therapy services that address functional cognition has been shown to lower hospital readmission rates (Giles et al, 2020). Despite this, some still call for traditional neuropsychological assessments to be conducted in tandem with assessments of functional cognition (Ranka et al., 2025).

4.5.3 Information Processing

The information processing model is a way of understanding how individuals use cognition in everyday functioning (Cambridge Cognition, 2023) and the challenges they may face in meeting the cognitive demands in different occupations and environments. Information processing is viewed as a self-organised cycle involving the collection, processing, and utilisation of information. The information processing model considers attention, perception, memory, thinking, response generation, and executive control as part of a continuous flow of information in the brain. As individuals participate in daily activities, they actively gather information from people, objects, and events in their environment. They mentally organise and encode this information to keep it accessible and comprehensible (Chapparo & Ranka, 2011). This information is then compared with previously acquired knowledge, noting similarities and differences in both performance and outcomes, and stored for future reference. Over time, individuals develop a wide range of automatic thinking skills, which streamline occupational performance. These automatic skills are strategically employed to solve problems and enhance the ability to remember how to perform tasks and adjust performance when necessary (Chapparo & Ranka, 2011). This process can be seen in Figure 4.8.

Cognitive strategies used for information processing during occupational participation are influenced by the demands of the occupation and environment, as well as the individual's processing capacity. During times of illness, fatigue, or emotional distress, people can struggle using the cognitive strategies required to meet these demands. For example, individuals may have trouble staying focused, miss important sensory signals, forget key information, lose their train of thought, or find it difficult to follow through with intentions. While these difficulties are often temporary for most people, individuals with neurological, psychological, developmental, or emotional disorders may experience persistent challenges in cognitive strategy use. The nature of the disorder is not seen as a deficit in cognition but as a difficulty in applying the

cognitive strategies required for safe and effective occupational participation (Ranka et al., 2025).

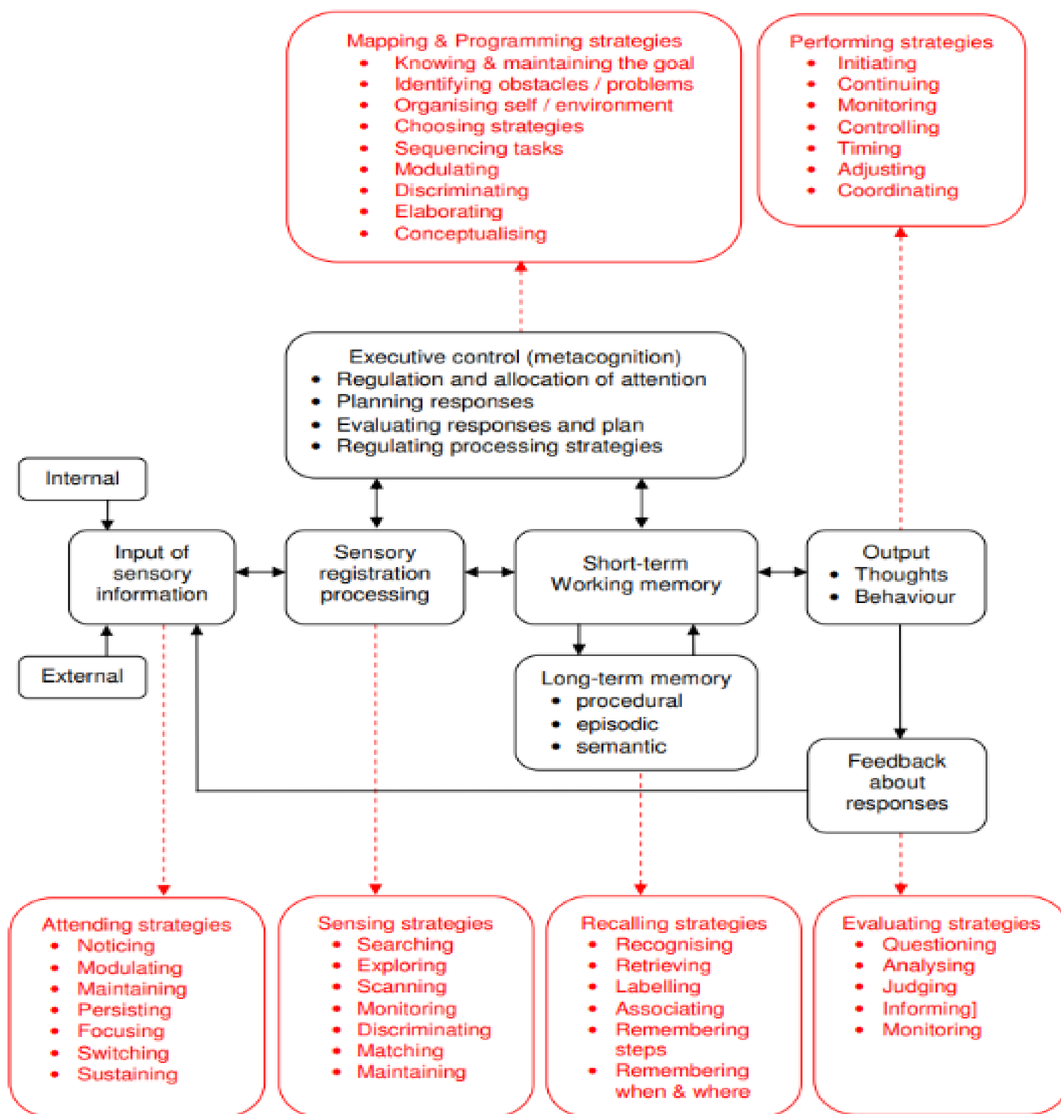

Figure 4.5: Information processing model with associated processing strategies.

4.5.4 The Perceive, Recall, Plan and Perform Assessment (PRPP-A)

The PRPP Assessment (PRPP-A) is an observation-based tool used exclusively by occupational therapists to assess task mastery and cognitive strategy application in clients' natural environments, focusing on everyday tasks that are personally and culturally meaningful (Ranka et al., 2025). It is administered in two stages. The occupation and criteria to be assessed

are collaboratively determined by the therapist, the client, and/or relevant others (e.g., parents, support worker, employer) based on what the individual is expected to do in their environment now and in the future (Chapparo & Ranka, 2011). From this, the therapist judiciously sets the performance criteria. These criteria are person-specific, which is different from other cognitive assessment tools that measure against one standard criterion (White et al., 2020). Stage One and Stage Two can be conducted via direct therapist observation (Ranka & Chapparo, 2010), a structured therapist interview (Bootes & Chapparo, 2010, 2013), and/or a structured questionnaire (Bootes & Chapparo, 2013; Chapparo et al., 2013). Occupational therapists must participate in a standardised 5-day training course to administer the PRPP-A (Chapparo & Ranka, 2014).

Stage One: Performance Mastery

Stage One measures performance mastery. Task analysis is used to break down the sample of occupations into roles, routines, tasks, steps, skill sets, or social interactions. Therapists observe the person performing a sample of occupations and determine whether routine or task performance is effective compared to the person-specific criteria established. Performance is observed and scored using a standardised rubric of four types of errors: accuracy, omission, repetition, and timing (Nott et al., 2009). The overall task mastery score is calculated by dividing the number of error-free steps by the total number of steps and converting this to a percentage (Steultjens et al., 2012). Scores of 85% or greater indicate effective performance (Aubin et al., 2009; Ranka & Chapparo, 2010). This score is then compared to the person-specific expected performance criteria for the task.

Stage Two: Cognitive Strategy Application

Stage Two measures the use of cognitive strategies during performance, identifying strengths and reasons for reduced mastery. It considers information processing from within the person and the context to shape action in everyday life. The goal of assessing cognitive strategy

application is to determine whether people can process information required by specific occupations in specific contexts to meet their own or others' requirements. The Stage Two model is presented in Figure 4.9. Information processing occurs in four central dimensions (inner layer of Figure 4.9):

1. Perceive (sensory registration information)
2. Recall (memory - storing and retrieving information)
3. Plan (planning and evaluating decisions)
4. Perform (initiating action and monitoring performance) (Ranka, Chapparo & Nott, 2025).

These four quadrants are further broken down into 12 sub-quadrants, which represent information processing operations (middle layer of Figure 4.9) and are comparable to the 'cognitive domains' described in traditional neuropsychological approaches. Each sub-quadrant contains two or three descriptors (outer layer in Figure 4.9), with a total of 35. The 35 descriptors are cognitive strategy applications, each with operational definitions. Descriptors are considered observable behaviours. Cognitive strategies or 'tactics' are defined as internal mental techniques used to process and respond to information in the 'here and now' (Chapparo & Ranka, 2011). The therapist interviews and observes the client's behaviours during the assessment in consideration of these cognitive strategy descriptors. Effective task performance requires the interplay between the four quadrants and flexible, spontaneous use of the descriptor behaviours (Chapparo & Ranka, 2011). This is demonstrated through the multidirectional and recursive arrows in Figure 4.9.

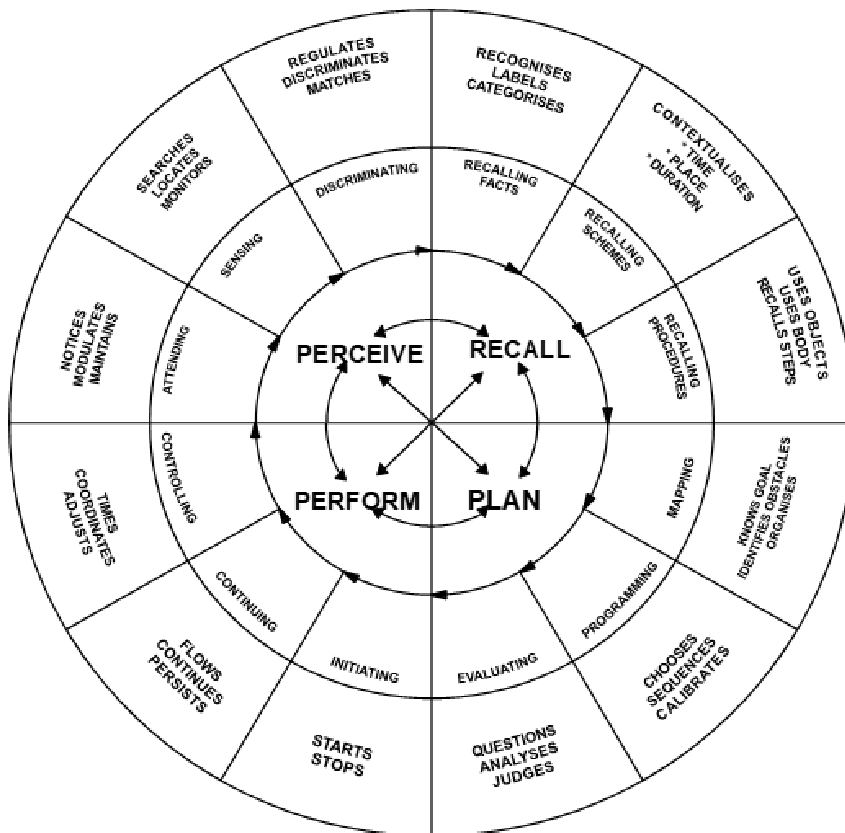

Figure 4.6: The Perceive, Recall, Plan and Perform (PRPP) Assessment Stage Two Conceptual Model.

Occupational therapists administering Stage Two engage in practice reasoning questions to guide quality and ethical practice, asking themselves about the cognitive strategies demanded by the occupation and context. These are presented in Figure 4.10, and for example include:

- What cognitive strategies does this occupation demand?
- What cognitive strategies does the participation context demand?
- Is the person applying the cognitive strategies needed for safe, effective, ethical performance in context?

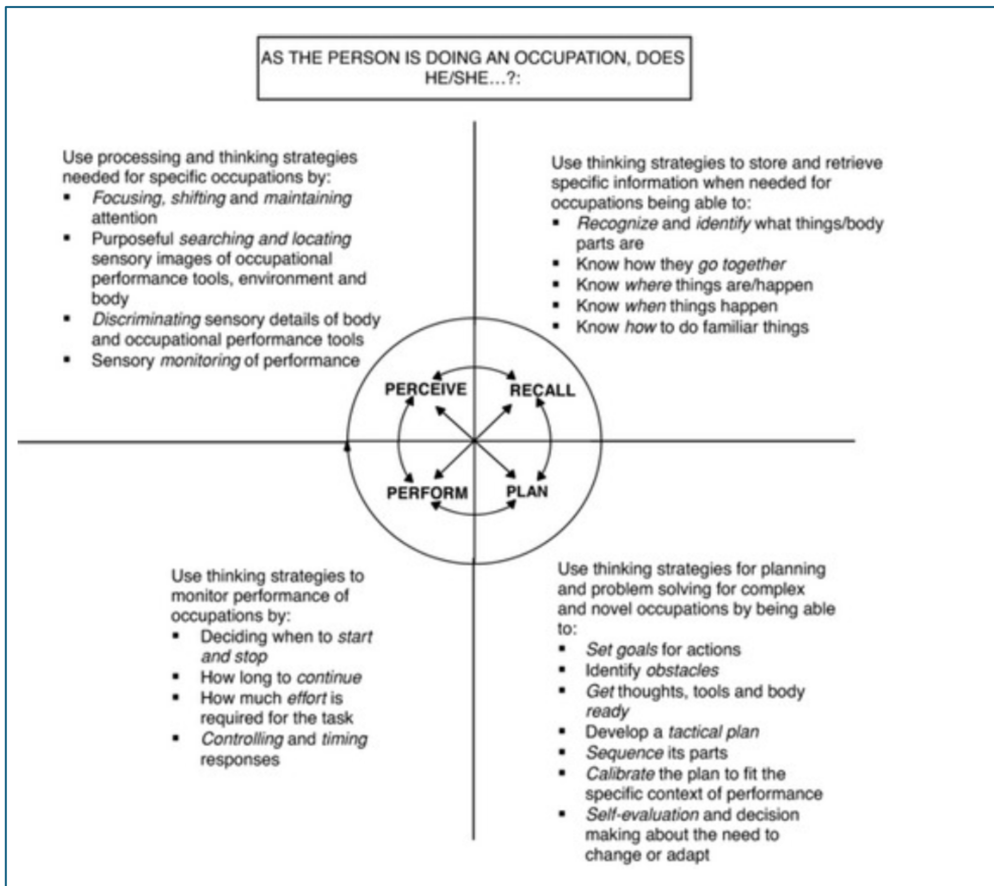

Figure 4.7: Practice reasoning questions to guide evaluation of cognitive strategies.

4.6 A pilot study to determine how the PRPP-A could be used with a breast cancer population to identify cognitive problems at work

Given the difficulties women with breast cancer experience when returning to work and the potential for cognitive problems to be a major contributor, the PRPP-A was applied to pre-collected data from another study (Player et al., 2014). In Player et al. (2014), women were interviewed about their everyday cognitive changes after breast cancer, particularly in their occupational productivity. The interviews, conducted by occupational therapy students, were semi-structured and did not use a functional cognition assessment approach. The data was presented in written transcripts, and PRPP-A Stage 2 was applied to this transcript data. This pilot study aimed to examine whether the PRPP-A could detect cognitive strengths and deficits experienced by women with breast cancer in their work occupations. As the PRPP-A had not been utilised with a cancer population before and did not use a traditional observation or direct interview approach, this was considered an exploratory study conducted under the guidance of the PRPP-A authors (Chapparo & Ranka, 2014) to determine further research needs in this population.

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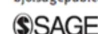

Work after breast cancer: Identification of cognitive difficulties using the Perceive, Recall, Plan, and Perform (PRPP) System of Task Analysis

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Abstract

Introduction: Few ecologically valid assessment tools are available for occupational therapists to evaluate the cognitive demands and performance of women with breast cancer in the workplace. This study aims to identify difficulties in work-related cognitive strategy use experienced by women with breast cancer using the Perceive, Recall, Plan, and Perform (PRPP) System of Task Analysis.
Method: Deductive content analysis was used to code secondary data from 10 interview transcripts involving women who had breast cancer and experienced difficulties in everyday cognitive functioning after treatment. Thirty-four PRPP cognitive strategy items were used as pre-determined codes in a secondary analysis to identify and quantify specific cognitive difficulties described by the women.
Results: The 10 women experienced problems with work tasks that required the cognitive strategies related to the 'programming', 'continuing', and 'attending' processing categories of the PRPP system. In addition, the women demonstrated strengths in their capacity to evaluate their own thinking and performance.
Conclusion: This pilot study indicated the need for further research to determine how cognitive impairments which may occur after breast cancer treatment impact on occupational performance in a complex work environment. The PRPP System of Task Analysis was identified as a potentially useful measurement and interview tool for this purpose.

Keywords

Breast cancer, cognition, return to work

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Introduction

Resuming work is seen as a crucial milestone after breast cancer (Duijts et al., 2014; Munir et al., 2010). However, many women report ongoing cognitive problems which impede return to work (Player et al., 2014). Associated self-confidence and job security issues arise when work performance is impacted by cognitive impairment (Becker et al., 2015). There are few ecologically valid assessment tools (Nelson et al., 2014) which occupational therapists can use to evaluate the cognitive demands of women with breast cancer during work performance (Newman, 2013), enabling return to work interventions to be planned. This pilot study used the Perceive, Recall, Plan, and Perform (PRPP) System of Task Analysis (Chapparo and Ranka, 2014) to identify difficulties in work-related cognitive strategy use experienced by women with breast cancer.

Literature review

Breast cancer and work

The survival rate for women with breast cancer is now 5 to 10 years, making the 'survivorship' phase an important consideration in the continuum of return to everyday activities. Women with breast cancer have identified returning to work as a significant stage in their recovery (Munir et al., 2010). While it is estimated that 60% of cancer survivors are of working age (Oberst et al., 2010), there is little information about how cancer and related treatments impact on return to work. Diminished quality of work, as well as a reduction in quantity of work, have been suggested, leading to absenteeism, presenteeism, performance management, problems working with colleagues, early retirement, and termination of employment or resignation (Boykoff et al., 2009).

Despite research showing that breast cancer survivors score significantly lower in the cognitive domains of

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executive functioning, working memory, and divided attention, than non-cancer controls (Lindner et al., 2014), female breast cancer survivors report frustration at the lack of acknowledgement that they receive from many health professionals when they report cognitive difficulties (Becker et al., 2015; Player et al., 2014). They report that their work performance is affected by physical (fatigue, reduced upper limb function, and sensory discriminations) (Tager et al., 2010), psychological (anxiety, distress, and depression), and cognitive difficulties (Boykoff et al., 2009). Specific cognitive difficulties include reduced attention, memory, concentration, multi-tasking, organising information, and processing speed in their everyday and work tasks (Becker et al., 2015; Vardy and Dhillon, 2011). Some studies have shown these cognitive difficulties to last months and years after treatment has ceased (Oberst et al., 2010).

Possible causal factors of cancer-related cognitive changes

Several hypotheses have been associated with cancer-related cognitive changes (CRCC) in breast cancer survivors (Ahles et al., 2012). Two assumptions form the foundation of studies exploring the causality of CRCC. First, women with breast cancer have normal cognitive functioning prior to any treatment. Second, that chemotherapy has been the agent responsible for cognitive changes noted by women, neuropsychological tests, and imaging studies (Ahles et al., 2012). Studies which have been able to obtain pre and post chemotherapy cognitive testing on women with breast cancer indicate 20–30% of women had lower than expected cognitive performance, based on education level and age, before commencing any treatment or having surgery, and was not correlated with psychological factors such as depression or anxiety (Castellon et al., 2004; Wefel et al., 2004). This would suggest that factors other than drug therapy (such as chemotherapy) be considered as causal factors. Other possible factors may include ageing, genetics, and hormone drug therapies (Vardy and Dhillon, 2011).

Neuroanatomical changes

Magnetic resonance imaging (MRI) and positron emission tomography (PET) studies carried out during the performance of selected neuropsychological tests (such as short-term verbal memory tasks) have shown specific functional and structural changes of the brain that occur with CRCC. First, there is decreased neural function in frontal (Ferguson et al., 2007; Inagaki et al., 2007; Silverman et al., 2007), hippocampal (Inagaki et al., 2007), and cerebellar structures (Silverman et al., 2007) which contribute to language, planning, memory, and coordination. Second, these studies also showed breast cancer survivors had wider recruitment of neural activity during such simple cognitive tasks when compared to those without breast cancer. Researchers hypothesised that women breast cancer survivors may recruit additional brain regions to perform specific cognitive tasks in an attempt to compensate for subtle changes in cognitive ability (Ferguson et al., 2007), increasing the cognitive load, and therefore the overall performance effort for even simple everyday tasks.

Measurement of cancer-related cognitive changes

The two forms of measurement commonly used to identify CRCC in women with breast cancer are neuropsychological testing and self-report measures (Newman, 2013), of which there have been inconsistent correlations (Moore, 2014; Tager et al., 2010). Castellon et al. (2004) reported that individual perception of CRCC appeared worse than objective neuropsychological assessment results for women breast cancer survivors.

A meta-analysis by Lindner et al. (2014) found that breast cancer survivors performed more poorly on neuropsychological tests, compared to norms and health, age, and education matched women. It is estimated that 15–25% of women experience cognitive impairments for months or years after treatment (Ahles et al., 2012); however, some estimates are as high as 60% (Vodermaier, 2009). While some women report profound cognitive deficits, for most, the effects are subtle or mild. Many of the neuropsychological tests used to detect CRCC in women with breast cancer were intended for assessment of individuals that had sustained traumatic brain injury, stroke, or dementia, where the impairments are likely to be moderate to severe.

The ability of neuropsychological tests to detect subtle or mild changes in everyday performance is poor in community functioning people with other mild neurocognitive disorders similar to CRCC (Aubin et al., 2014; Bootes and Chapparo, 2010). Conditions required for standardised neuropsychological test administration do not reflect real life everyday environments and the events in which women have reported difficulty. CRCC experienced in normal everyday occupations may not be reflected and evaluated in these standardised assessments. Women with breast cancer report problems with complex tasks such as driving or multi-tasking at work (Reid-Arndt et al., 2009). Such tasks require dynamic use of cognitive strategies in 'real time'. A persistent but subtle cognitive impairment appears to make a significant impact, particularly in the workplace.

There are a variety of self-reported measures issued to women breast cancer survivors to rate their cognitive limitations and abilities. For example, the functional assessment of cancer therapy – cognition (FACT-Cog) (Ottati and Feuerstein, 2013) tests immediate and delayed verbal memory and executive function and, while demonstrating good concurrent validity with other neuropsychological measures (Von Ah and Tallman, 2015), lacks applicability to a complex work environment. Ottati and Feuerstein (2013) developed a brief 21-item measure of the cognitive symptom checklist-work-59 (CSC-W59), asserting it can be used to quickly assess work-related cognitive problems

for breast cancer survivors. While Moore (2014) suggests a current need for standardised self-reported measures of cognitive function for use in daily practice, they are viewed as somewhat subjective and lack credibility among some health professionals as well as health funding schemes. The need for data collection methods and assessment tools that are simultaneously objective, reliable, and ecologically valid is required for this sensitive area of practice.

The PRPP System of Task Analysis

The PRPP System of Task Analysis is a process-orientated, criterion referenced assessment that uses task analysis methods to identify problems with cognitive strategy use (Chapparo and Ranka, 2014). The assessment targets everyday functional tasks performed in the context of the person's natural home and work environment (Bootes and Chapparo, 2010). An underlying assumption of the assessment is that a person's capacity to process the cognitive demands inherent in everyday tasks can be observed, identified, and used to determine the need for occupational therapy (Chapparo and Ranka, 2014).

The PRPP conceptual model used as the framework for analysis in this study is based on four information processing typologies used during task performance. Termed 'quadrants', these are based on information processing theory and reflect sensory perception (perceive), memory (recall), response planning and evaluation (plan), and performance monitoring (perform) (Chapparo and Ranka, 2014). These four processing quadrants are illustrated as the inner layer of the PRPP System model (Figure 1).

The four PRPP quadrants are divided into a further 12 sub-quadrants (middle layer Figure 1) and 35 cognitive strategies (termed *descriptors*) form the outer layer of the PRPP System model, and are considered cognitive strategy behaviours that can be observed by the assessor. Stage 2 of the PRPP analysis involves rating the participant's performance on a three point scale, indicating how effectively the person applied each cognitive strategy (3 = effective for task performance, 2 = questionable, 1 = not effective).

The PRPP is administered through the use of 'occupation sampling', where specific tasks and routines nominated by the client or others in the client situation are used as examples of cognitive strategy application difficulties generally experienced in daily living (Chapparo and Ranka, 2014). This general and specific information is obtained by using three data collection methods, each of

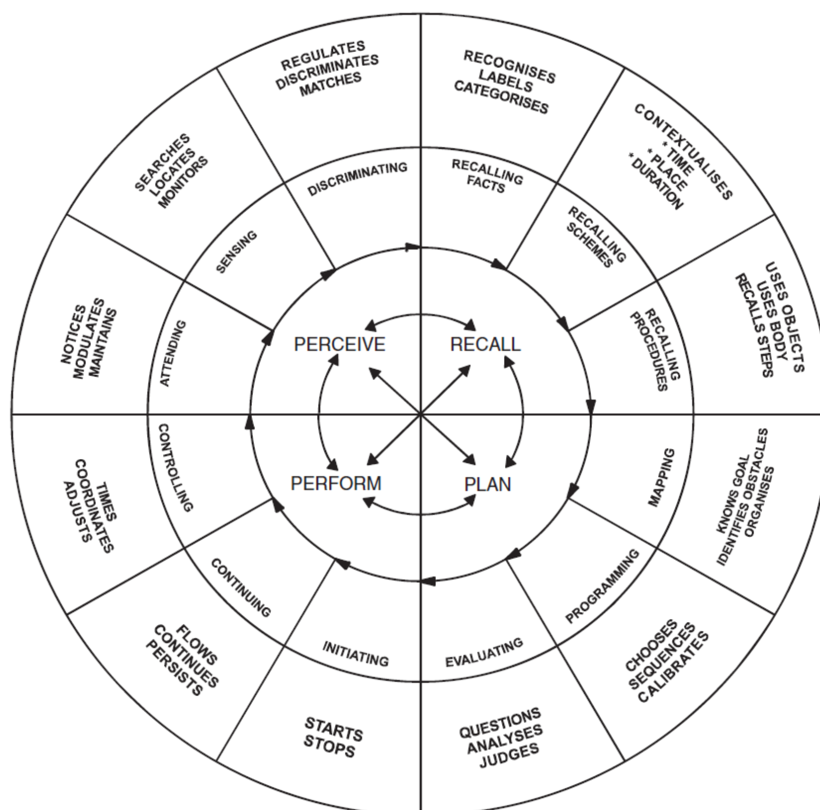

Figure 1. The perceive, recall, plan, and perform system model (Chapparo and Ranka, 2014).

which has demonstrated reliability and validity. First, observation of task performance yields a description of cognitive strategy use strengths and weaknesses that can be scored by a therapist observer. Second, questionnaire formats have been developed for use at school (Chapparo et al., 2013) and work (Bootes and Chapparo, 2013) that generate information about specific cognitive difficulties as conceptualised by stage two of the PRPP conceptual model. Third, interview formats can be used in situations where observation is not possible (Bootes and Chapparo, 2010, 2013). In an interview format, general information is sought about the difficulties experienced by the client, with follow up probes to obtain descriptions of examples of task performance where these general difficulties are experienced. From the descriptions of general and specific instances of reduced cognitive strategy use, a score can be derived to represent the extent of difficulties perceived by the interviewee. This third method of PRPP data collection was utilised in this study.

The PRPP has demonstrated reliability and validity for identifying cognitive strategy application deficits in adults with acquired brain injury (Nott and Chapparo, 2012), HIV-related dementia (Ranka and Chapparo, 2010), and schizophrenia (Aubin et al., 2014), but not for cancer patients. Studies (Calvio et al., 2010; Nelson et al., 2014) have called for more research into appropriate cognitive assessment methods for women with breast cancer that offer alternatives to current neuropsychological test methods and are work focused. Therefore, this pilot study sought to use the PRPP System of Task Analysis to identify specific cognitive strategy strengths and difficulties experienced by women with breast cancer when returning to work.

Method

Design

This study adopted a qualitative approach using deductive content analysis of secondary qualitative data which had been collected for a previous study and which described difficulties with everyday function experienced by women with breast cancer (Player et al., 2014). Qualitative inquiry was employed for this study because: (a) the focus was on the subjective experiences of women with neurocognitive disorder who returned to work after breast cancer; (b) subjective experience is time and context dependent and the purpose of the study was to discover how women experienced cognitive strategy disorder in their particular work contexts at the time of task performance; (c) the purpose of the research was not to discover generalisable 'truths' about CRCC, but to develop working hypotheses for further research; and (d) this inquiry was not concerned with causal relationships, but rather with the 'mutual shaping' of variables. This study sought to describe the subjective experiences of cognitive strategy use of women who returned to work after breast cancer.

Data collection

Secondary data were generated from transcribed narratives about women's experiences of 'chemo-brain'. The original interview questions did not focus on pre-determined cognitive assessments, but used a broad ethnological approach to explore the meaning that cognitive changes had on their daily lives. While the women were not asked directly about the impact of cognitive changes on their productivity, almost all voluntarily disclosed the impact of CRCC on their work tasks and their productivity role.

Participants

The participants in this study were previously recruited through methods utilised in a previous study (Player et al., 2014). The Player et al. (2014) study recruited women aged 40–70 years at time of diagnosis of breast cancer and who were undergoing or had completed chemotherapy, as they represented women of working age. Women were invited to participate in the study if they self-identified cognitive difficulties, were fluent in English, and lived in New South Wales.

Participants were 10 women aged 39–67 years old and had stage II or III breast cancer. Two had recurrent breast cancer. One woman was still receiving chemotherapy; others ranged from six months to two years since completing treatment. Seven women lived at home in metropolitan areas and three in rural areas. Eight women were in paid (open) employment at the time of the interview, but two were unsuccessful in their attempt to return to work. The occupations of the participants were as follows:

- Manager or administrator – 1
- Professionals – 5
- Associate professional – 1
- Advanced clerical or service worker – 1
- Intermediate clerical, sales, or service work – 2

Ethics approval for the original data collection and subsequent secondary analysis was received from the University of Sydney Human Research Ethics Committee.

Analysis of secondary data

Qualitative deductive content analysis was used to thematically re-code the 10 interview transcripts (Schreier, 2012). Deductive analysis starts with a preliminary conceptual model of the target of the research and generates probable explanatory hypotheses (Neuendorf, 2002). In this study, the target topic was cognitive strategy use during everyday task performance as conceptualised by the PRPP System of Task Analysis. Evidence of effective and/or ineffective cognitive strategy use was sought in the transcripts.

Three steps to deductive analysis were used in this study:

1. Conceptual units that represented cognitive strategy use during task performance were generated from the PRPP

system of task analysis standardised terms (Chapparo and Ranka, 2014).

2. These analytic units were synthesised and 'operationalised' into 12 main themes or codes, representing the sub-quadrant cognitive processing units in the PRPP System (see middle layer, Figure 1).
3. The PRPP codes were matched to the body of data in the transcripts using the following process.

First, the content of all transcripts was read several times. Second, the data were scanned line by line for meaningful 'chunks' of information. Data were broken down into the smallest pieces of information that could stand alone and be 'interpretable' in the absence of any additional information (Guba and Lincoln, 2005). This ranged from a phrase to whole paragraphs. Repeated analysis of examples given by participants about procedural (task mastery) and strategy application (cognitive) elements of home and work tasks enabled the researchers to establish and validate text meaning in comparison to concepts contained in the PRPP conceptual assessment model. Third, the 34 PRPP descriptors were used as a coding system. Each characteristic representing cognitive strategy use was taken one at a time. This involved identifying any of the 34 PRPP cognitive strategy descriptors described by the participant in the interview. The data were individually combed for evidence of (a) the presence or absence of the cognitive strategy, and (b) how the strategy was expressed in the interview data (Table 1). This involved reading, comparing, and coding successive data units on a 'feel-like' or 'look-like' basis using the standardised definitions in the PRPP System of Task Analysis assessment manual (Chapparo and Ranka, 2014) (Figure 1). When statements were aligned with more than one particular cognitive strategy, consensus between the researchers and independent assessor was used to determine its analytical placement. Fourth, the nominated cognitive strategies for each participant were then scored using the 1, 2, 3, standardised scoring rubric on stage 2 of the PRPP System. Finally, after all 10 transcripts were thematically analysed, coded and scored, the stage 2 scores were entered into an Excel database for conversion into descriptive statistics and visual analysis.

Findings

Findings are presented in two sections to answer the research aim, which was to identify the difficulties in cognitive strategy use experienced on return to work by 10 women breast cancer survivors who had undergone chemotherapy. First, difficulties as identified by the PRPP model and examples of accompanying narrative are given to illustrate three particular cognitive strategy application difficulties that were common to all the women. In this section, the women are identified by their participant number. Second, the group participant scores are presented and graphed visually, showing the minimum, maximum, and average PRPP sub-quadrant scores for the 10 participants (Table 2 and Figure 2). This mixed method approach is supported by

Table 1. Cognitive strategy expressed in interview data.

PRPP cognitive strategy items	PRPP standardised sub-quadrant definition	Quotation from transcript that fits the definition
Questions **Analyses**	Questions: verbally enquires about the location of missing items. Hesitates, looks at, or examines the task momentarily prior to making appropriate changes. Analyses: stops to evaluate a specific constraint.	'I would go and do something that I knew how to do like use my food processor . . . **I'd push the button and nothing would happen, I would look at it, and think "Why isn't this working?" I'd take it all apart and put it together again and then think** . . . oh I haven't plugged it in . . . [therefore] things would take me ages.' P8
Recalls steps	Performs the general and specific procedures and steps needed for known tasks and routines.	**'I would go and do something that I knew how to do like use my food processor . . . I'd push the button** and nothing would happen, I would look at it, and think "Why isn't this working?" I'd take it all apart and put it together again and then think . . . **oh I haven't plugged it in** . . . [therefore] things would take me ages.' P8
Contextualises to time	Remembers time. Performs at a known time.	**'Have to keep backtracking at the shops, because I had forgotten things. I don't know what time,** and I don't know how long to take and I don't know how I'm going to get there.' P7
Contextualises to place	Remembers place. Performs in known place.	**'Have to keep backtracking at the shops, because I had forgotten things.** I don't know what time, and I don't know how long to take **and I don't know how I'm going to get there.'** P7
Organises	Arrange objects and body to begin task. Rearranges environment as task progresses.	'My husband makes a lot of the **decisions** now- . . . like **"where do we want to be", what do we have to do, what do we have to get done?'** P3

PRPP: Perceive, Recall, Plan, and Perform

Table 2. Minimum, maximum, average, and standard deviation scores for group PRPP (perceive, recall, plan, and perform) sub-quadrant scores.

Sub-quadrant	Facts	Schemes	Procedures	Mapping	Programming	Evaluating	Initiating	Continuing	Controlling	Attending	Sensing	Discriminating
Minimum % score[a,d]	34	34	78	56	34	68	34	34	34	34	56	56
Maximum % score[b,d]	100	100	100	100	89	100	100	100	100	100	100	100
Average % score[c,d]	81.3	80.2	84.6	76	61.5	90.4	80.3	61.5	82.4	63.7	90.1	89
Standard deviation	19.4	24.2	9.3	15.3	15.8	15.5	27.8	21.5	20.2	28.4	15.1	15.6

[a]Minimum % score: This is the lowest score achieved by any one or more participants in the group. These scores are plotted as the dotted line on the radar graph in Figure 2.
[b]Maximum % score: This is the highest score achieved by any one or more participants in the group. These scores are plotted as the dash line on the radar graph in Figure 2.
[c]Average % score: All participants score for the sub-quadrant divided by the number of participants (10). These scores are plotted as the bold line on the radar graph in Figure 2.
[d]Expected performance is 90–100%.

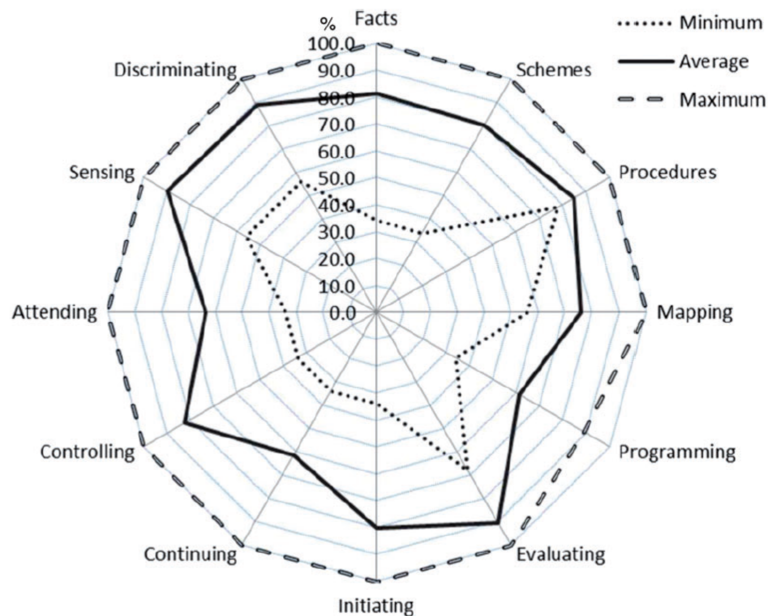

Figure 2. Radar graph illustrating group average minimum, maximum, and average Perceive, Recall, Plan, and Perform sub-quadrant scores.

constructivist researchers such as Mackenzie and Knipe (2006: 3), who stated that 'quantitative data may be utilised in a way, which supports or expands upon qualitative data and effectively deepens the description'.

Cognitive strategy use difficulties: Individual perspectives

All women gave examples of how they perceived CRCC to have reduced their self-confidence in their work ability. Participant 10, for example, stated that 'the employer can't see this underlying effort... it is difficult for them to understand... hard to explain why you aren't coping... affects your confidence in ability to do job'. Worry and distress over their inability to 'think straight' when needed were apparent, with some of the women indicating: 'I'm worried the cognitive problems will affect my ability to do my job' (P4). An additional concern centred on the impact of CRCC on their relationships with employers and colleagues, illustrated by P6, who stated: '... it [chemo-brain] caused problems with my work mates'.

While all 10 women described individual amounts and types of deficits in cognitive strategy application

difficulties, thematic coding using the PRPP sub-quadrant nomenclature indicated three areas received the most comment in the transcripts. These were 'programming' (chooses, sequences, calibrates), 'continuing' (flows, continues, persists), and 'attending' (notices, modulates, maintains) (Figure 1).

Programming. Programming is defined as the ability to choose an appropriate cognitive strategy based on the task requirement, then sequence and calibrate a plan of action and adapt this plan when required. Programming is responsible for being able to respond to novel and complex situations in a logical progression without unnecessary time to think (Chapparo and Ranka, 2014). Common programming difficulties experienced by participants in their work environment are described by Participant 3: 'You think at the time you are doing something right, and then you're not . . . then I can't think how to go forward because I know I have made these boo-boos', and Participant 5: 'What was affected was my personal strategies for dealing with things that didn't go my way.'

Specifically, these two quotations illustrate that while these women had knowledge about how to proceed with a known task, they were unable to change the plan and reformat performance when the situation demanded. They lacked flexibility in thinking strategies to enable rapid changes in response to a changing context.

Continuing. Continuing is defined as the cognitive strategies used to smooth out the sequenced response so that all the steps of the sequence are complete. Continuing is responsible for cognitive effort being produced in the face of obstacles that may arise so that performance persists (Chapparo and Ranka, 2014). Difficulty with continuing and persisting may be commonly misinterpreted as physical fatigue, but as Participant 10 indicates, cognitive fatigue may be a large component of the fatigue experienced by breast cancer survivors: 'Fatigue from effort about thinking about everything, and then takes 1 or 2 days to recover . . . taking longer to do something that you'd normally do.' Participant 7 similarly illustrates how this cognitive effort feels, stating: 'It's as though you've got glue in the system', and goes on to further describe how she has 'cut down the number of clients but still working as hard and as long'. Participant 9 describes how she would 'last about half an hour then fall off the mental perch'. Without an adequate compensatory strategy, she indicated that as a result she 'would go to work, but actually not do anything'. Participant 10 sums up the concerns voiced by some of the women when she recounted how she perceived her work performance to be different to pre-cancer work and having to 'look like' everything is alright in the presence of employers and work colleagues: 'It looks like you are doing fine on the outside . . . But the cognitive effort required to do the task in the expected time requires so much more cognitive effort than before cancer.'

Attending. Attending is defined as using cognitive strategies to notice, switch, modulate, and maintain attention on body, task, and environment. Attending is responsible for deciding what to attend to and what sensory information is or is not central to task performance (Chapparo and Ranka, 2014). Many quotations demonstrated the attending difficulties experienced by participants in their work environment. For example, participants recounted situations where noticing things in context during driving was an issue. 'I didn't see the car' (P2) and 'I hit the rail in the garage several times' (P10). Participant 7 found 'challenges in car parks, traffic lights . . . and roundabouts' while Participant 9 stated: 'I wasn't getting that "it's all clear" kind of message from myself'.

Concentration (PRPP 'maintains') appeared to be a common attention issue. Participant 7 indicated: 'I only read half the email message, then reply', while others made remarkably similar statements: 'Concentrating is hard . . . I feel agitated' (P2); 'I just can't do the concentrating like I used to' (P3); and 'I just sit there staring' (P1).

Cognitive strategy use difficulties and strengths: Group

The participants' sub-quadrant scores were summed and converted into an average score for the group of 10 women. Table 2 shows the group average and standard deviation score. Additionally, to demonstrate the range of scores within the group, the lowest and highest score from within the group for each of the 12 sub-quadrants was plotted (Figure 2).

Difficulties in cognitive strategy use. As a criterion-related assessment, the PRPP measures what a person can do against the individual standards set by their situation (Linn and Gronlund, 2000). Expected performance on the PRPP sub-quadrant score for functional cognitive strategy use during everyday activities is 90–100% (Linn and Gronlund, 2000). The 10 participants reported cognitive strategy difficulties at work in three to 11 PRPP sub-quadrants. On average, the participants had deficits in 7.4 of the sub-quadrants.

As seen in Table 2 and Figure 2, the only sub-quadrant in which no participant scored 100% as a maximum score was the planning sub-quadrant, 'programming', indicating that, in this group of women, planning was perhaps the most vulnerable cognitive strategy grouping to be impacted during work tasks. The 'programming' sub-quadrant includes 'chooses', 'sequences', and 'calibrates' cognitive strategy behaviours. In all other sub-quadrants, at least one participant scored 100%, indicating no difficulty. The minimum score obtained from the 10 participants shows low (34%) scores obtained for the sub-quadrants of 'facts', 'schemes', 'programming', 'initiating', 'continuing', 'controlling', and 'attending', indicating that the type of cognitive deficit experienced by women during work tasks is variable in type and severity.

The average scores provide more insight about the prevalence of difficulties across the sub-quadrants. Of these average sub-quadrants scores, 'facts', 'schemes', 'initiating', and 'controlling' all have averages of 80% or

more, probably indicating that the majority of the group are processing well in these areas, with perhaps one or two participants experiencing significant CRCC with those strategies. Alternatively, the lowest average scores were demonstrated in the sub-quadrants 'programming' (chooses, sequences, calibrates), 'continuing' (flows, continues, persists), and 'attending' (notices, modulates, maintains). This may indicate that these cognitive strategies are more vulnerable to CRCC, and confirms the emphasis given to these strategies by the women in their narratives. Other planning strategies used for mapping (knows goal, identifies obstacles, organises) had a minimum score of 56% and an average of 76%. While this was not the lowest score, when the average score is considered with the standard deviation of 15.3 this may indicate another area of difficulty that has impact on a number of the women's activities.

Strengths in cognitive strategy use. The PRPP was also able to identify cognitive strategy strengths. Strengths can be identified by findings which demonstrate PRPP sub-quadrants that have high percentage minimum scores, together with high percentage maximum scores, high averages, and low standard deviations.

For the minimum scores, Figure 2 shows high scores (greater than 50%) for: recalling procedures (uses objects, uses body, recall steps) (78%); evaluating (questions, judges, analyses) (63%); sensing (searches, locates, monitors) (56%); and discriminating (regulates, discriminates, matches) (56%).

The average for these sub-quadrants is 80–90%, which is in the range of what is expected of a criterion-related outcome. The standard deviation of 9.3 for 'recalls procedures', memory for how to do known activities, indicates it is the most common strength amongst participants in this study. The sub-quadrant 'evaluates', or the ability to question and analyse a situation and one's own performance effectively, is the second most common strength in these participants.

Discussion

A major finding of this study was that 'programming' was a problem for all 10 women in their work environments. Programming is one of the executive functions enabling problem-solving and planning, functions that have been identified in other studies as an associated difficulty experienced by women after breast cancer intervention (Duijts et al., 2014; Munir et al., 2010). However, from a PRPP perspective, the programming strategy group (chooses, sequences, calibrates) in this study more specifically targeted women being able to cope with changing situations in the work context. While the women were able to programme predictable events, they had particular problems generating an appropriate and timely course of action 'on the spot'. The ability to engage in this type of programming is critical to work in open employment, particularly professional and/or cognitively demanding work tasks, or situations where multi-tasking is required (Boykoff et al., 2009). These types of work situations are more likely to have duties and tasks that require workers to be able to cope with novel and complex situations rather than routine and repetitive tasks. It is possible that women who have occupations that are cognitively demanding, include many interruptions, or have challenging timelines are more likely to identify deficits in this area. Preliminary research indicating that doctors specify 'high functioning women' to be more likely to report cognitive changes (Smidt, 2014) supports this hypothesis. Further research would benefit from matching occupation classifications with particular cognitive strategy difficulties.

Deficits in the PRPP sub-quadrants of 'attending' and 'continuing' are supported by similar reports from studies using neuropsychological tests and self-reported measures (Duijts et al., 2014; Ottati and Feuerstein, 2103; Wefel et al., 2004). The findings from this study indicate that women spend more time and effort attending to tasks and re-programming a response to new stimuli, in comparison to pre-cancer performance. Participants likened the disturbance to 'a hidden disability' which was experienced by them but difficult to explain, and only observable to others by slow and hesitant work performance. The fMRI (functional magnetic resonance imaging) studies by Silverman et al. (2007) and Ferguson et al. (2007) support this finding. These studies, which showed increased neuronal activity during task performance in comparison to non-cancer women, could be indicative of increased cognitive effort. It is possible that although women who experience CRCC are able to do their work, they are working harder to complete a task that was previously perceived as easy. No doubt such persistent cognitive load would result in cognitive fatigue (Mizuno et al., 2011) and hence further errors in work performance. The impact on women who are not prepared for such an outcome, and who do not have compensatory strategies to assist with return to work, may be to conceal their CRCC symptoms for fear of losing their job.

The transcripts of the women clearly focused on their perceived difficulties with cognitive strategy use. While there were no specific questions relating to perceived strengths, it was clear from their narratives, and use of the PRPP model, that the women had definite strengths which they used to assist performance. Further research to investigate a strengths-based approach to inquiry in this area of practice would be beneficial to women and those who provide intervention for them.

Occupational therapists play a unique role in assessing the impact of CRCC on women's ability to perform work tasks. While cognitive assessment and rehabilitation have often been considered the domain of psychologists and neuropsychologists, Nelson et al. (2014: 2) call for a broader range of psychological scientists to 'bring their expertise' to the area of CRCC to help address some of the challenges presented by standardised neuropsychological testing in an aim to help improve the research and outcomes for women with breast cancer. Calvio et al. (2010) state that rather than dismissing women's reports of cognitive problems, a thorough exploration of the exact nature of the problems and active approaches should be

taken to reduce cognitive problems at work. Calvio et al. (2010) further state that there is a need for a more sensitive index of cognitive function at work. Where neuropsychological testing is able to identify cognitive trait deficits in isolation, this study demonstrated that the PRPP System of Task Analysis can evaluate how cognitive strategies interact in the context of job demands and workplace environment to impact on participation. Therefore, it is recommended that occupational therapists consider using the PRPP within a workplace assessment to highlight problems that are affecting the person–occupation–environment fit (Shaw and Strong, 2008).

The hypotheses arising from this study target the extent to which use of the PRPP during a workplace assessment may:

- Offer credible evidence to support women's self-reported difficulties upon return to work;
- Highlight how cognitive problems impact on a breast cancer survivor's work ability; and
- Provide justification about the type of workplace-based interventions that are needed to support women through other stakeholders, such as employers, private insurers, and government service providers.

It is possible that early workplace assessment and rehabilitation services, which target self-management of CRCC, may prevent instances of performance management, early retirement, and premature departure from the workforce, as described by other research (Boykoff et al., 2009; Duijts et al., 2014) and the women in this study.

Limitations of the study

The findings in this study relate only to those participating in the research. Other participants may have offered different data from those studied. It is likely that a larger number of participants would enhance the diversity of data obtained. Caution is suggested against generalising the findings to all women who experience CRCC who live in other geographical areas or who are of a different age range.

The data analysis was carried out on pre-existing information, and therefore is limited by the original data collection methods and questions. The questions did not focus on details of work performance to the level that purposeful PRPP interview methods suggest, and they were not asked directly about PRPP concepts. Consequently, detailed information about cognitive strategy use from an exploration of a variety of work scenarios was not obtained. However, the analysis was able to detect strengths and weaknesses experienced by this group of women in enough detail to generate scores, demonstrating the clinical utility of the tool and concepts. Further studies might achieve more robust triangulation and derive additional data from employing observation over time as well as interviewing.

The data were interpreted using a pre-determined model of cognition. It is recognised that interpretation of the data is, to a certain extent, affected by the perceptions of the researchers. It is possible that other researchers using either the same or another cognitive model may have focused on different data, or interpreted the data reported here in a different way. This study included women who were engaged in both paid (open employment) and unpaid (household and family management) work. Larger studies of women that have returned to paid work are needed to confirm the findings of this study.

Conclusion

This pilot study sought to use the PRPP System of Task Analysis to identify specific cognitive strengths and difficulties experienced by women with breast cancer when returning to work. Using the PRPP, it was found that all 10 women who participated in this study had difficulties with cognitive strategy use when participating in paid or unpaid work tasks. While cognitive difficulties were unique to each woman, all had cognitive strategy difficulties with 'attending', 'programming', and 'continuing'. Occupational therapists are in a unique position to provide workplace assessments for women returning to work after breast cancer. This study indicates that assessments should include elements of cognition, using an occupation-focused tool such as the PRPP System of Task Analysis. Further research is required to confirm the findings of this pilot study.

Key findings

- Women with breast cancer experience CRCC.
- This study suggests that common CRCC may be in 'attending', 'programming', and 'continuing' with work tasks.

What the study has added

Occupational therapists need to use an ecologically valid tool, such as the PRPP System of Task Analysis, when assessing work-related cognitive function.

Research ethics

Ethical approval was obtained from the University of Sydney Human Research Ethics Committee, reference number 2012/2119.

Declaration of conflicting interests

The authors confirm that there is no conflict of interest

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4.7 Key findings

This chapter examined different approaches to assessing cognition, highlighting their respective strengths and limitations. There was a growing emphasis on assessments that captured clients' everyday functional cognition and their participation in tasks and occupations. The PRPP-A was presented as a structured, clinician-mediated tool that balanced accurate assessment with client-centred outcomes. Unlike traditional neuropsychological tests, which lacked sensitivity to mild cognitive changes common in breast cancer, the PRPP-A identified specific cognitive strategy challenges, particularly in work-related tasks.

All participants in the study experienced difficulties with programming, specifically, generating appropriate and timely actions in unpredictable work situations. These challenges were especially critical in professional and cognitively demanding roles. Women reported spending more time and effort attending to tasks and re-programming responses, which led to cognitive fatigue and errors, often described as a 'hidden disability.' Through the transcripts of employed women with breast cancer being interviewed generally about their cognition, the PRPP-A was able to detect work-related cognitive impacts. Further research was recommended to assess women directly about their work tasks. The chapter concluded by calling for further investigation into how the PRPP-A could be implemented in occupational therapy practice.

CHAPTER 5: EFFECTIVENESS OF THE PRPP@WORK

5.1 Introduction

This chapter explores a workplace-based version of the PRPP-A, called the PRPP@WORK, as a tool for assessing cognitive changes and predicting work participation outcomes in women with breast cancer. It aims to answer the question: *What is the effectiveness of the PRPP-A (PRPP@WORK) at assessing work-related cognitive changes in women with breast cancer?* Cognitive impairments following cancer treatment, often referred to as "chemo brain," can significantly affect a woman's ability to return to her pre-illness worker roles. Despite growing recognition of these challenges, there remains a paucity of research on workplace-based cognitive assessments and interventions tailored to this population. The chapter outlines the evolution of the research design in response to ethical and practical constraints, including the impact of the COVID-19 pandemic, which required a shift from onsite workplace assessments to online interviews. It introduces the PRPP@WORK as a structured, clinician-administered tool adapted for remote use, and details its integration with the Cambridge Neuropsychological Test Automated Battery (CANTAB) to provide a comprehensive evaluation of cognitive functioning. By comparing outcomes from both tools, this study aims to validate the PRPP@WORK as a practical and ecologically relevant assessment method for occupational therapists and understand the early cognitive assessment and rehabilitation needs of women with breast cancer, as well as the role of occupational therapy in facilitating successful return-to-work outcomes. The paper is currently under review:

Lewis, J., Mackenzie, M., Chapparo, C., & Ranka, J. (under review). Assessment of cognitive difficulties and impact on work for women with breast cancer: Comparing results from the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A) and Cambridge

Neuropsychological Test Automated Battery (CANTAB). *Australian Occupational Therapy Journal*. Manuscript ID 2924815.

5.2 Circumstances impacting the research design and methodology of this study

The original plan for Stage 4 of this research was to build on the work of Bootes & Chapparo (2010) and use the PRPP @ WORK to evaluate women with breast cancer who are experiencing cognitive changes through a workplace assessment, conducted at their workplace. This would involve using the observation method of the PRPP-A. The benefit of performing assessments in the workplace is the ability to observe the client performing their work tasks and to allow the occupational therapist to directly assess the physical, cognitive, and psychological demands of the work environment. This may include interviews and feedback from the line manager or other employer representatives, providing an additional layer to the PRPP @ WORK, but aligning with how Bootes & Chapparo (2013) carried out the PRPP @ WORK with adults who have acquired brain injury. However, as the ethical implications of this methodology were explored, it became clear that there would be challenges.

There has been a call for more research to develop interventions to address cognitive impairments and support return to work. work (Egan et al., 2013; Haywood et al., 2023; Richardson et al., 2011; Todd et al., 2011; Von Ah et al., 2016). Richardson et al. (2011) acknowledge that many gaps in knowledge about cancer survivorship interventions may be due to areas that are difficult to research or issues with implementing solutions in everyday practice. The scarcity of research on workplace-based assessments and interventions for cognitive dysfunction may be one of these areas, as studies involving employers that could negatively impact women's employment pose significant ethical challenges. Conducting ecologically valid research in workplaces is difficult, as women with breast cancer may not have disclosed their

illness or cognitive difficulties, preventing the employer from actively participating in assessment or intervention strategies. Workplace rehabilitation can significantly impact the quality and quantity of work for injured or ill workers; however, it must be done in collaboration with the client, employer, and allied health professionals (Australian Faculty of Occupational and Environmental Medicine, 2011). Even if women with breast cancer have disclosed their illness and cognitive dysfunction to their employer, a research program evaluating cognitive assessments and rehabilitation at work may uncover hidden problems and raise employer concerns about work performance, potentially jeopardising employment. Therefore, research on women's cognitive deficits affecting work performance after breast cancer needs to be carefully designed with a strong ethical framework to minimise any negative impact on employment.

The next option involved training registered occupational therapists, who provide workplace rehabilitation services for women with breast cancer, especially those involved in insurance-based claims (i.e., through income protection or life insurance claims), in the use of the PRPP@WORK. Meetings were held with insurers regarding the recruitment of their claimants, who would be women with breast cancer. Meetings with occupational therapists working in this specialised area of practice (of whom there are not many) were held to discuss training opportunities. With a project proposal and ethics submission ready to go in early 2020, unfortunately, the COVID pandemic prevented these plans from being implemented. All face-to-face meetings moved online, and this became the new norm for occupational therapists providing workplace rehabilitation services as well. Occupational therapists were required to conduct workplace assessments online with clients, who were working from home or in a workplace, but visitors were not permitted due to public health orders. With so many unknowns, pivoting to a third option was needed, which has now resulted in important findings for the occupational therapy profession in working with women with breast cancer, particularly regarding the assessment of cognition.

Due to ongoing public health orders and future uncertainties, it became clear that data collection for Stage Four of the project could not be performed in the workplace or face-to-face but rather needed to be conducted online using the interview methodology. To facilitate online interviews, minor modifications were made to the PRPP@WORK (Bootes & Chapparo, 2010, 2013), including references to 'observations' and 'input or feedback from employers.' The revised PRPP@WORK was then piloted with four women who had various cancer diagnoses to identify any challenges with its administration. The modified PRPP@WORK is available in Appendix I. A successful grant application allowed the use of the Cambridge Neuropsychological Test Automated Battery, a set of computerised cognitive assessments developed by Cambridge Cognition as part of the study. Consequently, a research proposal was designed to revisit the research aims of Stage Four, and an ethics submission was prepared. This can be found in Appendix F and Appendix G. The primary research aim of this study was to determine whether the PRPP-A (in the form of the PRPP@WORK) would be a suitable tool for occupational therapists to use during a workplace assessment when evaluating women's cognition after breast cancer. The secondary aims were 1) to investigate the relationship between the CANTAB neuropsychological tests and the clinician-administered PRPP-A and 2) whether scores in either assessment are associated with women returning to their pre-cancer jobs and hours of work.

5.3 Workplace Assessments

Workplace assessments are a vital part of rehabilitation after injury, illness, or disability, ensuring individuals can safely, sustainably, and meaningfully return to or stay at work (Innes, 2012). An occupational therapist evaluates a person's functional capacity, the job demands, and the work environment to make recommendations about their ability to return to work and suggest interventions to support this. These may include a graded return-to-work program,

assistive technology, and task or environmental modifications (Wolf & Dobson, 2012). The process involves input from the employee, employer, and other health professionals involved in the person's health management. Phan (2022) states that workplace assessments are key in evaluating cognitive-related cancer impairment claims in insurance.

5.3.1 Assessing cognitive work demands

Assessing the demands of a job (often called task analysis) provides occupational therapists with the requirements needed by workers to perform the tasks (Shaw & Strong, 2008). This should occur so a worker's functional capacity can be assessed against the job demands (Shaw & Lysaght, 2008). A task analysis generally occurs through gathering data about the tasks from observation, interviewing, reviewing job descriptions, and other related resources (Innes, 2012). However, sometimes not all sources of data can be accessed for the task analysis, and there may be reliance on one or two methods (Shaw & Lysaght, 2008). While physical impairments are often more visible and measurable, cognitive impairments can be subtle and harder to identify, yet they greatly affect work performance. Similarly, physical work demands can be assessed through objective measures such as time, repetitions, weights, and distances (Innes, 2012). A person's ability to perform physical tasks can then be evaluated based on strength, endurance, and range of motion (Innes, 2012).

Conversely, the cognitive demands of work tasks are usually complex and multidimensional, making it difficult to isolate them to a single cognitive domain (Shaw & Lysaght, 2008), as previously described in the information processing model. Cognitive tasks require nuanced judgment, including processing information, monitoring progress, adjusting strategies, and managing competing demands (Bootes & Chapparo, 2013), which require a constant flow and integration of cognitive processes. Furthermore, cognitive work performance is more heavily influenced not only by the tasks themselves but also by the dynamic environment, routines, and social interactions in the workplace, compared to physical work

performance (Wolf & Dobson, 2012). This complexity makes standardised cognitive assessments in workplace settings challenging.

Many countries have skill-based classification systems used to categorise and organise job information, such as certifications, skills, knowledge, and abilities required. These systems aid occupational therapists with the task analysis of work demands. The Occupational Information Network (O*NET) is a U.S.-based system (U.S. Department of Labor, 2025) that provides detailed descriptions of mental processes (or cognitive demands) needed in work environments, such as information sorting, deductive and inductive reasoning, problem sensitivity, and flexibility of closure. This can help occupational therapists determine the cognitive demands of jobs. Unfortunately, the Australian equivalent, the Occupation Standard Classification Australia (OSCA) (Australian Bureau of Statistics, 2025) only contains occupational qualifications and tasks and does not include information on the physical and cognitive demands of tasks. Therefore, in Australia, there are limited practical tools specifically designed to systematically assess the cognitive demands of work tasks. This highlights the need to develop and implement structured assessment tools, such as the PRPP@WORK, which includes a task analysis based on an interview with the client and then an assessment of the client's ability to meet the cognitive demands of the tasks. The PRPP@WORK is potentially a tool that will assist occupational therapists in accurately identifying cognitive challenges and adapting supports or accommodations (Bootes & Chapparo, 2013) to help women with breast cancer return to work.

5.3.2 Occupational therapy and cognitive-based workplace assessments

Occupational therapists are best qualified to conduct comprehensive workplace assessments focused on cognitive functioning. Their training in the biopsychosocial model, use of the ICF framework (World Health Organization, 2001), and emphasis on person–occupation–

environment fit (Shaw & Strong, 2008) enable them to evaluate the interaction among the worker's abilities, job demands, and workplace supports. As discussed earlier in Chapter 4, having a broader understanding of all factors influencing functional cognition is crucial for designing effective interventions. Désiron et al. (2015) conducted a study examining the role of occupational therapists in workplace rehabilitation for women with breast cancer in Belgium. They carried out a qualitative inquiry with oncology rehabilitation specialists to assess the value of occupational therapy in helping patients return to work and to define what constitutes 'good practice' in these interventions according to 'the experts.' The authors highlight issues arising from a lack of integrated care between inpatient and community rehabilitation, a greater need for holistic approaches, limited access to the employer or workplace for task-specific interventions, and financial and administrative barriers that prevent patients from obtaining necessary occupational therapy services (Désiron et al., 2015). These issues are very similar to those experienced by women with breast cancer (Breast Cancer Network Australia, 2017a; Campbell et al., 2024) and occupational therapists in Australia. The challenges around recognition of cognitive changes and returning to work after breast cancer are accentuated when considering an Australian developed survey for all people with cancer called the 'Supportive Care Needs Survey' (SCNS-SF34) (Boyes et al., 2009). In this 34-question survey, there is not one question about changes in cognition or participation in work (Boyes et al., 2009; Roseleur et al., 2023).

In Australia, health services for people with cancer are well-established within the secondary and tertiary healthcare system. However, questions remain about the unmet rehabilitation needs of women with cancer during the survivorship phase within the healthcare system (Campbell et al., 2024). The findings of a program called 'Beyond Cancer', a short course of focused workplace rehabilitation for women with breast cancer, were recently published (Sheppard et al., 2023). On a positive note, it uses a biopsychosocial approach to assessment and provides intervention using health coaching. However, the research only considers

‘cognitive fatigue’ as an issue within the biopsychosocial assessment and does not acknowledge cognitive function and strategy deficits. The ‘Beyond Cancer’ program also does not report on specific workplace assessments being conducted for each client or specific cognitive strategies being addressed. The program is reportedly designed in consideration of the occupational therapy intervention model of return to work for women with breast cancer proposed by Désiron et al. (2016).

There is a paucity of international research on cognitive assessments and interventions provided by occupational therapists to support women with breast cancer returning to work. He et al. (2023) conducted a systematic review using pooled data to compare healthy control groups with women with breast cancer, finding that occupational therapy intervention made a significant difference to the cognitive function of women with breast cancer. However, the details on assessments used are vague, with only the MOCA (Nasreddine et al., 2005) being highlighted. The description of the interventions is also vague and does not relate to direct cognitive interventions but rather measures facets of cognition as an outcome of more generic interventions. There are two authors, in particular, who have focused on occupational therapists conducting cognitive assessments and rehabilitation for women with breast cancer, with interventions focused on addressing cognitive challenges at work and improving return-to-work outcomes (Newman, 2013; Ryan et al., 2011). Both studies conducted interventions in community and clinical-based settings, and although directed towards work-related tasks, did not include individual workplace assessments or interventions occurring in the workplace. These studies were described in (Lewis & Mackenzie, 2022), the published paper in Chapter 3. González-Santos et al. (2022) published a protocol for a randomised controlled trial for women to participate in a 12-week telehealth-based cognitive training program conducted by occupational therapists, with a possible aim of addressing issues early to prevent the development of cognitive impairments that affect occupational functioning, but program outcomes have not yet been published. Although this did not have workplace-based specificity,

this type of program could form the basis for the role of occupational therapy in developing and delivering comprehensive cognitive-based programs early in a woman's cancer experience, aiming to reduce the impact on work performance and participation.

In other countries, such as Belgium, participating in work and preventing job loss are considered important goals and integral parts of rehabilitation for women with breast cancer, starting right from the point of diagnosis (Désiron et al., 2016). Unfortunately, this is not the case in Australia, where health and employment-based rehabilitation services are fragmented (Collie et al., 2019; Knott et al., 2014; Koczwara, 2016). Occupational therapists working in secondary healthcare systems are often not funded or resourced to provide workplace rehabilitation services. Some occupational therapists may also lack understanding of how workplace rehabilitation functions and may not realise how their assessments and interventions influence return-to-work outcomes. Even if occupational therapists are aware of return-to-work goals, they may lack the scope of practice to deliver workplace rehabilitation services. This segregation, along with the complexities of insurance-based systems (Collie et al., 2019), reduces women's awareness and ability to access workplace rehabilitation services that could help manage cognitive difficulties at work (Sheppard et al., 2023). Survivorship plans that include returning to meaningful employment are vital for breast cancer survivors, and work has been identified as the third most important issue for them, after engaging in social activities (Duijts et al., 2014). The economic effectiveness of occupational therapy and its usefulness in reducing disease consequences in people with cancer have been highlighted (Pergolotti et al., 2016), but occupational therapy is still rarely provided in the rehabilitation of cancer patients (Player et al., 2014). Therefore, research focused on cognitive assessment, functioning, and work participation for women with breast cancer could improve the delivery of workplace rehabilitation and occupational therapy services overall, thus enhancing women's involvement in employment.

5.4 This study

The PRPP@WORK is an assessment tool developed by Bootes & Chapparo (2010, 2013) to evaluate the cognitive strategy strengths and weaknesses in people with an acquired brain injury (Bootes & Chapparo, 2010, 2013). The PRPP@WORK is based on the PRPP-A but includes additional elements to make it more suitable for workplace assessments. Building on the findings from Chapter 4, which used the foundational PRPP-A to identify cognitive difficulties in women with breast cancer, this study employs the PRPP@WORK to focus on cognitive strategies at work and will be used during workplace assessments. As previously mentioned, the PRPP-A and, by extension, the PRPP@WORK, utilise a functional cognition approach (Ranka et al., 2025). However, applying it in a workplace setting also provides a broader understanding of the environmental and contextual factors affecting cognitive performance at work and incorporates an ICF approach as well. Since the cohort studied consists of women with breast cancer, there was a need to consider the recommendations by the ICCTF (Wefel et al., 2011) to use neuropsychological testing alongside the PRPP@WORK to determine if there are similarities in assessment outcomes. If the PRPP@WORK and neuropsychological testing yield related results, this could demonstrate to occupational therapists and third-party stakeholders (such as researchers, insurers, and employers) the validity of the PRPP@WORK as an assessment tool for evaluating work-related cognitive strategy difficulties in women with breast cancer. Using a clinician-administered interview-based tool, together with neuropsychological testing, aligns with the DSM-5-TR approach used by psychiatrists and psychologists in the diagnosis of neuropsychological disorders in accordance with the DSM-5-TR guidelines. (American Psychiatric Association, 2022b).

5.4.1 Using the PRPP@WORK

While the PRPP System of Task Analysis has a strong evidence base in the context of brain injury rehabilitation (Bootes & Chapparo, 2010; Chapparo & Ranka, 2011; Nott & Chapparo, 2012; Ranka et al., 2025; Ranka & Chapparo, 2010; Smith et al., 2023), more research is needed to confirm its suitability as a tool for workplace assessment. Ideally, therapists would conduct real-time observations in the workplace to assess how individuals manage planning, organisation, and task execution. However, this is not always practical, especially in fast-paced or complex work environments (Sohlberg & Mateer, 2001). To overcome such challenges, the original tool was adapted into a semi-structured interview format, known as the PRPP@WORK Questionnaire/Interview (Bootes & Chapparo, 2010). This version enables therapists to gather meaningful information about job demands and cognitive strategy use through interviews when direct observation is not possible. Structured interviews are considered a reliable alternative, particularly when properly administered by trained professionals (Donnelly et al., 2011). Structured, clinician-led interview assessments have also been shown to produce more complete and accurate data, particularly in populations experiencing health challenges (Reilly et al., 1993), supporting their value as a practical and valid method of assessment. Ideally, the PRPP@WORK, as a robust workplace assessment tool, would also collect input from key workplace stakeholders (e.g. supervisors or managers), via a structured interview (Innes, 2012) in addition to the women with breast cancer. However, as discussed earlier, ethical considerations and methodological design challenges can prevent this.

5.4.1.1 Administration of the PRPP@WORK

The PRPP@WORK assessment is designed to evaluate how effectively individuals use cognitive strategies to meet the requirements and expectations of their work tasks, duties, and workplace. The PRPP@WORK is based on operational definitions of the 35 descriptors (outer layer of the model in Chapter 4, Figure 4.9) of cognitive strategy applications, with additional

details including examples of work-related tasks, situations, or contexts to enhance ecological validity. Examples of these can be found in Figure 5.11 and the complete PRPP@WORK is in Appendix I.

PERCEIVE

	Notices	Modulates	Maintains
ATTENDING	• Notices all sensory information and input • Aware of all job and body components • Alerted spontaneously reacts, orienting by head turning, looking, reaching, adjusting body position, listening to stimuli that should be attended to • Examples: hears photocopier buzzer, sees light flashing, smells something is burnt, sees blank sections in spreadsheet or document, looks at a customer entering shop); hyper-alertness, feeling overwhelmed in novel situations, restlessness,	• Flexible attention by spontaneously narrowing and broadening focus • Shifts and divides the allocation of attention between two or more tasks that need to be performed, or when interacting with more than one person, over the same time interval • Deferring and restarting tasks after noticing the need for change. • May shift attention too often or not enough. • Examples: monitoring email enquiries whilst answering phone calls; working on four different tenders whilst keeping reports up to date; dividing attention between various people and themself during conversation and in meetings	• Concentrates long enough for job completion (quality and quantity) without getting distracted • Distraction allowed will depend on context • Examples: Focuses on meetings and conversations without being distracted

RECALL

	Recognises	Labels	Categorises
RECALLING FACTS	• Remembering what the correct facts and concepts are to do the job • Recalling correct facts and concepts • Correctly interprets familiar objects, materials, body parts and sensory events to be what they are. • Recognises known people, emotions, expressions, and behaviours. • Recognise own feelings, and emotions • Example: can recognise frustrated voice or body language of customer or colleague; can recognise an allocated task that has been completed, can recognise own fatigue	• Remembering the names of tasks, equipment, objects, materials, body parts relevant to the job • Recalls and understands words, instructions, and symbols. • Uses words, language, and symbols effectively during tasks and job. • Examples: Remember and use client and colleagues' names; saves files according to requirements	• Groups and classifies tasks, procedures, equipment, items, objects, symbols, body parts according to function • Demonstrates knowledge of classification, concepts, constructs, and part / whole relationships to meet job requirements • Example: sterile and non-sterile equipment; debits and credits spread sheet; can group people according to function at work;

PLAN

	Knows goal	Identifies obstacles	Organises
MAPPING (action plan)	• Acts in a way that demonstrates focusing on the goal, both individually, for the team and role. • Formulates and re-formulates goals and outcomes for what needs to be achieved with objects, equipment, information, staff, and environment. • Formulates and re-formulates goals and outcomes for what needs to be achieved individually and within a teamwork environment. • Keeps outcomes in mind during performance. • Example: Actions are oriented and remain focused on following, no ideas, or plans, so it relies on known facts, and doesn't try different options. Are the goals realistic, incomplete, or do ot align with the employer?	• Identifies barriers that will prevent the outcome from being achieved or the task from being completed. • Examines the plan of action for potential difficulties. • Explores and identifies potential barriers (e.g., task procedures, staff and equipment limitations, environmental constraints, self) to complete the task, routine, and role. • Note that they might see too many obstacles or miss obstacles. • Example: Everything is too hard; taking too many risks, doesn't have the knowledge needed to do the task, not enough time or money, or resources.	• Gets ready to perform. • Arranges self, thoughts, ideas, body, objects, equipment, people, and environment to begin the task. • Rearrange ideas, thoughts, equipment, and environment as the task progresses to deal with changes. • Example: Lack of preparation before the task takes place. Missing equipment or a step in the process before performance. OR over-organised, where organisation becomes the task. • This is about novel situations – may use some recall, but usually in situations where not enough is known, or unexperienced.

PERFORM

	Starts	Stops	
INITIATING	• Begins task performance. • Commences expected part of the task or whole task/ routine on time to match expected performance / criteria at work/ rule use. • Restarts after interruption or stopping. • Examples: Leaves tasks unfinished, other people having to complete tasks; Does not start tasks on time or there is hesitation; needs prompts and cues of when and how to start.	• Stops task performance or routine. • Stops at appropriate time – when needed for safety, to evaluate, according to rules, to match plan, when requested to do so. • Example: Stops before task is dangerous to self or others; linked to restart – may stop for too long. Stops at the wrong time before a task is completed. Not stopping to prevent fatigue.	

Figure 5.8: Examples of PRPP@WORK cognitive strategy definitions.

The first part of the assessment involves collecting information about the woman's diagnosis, treatment, rehabilitation, general functional abilities, psychological well-being, work history, and other complicating factors during and after breast cancer treatment. Questions focus on the trajectory of cognitive function changes and any support services accessed.

Employment status at the time of diagnosis, during treatment, and post-treatment is discussed to identify changes in roles and hours.

The second part of the assessment includes a task analysis and assessment of cognitive strategies. The therapist asks questions about the woman's role, routine, and duties before illness. Questions then target describing each duty, task, demand, and environmental factor to determine the cognitive requirements of the job.

The third part of the assessment involves the occupational therapist asking targeted questions about the capacity to perform required tasks and duties, based on qualitative and quantitative data. Notes are taken regarding reduced hours, modified work patterns, changed tasks, decreased responsibilities, job redesign, increased time to complete tasks, feedback from colleagues, safety issues, and adjustments made to the work environment that do not meet the demands of the pre-illness job or fall below the woman’s expected or desired level of performance. For each main duty, the occupational therapist considers the standard descriptors and scores the cognitive performance for each of the 35 strategy descriptors based on how well they are performed, referencing the outer layer of the model in Chapter 4, Figure 4.9. A sample of this is shown in Figure 5.12 and the full assessment can be found in Appendix I.

Duty:

PERCEIVE (ATTENDING)

Notices / general awareness of work environment and people

SCORE	1	2	3

Modulate attention between parts of the job, tasks and people

SCORE	1	2	3

Maintains attention and concentration – job and tasks

SCORE	1	2	3

RECALL (RECALLING FACTS)

Remembers objects/ equipment, people, language, task and environment requirements.

SCORE	1	2	3

Remembers and uses labels and names **(labels)**

SCORE	1	2	3

Remembers what goes together **(categorises)**

SCORE	1	2	3

PLAN (MAPPING (action plan))

Know / formulate / store **goal**/s

SCORE	1	2	3

Identify and explore potential **obstacles**

SCORE	1	2	3

Organise/schedule the task, equipment, environment and body

SCORE	1	2	3

PERFORM (INITIATING)

Start / re-initiate a task / action

SCORE	1	2	3

Stop a task / action

SCORE	1	2	3

Figure 5.9: PRPP@WORK scoring of each cognitive strategy descriptor for a duty (sample)

A three-level rating scale, presented in Table 5.9, is used, and scores are then summed for each sub-quadrant (inner layer of the model in Chapter 4, Figure 4.9) and quadrant.

Table 5.9: PRPP@WORK three-tier scoring system.

Score	Performance Descriptor
3	**Meets duty/task/workplace criterion expectations (qualitative and quantitative outputs) with performance that:**
	- Is completed within a reasonable time - Has no difficulty in performing the task - Requires no additional assistance or prompts - Is safe for the individual, co-workers, and others - Is consistent with the expectations, rules, policies, and procedures of the workplace
2	**Almost meets duty/task/workplace criterion expectations (qualitative and quantitative outputs) with performance that:**
	- Takes additional time to complete tasks - Has minimal difficulties in performing the task - Requires minimal support or prompting to perform work tasks - Raises minor concerns about safety to the individual, co-workers, or others - Is mostly consistent with the expectations, rules, policies, and procedures of the workplace
1	**Does not meet duty/task/workplace criterion expectations (qualitative and quantitative outputs) with performance that:**
	- Takes significant additional time to complete tasks - Has significant difficulty in performing the task - Requires moderate assistance, support, or prompting to perform tasks - Is unsafe (or potentially unsafe) for the individual, co-workers, or others - Is inconsistent with the expectations, rules, policies, and procedures of the workplace - Has consequences that are inconsistent or contradictory to the employer's mission, goals, or values

5.4.2 Using CANTAB assessments

To address the research question and meet the methodology requirements, the CANTAB assessments selected for this study needed to satisfy two criteria: 1) assess equivalent cognitive domains to those of the PRPP-A (perceive, recall, plan, and perform), and 2) be validated for remote online testing without a clinician-provided device (i.e., iPad). Although this

limited the available CANTAB assessment options, at least one option existed to assess aspects of perception, recall, and planning. There were no remote CANTAB options to evaluate motor processing performance.

The Rapid Visual Processing (RVP) test evaluates attention and was used to determine if there was a relationship with the PRPP-A Total Perceive score or any of the Perceive sub-quadrant scores (attending, sensing, discriminating). The RVP had been used in a study assessing the cognitive domain of attention and its relationship to inflammation markers before and after chemotherapy treatment (Belcher et al., 2022). After chemotherapy, elevated inflammation markers appeared to negatively impact sustained attention as measured by RVP. Additionally, pre-chemotherapy anti-inflammatory cytokines seemed to be protective and predicted improvements in RVP performance over time (Belcher et al., 2022). However, whether this reflected in improved attention in everyday functioning and work tasks is unknown and questionable, given that neuropsychological test results rarely correlate with self-reported functioning.

The Spatial Working Memory (SWM) test assesses executive functioning and was used to explore its relationship with PRPP-A total Plan score or any of the Plan sub-quadrant scores (mapping, programming, evaluating). Bender et al. (2015) used RVP and SWM (along with several other neuropsychological tests) to compare the cognitive functioning of women with breast cancer receiving hormone therapy only versus those receiving chemotherapy combined with hormone therapy, along with healthy controls. The SWM contributed to findings that the group of women who had chemotherapy plus hormone therapy and the group with hormone therapy alone showed poorer executive function compared to the control group at 6, 12, and 18 months since treatment started. The RVP revealed that concentration declined during the first six months of hormone therapy, improved between six and twelve months, then declined again between twelve and eighteen months (Bender et al., 2015). Gentry et al. (2018) proposed a

protocol to examine whether moderate-intensity aerobic exercise, initiated before starting aromatase inhibitor therapy, could improve cognitive function in postmenopausal women with early-stage breast cancer. They also planned to use the RVP and the SWM (Gentry et al., 2018).

The Delayed Matched to Sample (DMS) test assesses visual memory and was used to explore its relationship with the PRPP-A Total Recall score or any of the Recall sub-quadrant scores (facts, schemes, procedures). The DMS was also used in a study of women with breast cancer who had received chemotherapy, with a healthy control group for comparison (Janelsins et al., 2018). Control group scores remained stable, but women with breast cancer showed no significant change in DMS scores from pre- to post-chemotherapy; however, a notable decline in visual memory scores was observed at the 6-month mark after chemotherapy ended. This suggests that memory changes may be a delayed cognitive symptom. The RVP was also utilised in the Janelsins et al. (2018) study, which reported a significant decline in attention scores six months post-chemotherapy. This raises the possibility that CANTAB tests like RVP and DMS may detect more subtle and long-lasting declines, supporting the idea that cognitive domain-specific computerised tests could help identify long-term cognitive deficits (Janelsins et al., 2018). Williams et al. (2018) also used the DMS to evaluate the visual memory of women with breast cancer and the relationship with the level of cytokine receptors. The authors found that women with increased levels of cytokine receptors had worse short-term visual memory scores. So, the Janelsins et al. (2018) and Williams et al. (2018) studies showed declining memory scores during and six months after chemotherapy was completed.

Given the findings of these studies, there is support for using the CANTAB tests chosen for this research, given their prior use with women with breast cancer. However, CANTAB tests have not been compared with clinician-administered assessment tools, and no CANTAB tests have been evaluated for their ability to predict return-to-work outcomes, which adds to the uniqueness of this study.

5.5 Paper: Assessment of cognitive difficulties and impact on work for women with breast cancer: Comparing results from the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A) and Cambridge Neuropsychological Test Automated Battery (CANTAB)

Australian Occupational Therapy Journal

Feature Article

Assessment of cognitive difficulties and impact on work for women with breast cancer: Comparing results from the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A) and Cambridge Neuropsychological Test Automated Battery (CANTAB)

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Name	Type of File	Size	Page
Manuscript.docx	Anonymized Main Document - MS Word	483.0 KB	Page 3
Manuscript Supplementary File.docx	Supplementary Material for Review	32.7 KB	Page 34

Title: Assessment of cognitive difficulties and impact on work for women with breast cancer: Comparing results from the Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A) and Cambridge Neuropsychological Test Automated Battery (CANTAB)

Key Words (MESH)

1. Breast Neoplasms
2. Cognition Disorders
3. Occupational Therapy
4. Workplace
5. Neuropsychological Tests

Key Points for Occupational Therapy

1. The PRPP-A effectively assesses cognitive difficulties in women with breast cancer related to work tasks.
2. Early, targeted support may be needed for women with perceptual and planning issues to prevent reduced work challenges.
3. Integrating PRPP-A into workplace assessments could enhance return-to-work outcomes by guiding tailored interventions.

Abstract

Introduction

An increasing number of working-age women are diagnosed with breast cancer, making it critical to understand any cognitive deficits that may affect their work performance. This study investigates the self-reported cognitive changes experienced by breast cancer survivors. It compares the results of the Perceive, Recall, Plan and Perform System of Task Analysis Assessment (PRPP-A) and the Cambridge Neuropsychological Test Automated Battery (CANTAB) tests to determine the capacity of these tools to identify work-related cognitive problems.

Methods

The pilot study involved 12 women who had been diagnosed with breast cancer and were employed at the time of their diagnosis. Participants underwent cognitive assessments using both the PRPP-A and CANTAB tests (Rapid Visual Processing (RVP), Delayed Match to Sample (DMS), and Spatial Working Memory-SWM).

Consumer and Community Involvement

Women were recruited through Breast Cancer Network Australia (BCNA). The study was advertised on the BCNA website, and a national webinar was conducted to encourage participation.

Results

The PRPP-A showed difficulties in the following items: 'Continuing' (mean = 47.08, SD = 17.464), 'Initiating' (mean = 56.92, SD = 13.118), 'Attending' (mean = 58.25, SD = 15.428) and 'Programming' (mean = 59.42, SD = 11.204). Significant correlations were found between PRPP-A Total Perceive and CANTAB RVP ($\tau = .477$, $p = .036$) and PRPP-A Plan and CANTAB SWM ($\tau = -.735$, $p = .002$). ROC analysis showed PRPP-A Total Perceive (AUC = .969) and PRPP-A Total Plan (AUC = .734) were associated with non-return to pre-cancer roles and hours of work.

Conclusion

The PRPP-A is an effective tool for assessing functional cognitive difficulties in breast cancer survivors, aligning well with neuropsychological tests. Interventions that address cognitive deficits related to attention, concentration, and executive functioning are needed to help women with breast cancer maintain their employment

Plain Language Summary

Many working-age women are diagnosed with breast cancer, and it's important to understand how this affects their ability to work. This pilot study looks at how breast cancer impacts cognitive functions (like memory and attention) and work performance. It compares two assessment tools: the PRPP-A System of Task Analysis and the CANTAB tests. The study involved 12 women who had breast cancer and were working when diagnosed. They took part in cognitive tests using both PRPP-A and CANTAB methods. These tests included tasks to measure attention, memory, and planning skills. Women were recruited through Breast Cancer Network Australia (BCNA) and participated voluntarily. The study was promoted on the BCNA website and through a national webinar. The results showed that many participants had significant cognitive difficulties, especially with attention, memory, and planning. The PRPP-A identified specific challenges like continuing tasks, starting tasks, paying attention, recalling facts, and planning. These findings matched previous studies. The study also found that PRPP-A and CANTAB scores were closely related, meaning both tools measured similar cognitive skills. The PRPP-A scores were particularly good at predicting which women struggled to return to their pre-cancer work roles. The PRPP-A is effective for assessing cognitive difficulties in breast cancer survivors and works well with neuropsychological tests. Using PRPP-A in regular practice could help create personalized interventions to address specific cognitive issues, especially those related to attention and planning, and in turn improve work outcomes for breast cancer survivors. Future research should involve more participants and include employers to validate PRPP-A findings and add an environmental perspective to the assessment.

Manuscript

Introduction

There is an increasing number of working-age women being diagnosed with breast cancer. The median age for women to be diagnosed with breast cancer is 61 years, indicating that 50% of the women diagnosed are younger than 61 years of age (Breast Cancer Trials, 2025). It is estimated that 18% of breast cancers in 2025 will be in women under 50 years of age (Breast Cancer Facts and Statistics 2025). In recent years, the incidence of breast cancer has been increasing by 1% per year. This, together with increased survival rates through the availability of more tailored and advanced treatments and screening techniques (Breastcancer.org, 2025),results in women with breast cancer living longer with a multitude of side effects from the disease and treatments. Research has shown that women with breast cancer have reduced physical, cognitive, emotional, social, and role functioning compared to healthy age-matched controls up to 12 years after being diagnosed (Vrancken Peeters et al., 2025).

The long-term side effects of breast cancer impact women's work participation (Islam et al., 2014). Women are more likely to be unemployed, reduce their working hours (Lewis et al., 2020), or reduce role demands due to the side effects of cancer (which may include cognitive impairments), compared to healthy age-matched controls. Cognitive difficulty after breast cancer has been described as a 'hidden disability' (Lewis et al., 2016) and there is a variation in experience and duration among women (Player et al., 2014). Synthesised findings suggest that approximately one in three breast cancer survivors may experience clinically significant cognitive impairment, with self-reports reflecting a higher prevalence (Whittaker et al., 2022). While initial cognitive changes noticed during treatment can be more severe, it has been found that 36% of women continued to report some form of cognitive difficulties 5 years after completing treatment (Schmidt et al., 2018). The existence of cognitive impairments following cancer is not universally recognised (Smidt et al., 2016), and causation is debated (Hamilton et al., 2024; Smidt et al., 2016; Wefel et al., 2011). A scoping review has shown that persistent difficulties with cognition have led to reduced workforce participation for women with breast cancer (Lewis & Mackenzie, 2022). Women have reported difficulties with work performance, such as working normal hours, meeting deadlines, focusing on tasks, organizing work schedules, and learning new processes due to deficits in memory, attention, concentration, and executive functioning. Women also describe a 'cognitive fatigue' due to the increased time

and cognitive effort taken to perform tasks compared to their pre-illness functioning (Lewis et al., 2016). Reduced work ability can then lead to psychological distress, compounding cognitive dysfunction (Cheng et al., 2016, 2018).

The ability to work is a critical aspect of quality of life for many women with breast cancer, particularly due to the increased cost of living and the financial challenges that result from out-of-pocket costs from treatment and other health needs (Breast Cancer Network Australia, 2017; Goldsbury et al., 2024). Some women with breast cancer may have income disability insurance through income protection or superannuation policies. This type of insurance claim would enable workplace rehabilitation services to support a return-to-work program for women with breast cancer. When self-reported cognitive impairments or fatigue impact women's work ability, referral to occupational therapy with requests to conduct workplace assessments to assist with validating subjective reports and developing intervention plans for improving functional capacity and measurable work capacity (Phan, 2022). It is important to consider the types of tools required and available for occupational therapists to conduct workplace assessments. Unfortunately, women without insurance claims may need to rely on their employer or government-based support services to address cognitive changes impacting work ability. There is a paucity of research comparing the work participation outcomes of women who received workplace rehabilitation support after a breast cancer diagnosis and those who did not.

The two forms of measurement commonly used to identify cognitive changes in women with breast cancer are neuropsychological testing and self-report measures. Neuropsychological tests, as objective assessments, are promoted and endorsed by the International Cognition and Cancer Task Force (ICCC) (Wefel et al., 2011)as the gold standard in trials, to explain specific cognitive component deficits in patients with cancer. The Cambridge Neuropsychological Test Automated Battery (CANTAB) is not part of the ICCC recommendations but offers a standardized method for assessing cognitive changes after cancer and has a range of computer-based measures with norm comparison groups for each of the tests. The Rapid Visual Processing (RVP), Delayed Match to Sample (DMS), and Spatial Working Memory (SWM) from the CANTAB battery (Belcher et al., 2022; Bender et al., 2015; Gentry et al., 2018; Janelsins et al., 2018, 2022; Williams et al., 2018)have been used to assess the cognition of women with breast cancer related to treatment (e.g., chemotherapy or aromatase inhibitors). The benefits of neuropsychological testing include consistent and reliable methods that compare scores on specific cognitive domains to normative data. However, these tests are expensive, difficult to access, and lack ecological validity, suggesting

that they may not accurately reflect real-world cognitive functioning in this population. As far as the authors are aware, CANTAB battery tests have not been used to assess the cognition of women with breast cancer concerning work performance or participation. Therefore, it is unclear if CANTAB assessments will accurately reflect the cognitive challenges faced by women with breast cancer in their work environments.

Self-reported cognitive measures such as the Functional Assessment of Cancer Therapy-Cognitive Function (FACT-Cog) (FACIT.org, 2025), The Cognitive Failures Questionnaire (CFQ) (Broadbent et al., 1982), the Patient-Reported Outcomes Measurement Information System (PROMIS) Cognitive Function (Northwestern University, 2025), and the Cognitive Symptom Checklist – Work (CSC-W) (Ottati & Feuerstein, 2013) have been used to assess women with breast cancer, contributing to reports of the cognitive challenges they experience at work. These self-report methods provide valuable insights into the subjective experiences of cognitive impairment but are not robust enough to guide interventions. There is a need for cognitive assessments that can measure functional performance. In the work context, addressing concerns posed by insurers is necessary to ensure women with breast cancer receive the support they need for returning to work. Therefore, insurers seek more than self-report measures, as these are considered subjective, leading to issues such as intentional poor performance, exaggeration, and unreliable memory, which can lead to issues such as deliberate poor performance, exaggeration, and non-credible memory (Phan, 2022).

Research has indicated inconsistencies between neuropsychological tests and self-report measures. Despite reporting cognitive difficulties, women with breast cancer often perform within the normal range in neuropsychological tests, which fail to recognize the impact of cognitive decline in women who were previously in high-average or superior intellectual ranges. Formal neuropsychological testing does not detect subtle cognitive changes in cancer patients, which have detrimental impacts on work performance and participation, as it only focuses on significant deviations from population norms. Furthermore, these women are often in highly cognitively demanding jobs, making the impact of cognitive decline during and after breast cancer more pronounced at work, where they struggle to perform complex cognitive tasks in actual work environments in real time (Ryan et al., 2015). Oncologists have also reported that it appears that 'high-functioning women' are more likely to report cognitive changes (Smidt et al., 2016). Self-reported cognitive measures have also been correlated with increased levels of anxiety and depression (known as a cluster of symptoms) and can be influenced by emotional and psychological factors (So et al., 2021).

Sitting between objective and subjective cognitive assessments are those that are clinician-administered. Clinician-administered cognitive tests such as the Mini Mental State Examination (MMSE), Mini-COG (Borson et al., 2000), and Montreal Cognitive Assessment (MOCA) (Nasreddine et al., 2005) are not specific enough to capture cognitive strategy difficulties and are not directed towards work-related activities. There have been calls for a more sensitive evaluation of cognitive function at work and for researchers to address some of the challenges presented by the current cognitive assessment options to help improve research and outcomes (Calvio et al., 2010; Nelson et al., 2014). While neuropsychological testing can identify cognitive trait deficits in isolation, a previous pilot study (Lewis et al., 2016) demonstrated that the clinician administered Perceive Recall Plan and Perform Assessment (referred hereon as the 'PRPP-A-A') (Ranka et al., 2025) could identify cognitive impairments associated with a breast cancer diagnosis that are linked to cognitive strategy use. The PRPP-A can also evaluate how cognitive strategies interact with job demands and the workplace environment to impact participation in employment. Lewis et al. (2016) found that women with breast cancer had unique individual cognitive difficulties. but there were common cognitive strategy difficulties with 'attending', 'programming', and 'continuing' subcomponents of the PRPP-A-A, which are related to perception, planning, and performing, affecting work performance. These PRPP-A results were not evaluated against neuropsychological testing and have not been used to consider the relationship with work participation in people with cancer. Therefore, this pilot study aimed to determine whether the PRPP-A would be a suitable tool for occupational therapists to use when assessing women's cognition after breast cancer concerning their work performance and participation. The secondary aims were to:

- Assess the cognitive performance of women with breast cancer using CANTAB and PRPP-A to identify deficits in cognitive function and strategy application.
- Investigate the association between the CANTAB neuropsychological tests and the clinician-administered PRPP-A.
- Explore whether the CANTAB and/or PRPP-A scores are associated with women returning to their pre-cancer jobs and hours of work.

Methods

Study Design

This cross-sectional study design used purposive sampling to recruit women who experienced cognitive changes following a breast cancer diagnosis. This was to allow a comparison of cognitive assessment methods. This study was approved by the XXXXXXXXXXXXX Human Ethics Committee (Project No.: 2022/206).

Funding

The authors received a grant from xxxxxxx, allowing access to some of the neuropsychological tests and received a grant xxxxxxxxxxxx, which enabled the purchase of additional neurological tests from CANTAB and gift vouchers for participants.

Positionality Statement

All authors are occupational therapists based in Australia. JL initiated and designed the research, in consultation with LM, CC and JR, as part of her PhD. LM, CC and JR are all experienced academics. All authors have previously published research on the topic of cancer, breast cancer, cognition, cognitive assessments, and return to work. JL is an academic and clinician working in the private cancer wellbeing sector.

Participants

Women who had been diagnosed with breast cancer, were aged 18-65 years and were employed at the time of their diagnosis were recruited to the study. Women who had left the workforce before their breast cancer diagnosis or had been hospitalised due to a mental illness were excluded from the study, as mental health conditions can impact cognitive performance, which was the focus of the testing in this study. There was no limit on the amount of time since diagnosis.

Recruitment

Women were recruited through Breast Cancer Network Australia (BCNA). The study was advertised on the BCNA website, under the research section, which enables women with breast cancer to choose to participate in studies that are relevant to their circumstances. Further, a national webinar was conducted by one of the researchers for BCNA on ‘Cognitive Changes After Breast Cancer’, during which there was a call for women to participate in the study. The

researcher provided a contact email address to which women voluntarily indicated their willingness to participate in the study.

Process

Twelve participants were assessed, and their results are presented in this study. Each participant was contacted, and a one-hour online interview time was booked to conduct the PRPP-A. After the PRPP-A was completed, participants were emailed the CANTAB link and instructions to complete the CANTAB Neuropsychological Tests on the CANTAB platform. All participants received a $30 AU gift voucher.

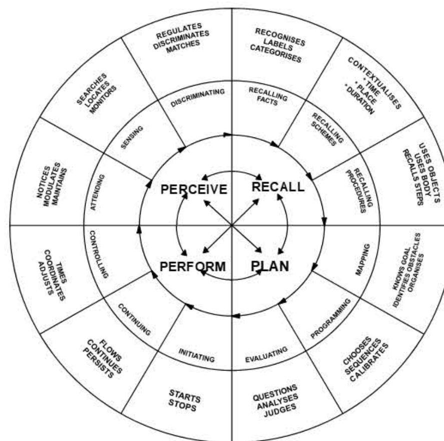
Data Collection

Cognitive Assessment Tools and Administration

A. Perceive, Recall, Plan and Perform System of Task Analysis (PRPP-A)

The PRPP-A model is centered on four quadrants that categorise cognitive processing strategies used during task performance: attention and sensory perception (Perceive), memory (Recall), response planning and evaluation (Plan) and performance monitoring (Perform). These are illustrated as the inner layer of the of the PRPP-A system model. The multidirectional arrows indicate the various ways information can flow during cognitive processing. Each of the four quadrants is further divided into three sub-quadrants (middle layer), to which specific information processing strategies that support these areas are allotted. There are 34 strategies (termed descriptors) that form the outer layer of the PRPP-A system model and are behaviours that the assessor can observe (See Figure 1). Information about the use of the PRPP-A tool for women with breast cancer was described in Lewis et al., (2016). Stage 2 of the PRPP-A involves rating the participant's performance on a three-point scale, indicating how effectively the person applied each cognitive strategy (3=effective for task performance, 2=questionable, 1=not effective).

Figure 1: The PRPP-A Stage Two Conceptual Model



The PRPP-A involves collecting data about participants' occupational performance through 'occupational sampling', where specific tasks and routines nominated by the client or others in the client situation are used to contextualise the assessment to an occupational performance situation where examples of cognitive strategy application difficulties are experienced (Ranka et al., 2025). This data can be gathered using three methods: therapist observation, predeveloped questionnaires (Bootes & Chapparo, 2010; Chapparo et al., 2013), or interview (Bootes & Chapparo, 2010, 2013). Each of these methods has demonstrated adequate reliability and validity. At the time of this study, the COVID-19 pandemic necessitated online semi-structured interviews by the assessing occupational therapist to gather data about participants' breast cancer diagnosis, treatment, and cognitive difficulties (include this as an attachment). The interview focused on pre- and post-employment status and a task analysis of pre- and post-cancer occupations, with a focus on the difficulties experienced by the participant, with follow-up probes to obtain descriptions of examples of ask performance where these difficulties were experienced. From the descriptions of general and specific instances of reduced cognitive strategy use, a score was derived to represent the extent of difficulties perceived by the assessing occupational therapist.

B. Computerised neuropsychological assessments

The Cambridge Neuropsychological Test Automated Battery (CANTAB) is a digital platform developed by Cambridge Cognition to assess cognitive function across various domains, such as memory, attention, and executive function. There are over 25 different CANTAB computerised assessments that can be administered in-clinic or remotely. Tests are validated and normative data are provided for comparison (Cambridge Cognition, 2023b). Participants in

this study completed three CANTAB tests: Rapid Visual Processing (RVP), Delayed Matched Sample (DMS), and Spatial Working Memory (SWM). Raw scores, percentiles, and Z-scores were calculated for each of these tests and compared to normative data that was matched to the demographics of this group based on age, gender and education level. Further details about the CANTAB tests can be found in the Supplementary files.

1. Delayed Matched Sample (DMS)

The DMS evaluates visual memory. “The participant is shown a complex visual pattern, which is both abstract and non-verbal (the sample), followed by four similar patterns, after a brief delay. The participant must select the pattern that exactly matches the sample. In some trials, the sample and the choice patterns are shown simultaneously, in others, there is a delay (0, 4, and 12 seconds) before the four choices appear. Outcome measures include latency (the participant’s speed of response), the number of correct patterns selected and a statistical measure giving the probability of an error after a correct or incorrect response.” The DMS takes approximately 8 minutes to complete (Cambridge Cognition, 2023d).

2. Rapid Visual Processing (RVP)

The RVP test evaluates sustained attention. “A white box is shown in the centre of the screen, inside which digits from 2 to 9 appear in a pseudo-random order, at the rate of 100 digits per minute. Participants are requested to detect target sequences of digits (for example, 2-4-6, 3-5-7, 4-6-8). When the participant sees the target sequence, they must respond by selecting the button in the centre of the screen as quickly as possible. The level of difficulty varies with either one- or three-target sequences that the participant must watch for at the same time. Outcome measures cover latency (speed of response), probability of false alarms and sensitivity. The test takes approximately 7 minutes to complete (Cambridge Cognition, 2023a)

3. Spatial Working Memory (SWM)

The SWM evaluates executive functioning. “The test begins with several coloured squares (boxes) shown on the screen. The aim of this test is that by selecting the boxes and using a process of elimination, the participant should find one yellow ‘token’ in each of several boxes and use them to fill up an empty column on the right-hand side of the screen. Depending on the difficulty level used for this test, the number of boxes can be gradually increased until a maximum of 12 boxes are shown for the participants to search. The colour and position of the boxes used are changed from trial to trial to discourage the use of stereotyped search strategies. Outcome measures include errors (selecting boxes that have already been found to

be empty and revisiting boxes which have already been found to contain a token) and strategy." The SWM takes approximately 9 minutes to complete (Cambridge Cognition, 2023c).

Choice of Assessments

The three CANTAB subtests were chosen to assess across three of the PRPP-A quadrants. Attention is assessed using the RVP and is considered part of the 'Perceive' quadrant. Memory is assessed using the DMS and is considered part of the 'Recall' quadrant. Executive functioning is assessed using the SWM and is considered part of the 'Plan' quadrant of the PRPP-A-A. The choice of CANTAB tests was restricted by the methodology of the study. The original plan was for occupational therapists to conduct the PRPP-A and CANTAB neuropsychological tests (using an iPad) during an onsite workplace assessment for the participants. However, during the pandemic from 2020 – 2022, many workplaces were closed, or external visitors/contractors were not permitted on sites, with employees being forced or choosing to work from home. As such, the PRPP-A was conducted via interview over Zoom, rather than through observation. The CANTAB neuropsychological assessments chosen needed to be compatible (and validated) with remote testing methodology, using participants' PCs, rather than on-site using a researcher-issued iPad.

Other CANTAB assessments have been used in oncology research when examining cognitive changes experienced by people with cancer. Verbal Recognition Memory (VRM) would be used as part of the Recall quadrant. However, this test could not be used as it requires a researcher to be present in person during the assessment and is not validated for web testing. The Multitasking Test (MTT) assesses cognitive function in the planning quadrant of the PRPP-A, but it was unable to be used as it requires validated reaction time and latency measures using a researcher-issued iPad. So, when assessments are being conducted remotely using subjects' devices (e.g., a mouse or trackpad on a laptop, or a finger on their own iPad) to complete CATNAB tests, there is too much variability in the data for these time points to be accurate.

Statistical Analysis

Descriptive statistics were used to summarize the data collected from the participants to provide an overview of the demographic characteristics, including breast cancer type, treatment received, age at diagnosis, time since diagnosis, highest education level, and work status.

Group means, standard deviations, and ranges were calculated for the CANTAB and PRPP-A scores to summarize central tendency and variability of cognitive performance. Kendall's Tau was used to assess the correlation between CANTAB and PRPP-A scores, given the non-normative distribution of PRPP-A sub-quadrant scores and the small sample size.

Receiver Operating Characteristic (ROC) analysis was employed to evaluate the predictive power of cognitive assessments in determining employment outcomes and work hour changes post-cancer treatment. ROC quantifies how well a test can differentiate between positive and negative outcomes using sensitivity (true positive rate) and specificity (true negative rate) as key metrics. An ROC curve graphically represents the performance of a binary classification test, showing how well it distinguishes between groups. Sensitivity measures the proportion of correctly identified positives, while specificity measures the proportion of correctly identified negatives. The ROC curve plots sensitivity against specificity at various thresholds, with the Area Under the Curve (AUC) summarizing the test's overall performance. The Area Under the Curve (AUC) values provide a measure of each test's discriminatory ability (Zhou et al., 2011). Table 1)

Descriptor	AUC	Ability
Outstanding Discrimination	0.90 - 1.00	The model has excellent accuracy in distinguishing between the positive and negative classes
Excellent Discrimination	0.80 – 0.90	The model has good accuracy and is effective in distinguishing between the classes.
Acceptable Discrimination	0.70 - 0.80	The model has acceptable accuracy and can distinguish between the classes reasonably well.
Poor Discrimination	0.50 - 0.70	The model has poor accuracy and struggles to distinguish between the classes.
No Discrimination	+/>0.50	The model cannot distinguish between the positive and negative classes, which is equivalent to random guessing.

Table 1: Interpretation of area under the curve (AUC) scores (Bobbitt, 2021)

Results

1. Demographics

Demographics are presented in Table 2. There were 12 women with a previous diagnosis of breast cancer in this pilot study (Half of the participants had been diagnosed in the past two years and the other half between six and 15 years ago. All except one participant had obtained a university degree, with five participants having master's degrees. Five women were over 50 years old, and seven women were under 50 years old at the time of their diagnosis. All women

had surgery for their breast cancer treatment, and the majority also had chemotherapy. Seventy-five percent of participants also received radiation and /or hormone-based treatment. At the time of diagnosis, eleven women worked full time, and one woman worked part time. Post cancer diagnosis, only three women remained in full-time work, and the remaining nine women had reduced work to part-time. Post breast cancer, five of the twelve women changed their employer and/or job role. The change in job role was from higher levels of responsibility and cognitive demands for strategic management and executive functioning to those with more process and procedure-driven tasks.

Breast Cancer Type	n	%
HER2+	4	33.33
ER+	4	33.33
Triple Negative	2	16.67
Triple Positive	2	16.67
Treatment		
Surgery	12	100
Chemotherapy	11	91.67
Radiation	9	75
Hormone Therapy	9	75
Age at Time of Diagnosis		
<40 years old	2	16.67
40-49 years old	5	41.67
50-59 years old	4	33.33
60+ years old	1	8.33
Time Since Diagnosis		
< 2 years	6	50
< 6 years	4	33.33
< 15 years	2	16.67
Highest Education Level		
Master's Degree	6	50
Undergraduate Degree	5	41.67
Left formal education at 17/18 years	1	8.33
Employment Type at Time of Diagnosis		
Manager / Administrator	3	25
Professional	4	33.33
Associate Professional	2	16.67
Advance Clerical/Service Worker	3	25
Intermediate clerical, sales, or service work	0	0
Hours of Work at Time of Diagnosis		
Full time	11	91.67
Part-Time	1	8.33
Post Breast Cancer Employment Status		
Same Job / Same Employer	7	58.33
Different Job / Same Employer	0	0
Same Job / Different Employer	1	8.33
Different job / Different Employer	4	33.33

Post Breast Cancer Employment Type		
Manager / Administrator	1	8.33
Professional	3	25
Associate Professional	2	16.67
Advance Clerical/Service Worker	3	25
Intermediate clerical, sales, or service work	3	25
Post Breast Cancer Employment Hours		
Full Time	3	25
Part-Time	9	75

Table 2: Study participants (N=12)

2. CANTAB group results

The group ranges, means and standard deviations for the three CANTAB subtests are presented in Table 3. The overall accuracy of DMS is quite high across all delays at 88.92%, with a standard deviation of 10.3, with the probability of making an incorrect response very low at 0.02. The increased delay did not indicate lower scores, as the mean for 4 4-second delay (95.00) was higher than the score for the 0-second delay (91.67). The high mean value (0.895) and low standard deviation (0.073) in the RVP Total indicate consistent performance in detecting signals across participants. The mean for RVP Probability of False Alarms was very low (0.02), indicating a reliable assessment finding. The RVP Total Hits and RVP Total Misses are reciprocal scores (out of 54), but the high standard deviation indicates there was a large variability of performance in the group. SWM mean scores show errors increased with the number of boxes, indicating reduced performance with increasing complexity of tasks. The high mean errors (26.92) and standard deviation (12.139) for the SWM 12 Boxes indicate some poor performance in this task.

Delay Matched Sample (DMS)			
DMS Accuracy and Errors (n=12)	Range	Mean	Standard Deviation
DMS % Correct All Delays (%)	0-100	88.92	10.300
DMS % Correct Simultaneous	0-100	96.67	7.785
DMS % Correct 0-second delay	0-100	91.67	13.371
DMS % Correct 4-second delay	0-100	95.00	9.045
DMS % Correct 12-second delay	0-100	80.00	26.968
DMS Probability of Error (after an incorrect response)	0-1	0.02	0.072
Rapid Visual Processing (RVP)			
RVP Accuracy and Latency (n=12)	Range	Mean	Standard Deviation
RVP Total 'Detecting signal'	0-1	0.895	0.073
RVP Total Hits	0-54	34.17	11.575
RVP Total Misses	0-54	19.93	11.575
RVP Probability of False Alarm	0-1	0.02	0.067
RVP Response Latency (ms)	100-1900	542.50	168.524
Spatial Working Memory			

SWM Errors and Strategy (n=12)	Range	Mean	Standard Deviation
SWM Total Errors (Between4,6 & 8 boxes)	0-153	13.42	9.765
SWM Between Errors 4 Boxes	0-35	0.75	1.57
SWM Between Errors 6 Boxes	0-55	3.08	4.188
SWM Between Errors 8 Boxes	0-74	9.58	6.529
SWM Between Errors 12 Boxes	0-114	26.92	12.139
SWM Strategy Score	2-14	7.0	2.296

Table 3: CANTAB group results

3. PRPP-A group results

12 women had individual deficits in cognitive strategy application. Table 4 and Figure 2 present the PRPP-A Perceive, Recall, Plan, and Perform total and sub-quadrant overall minimum, maximum, and mean scores, suggesting that participants generally performed well across all areas, with the highest mean scores observed in the Perceive category and the lowest in the Plan category. The standard deviations indicate varying levels of consistency among participants. For example, Discriminating (SD: 7.165) and Controlling (SD: 5.416) show lower variability, suggesting more consistent performance in these areas. The PRPP-A sub-quadrants that had the lowest mean scores were Continuing (47.08), Initiating (56.92), Attending (58.25), Facts (59.42), and Programming (59.42). Attending and Continuing have higher variability (SD:15.428 and SD: 17.464, respectively), indicating significant differences in participants' abilities in these areas. The lower standard deviation for Programming (SD: 11.204) indicates a consistently lower performance in executive function across all participants. the group participant scores.

Perceive, Recall, Plan and Perform (PRPP-A-A) Quadrants and Subquadrants	**Range**	**Mean**	**Standard Deviation**	**Min**	**Max**
Attending	33-100	58.25	15.428	44	78
Sensing	33-100	86.25	12.520	67	100
Discriminating	33-100	81.67	7.165	67	89
Perceive Total		**75.39**			
Facts	33-100	59.42	13.912	33	78
Schemes	33-100	77.08	11.920	56	89
Procedures	33-100	82.58	11.920	67	100
Recall Total		**73.03**			
Mapping	33-100	68.67	13.459	44	78
Programming	33-100	59.42	11.204	44	78
Evaluating	33-100	64.17	12.741	33	89
Plan Total		**64.09**			
Initiating	33-100	56.92	13.118	50	83
Continuing	33-100	47.08	17.464	33	78
Controlling	33-100	92.67	5.416	89	100
Perform Total		**65.56**			

Table 4: PRPP-A group results

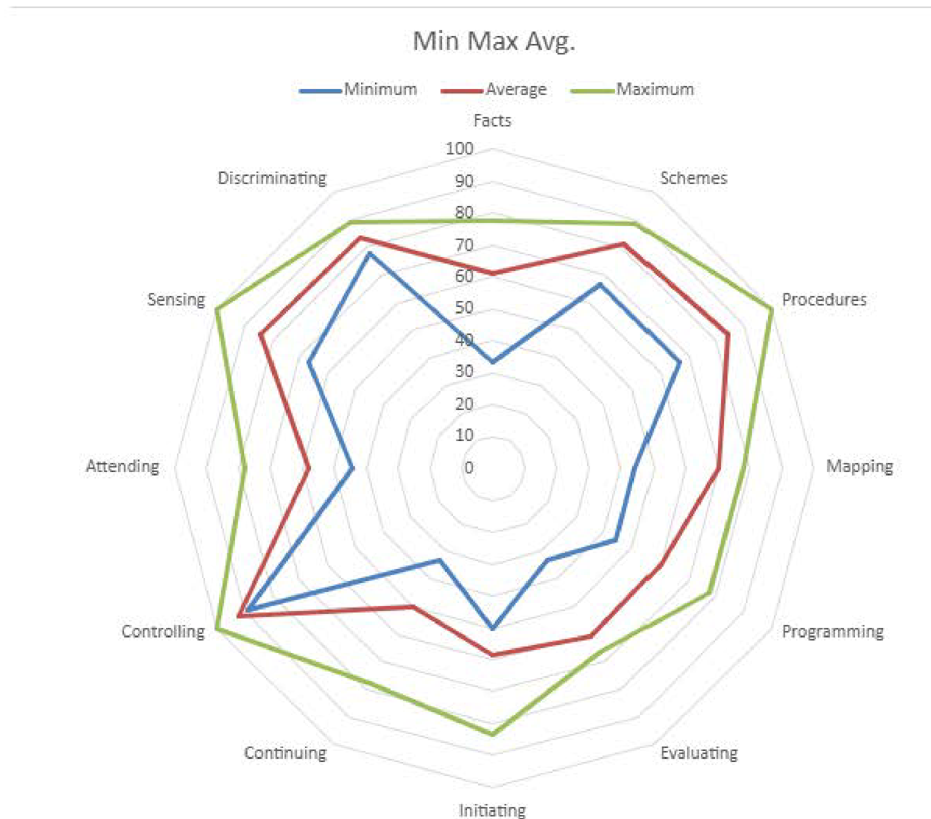


Figure 2: Radar graph illustrating group average minimum, maximum, and average Perceive, Recall, Plan, and Perform sub-quadrant scores.

4. Correlation between CANTAB and PRPP-A Assessments

Kendall's Tau was used as the non-parametric bivariate correlation test. Table 5 compares the CANTAB assessment and PRPP-A quadrant and sub-quadrant scores in similar cognitive capacities.

CANTAB Assessment	PRPP-A Components
Rapid Visual Processing (RVP) • RVP Total 'Detecting signal'	Quadrant Perceive • Total Perceive • Attending • Sensing • Discriminating
Delayed Matched to Sample (DMS) • DMS All Delays	Quadrant Recall • Total Recall • Facts • Schemes • Procedures
Spatial Working Memory (SWM) • SWMBE 468 Boxes Between Errors • SWM Strategy Score	Quadrant Plan • Total Plan • Mapping • Programming • Evaluating

Table 5: CANTAB assessment and PRPP-A quadrant and sub-quadrant scores in similar cognitive capacities.

Interpretation of the Kendall's tau correlation between SWMBE 468 Boxes Between Errors, SWM Strategy, and PRPP-A Plan scores (Table 6a) needs to be considered in light of inverse scoring systems for the assessment types. Lower SWMBE 468 Boxes Between Errors and SWM Strategy scores indicate a higher level of cognitive performance and strategy use, whereas higher PRPP-A scores indicate a higher cognitive performance. Meaning, as SWM scores increase (indicating poor cognitive performance) PRPP-A scores decrease (indicating poorer cognitive performance). There were significant negative correlations between SWMBE 468 Boxes Between Errors and PRPP-AMapping ($\tau = -.572$, $p = .020$), PRPP-AProgramming ($\tau = -.831$, $p < .001$), and Total Plan ($\tau = -.735$, $p = .002$), indicating that these could be measuring the same constructs. However, there was no significant correlation between SWMBE 468 Boxes Between Errors and PRPP-A Evaluating ($\tau = -.185$, $p = .455$). There was a significant negative correlation with SWM Strategy score ($\tau = -.602$, $p = .019$) and Total Plan ($\tau = -.532$, $p = .032$), indicating that these could be measuring the same construct. There was no significant correlation between SWM Strategy Score and PRPP-A Mapping ($\tau = -.293$, $p = .258$) and PRPP-A Evaluating. Overall, SWMBE 468 Boxes Between Errors score and PRPP-A Programming had the strongest correlation ($\tau = -.831$), followed by SWMBE 468 Boxes Between Errors and PRPP-A Total ($\tau = -.735$).

Both RVP Total 'Detecting signal' and PRPP-A scores (Table 6b) indicate better cognitive performance on these assessments. RVP score was positively correlated with PRPP-A Attending ($\tau = .752$, $p = .002$) and Total Perceive ($\tau = .477$, $p = .036$). There was no significant correlation with PRPP-A Discriminating ($\tau = .173$, $p = .487$) and PRPP-A Sensing ($\tau = .321$, p =

.174). The correlation between RVP Total ‘Detecting signal’ and PRPP-A Attending (τ = .752) was considered strong. Higher DMS All Delays and PRPP-A scores (Table 6c) indicate better cognitive performance. DMS All Delays scores were positively correlated with PRPP-A Facts (τ = .661, p = .008) and Total Recall (τ = .592, p = .014). The correlations could be considered moderate for both of these.

Table 6a: Kendall Tau correlation between SWM and PRPP-A Plan

		SWMBE 468 Boxes Between Errors	SWM Strategy	PRPP-A Mapping	PRPP-A Programming	PRPP-A Evaluating	PRPP-A Total Plan
SWMBE 468 Boxes Between Errors	(τ)	1.000	.635*	-.572*	-.831*	-.185	-.735*
	p	.	.008	.020	<.001	.455	.002
SWM Strategy	(τ)	.635**	1.000	-.293	-.602*	-.339	-.532*
	p	.008	.	.258	.019	.197	.032

Table 6b: Kendall Tau correlation between RVP and PRPP-A Perceive

		RVP Total ‘Detecting signal’	PRPP-A Attending	PRPP-A Discriminating	PRPP-A Sensing	PRPP-A Total Perceive
RVP Total ‘Detecting signal’	(τ)	1.000	.752*	.173	.321	.477*
	p	.	.002	.487	.174	.036

Table 6c: Kendall Tau correlation between DMS and PRPP-A Recall

		DMS All Delays	PRPP-A Facts	PRPP-A Schemes	PRPP-A Procedures	PRPP-A Total Recall
DMS All Delays	(τ)	1.000	.661*	.467	.467	.592*
	p	.	.008	.069	.064	.014

Table 6: Kendall Tau correlation between PRPP-A and CANTAB test scores

5. Return to work outcomes using Receiver Operating Characteristic (ROC)

Receiver Operating Characteristic (ROC) analysis was used to evaluate the predictive power of CANTAB and PRPP-A assessments in determining employment outcomes and work hour changes post-cancer treatment.

Change in Employment

ROC analysis was used to evaluate the sensitivity and predictive power of CANTAB assessments (RVP, DMS, SWM) and PRPP-A sub-quadrant scores (Perceive, Recall, Plan, Perform) in predicting women who were or were not able to return to their pre-cancer roles. This was indicated by women resigning or taking redundancies from their pre-cancer roles due to reported cognitive difficulties. These women reported moving to less cognitively demanding roles. This analysis helps identify which cognitive assessments are most useful for forecasting post-cancer recovery in terms of duties and roles. Table 7a shows the PRPP-A Total Perceive (AUC = .969) demonstrated outstanding sensitivity in predicting women not returning to their pre-cancer roles. Rapid Visual Information Processing (RVP) (AUC = .750) and PRPP-A Total Plan (AUC = .734) showed acceptable sensitivity and can also be considered.

Change (Reduction) in Work Hours

ROC analysis was used to evaluate the sensitivity and predictive power of CANTAB assessments (RVP, DMS, SWM) and PRPP-A sub-quadrant scores (Perceive, Recall, Plan, Perform) in predicting women who were or were not able to return to their pre-cancer hours of work. This was indicated by women reducing their hours of work due to reported cognitive difficulties. Table 7b shows that both the CANTAB SWM Strategy Score (AUC=.750) and PRPP-A Total Perceive (AUC=.719) show acceptable discriminatory ability in predicting reduced work hours.

Table 7a: Area Under the ROC Curve: Change in Employment		
Test Result Variables	**Area (AUC)**	**Interpretation***
RVP Total 'Detecting signal'	.750	Acceptable Discrimination
DMS All Delays	.391	No discrimination
SWMBE 468 Boxes Between Errors	.391	No discrimination
SWM Strategy	.625	Poor discrimination
Total Recall	.469	No discrimination
Total Plan	.734	Acceptable Discrimination
Total Perform	.188	No discrimination
Total Perceive	.969	Outstanding discrimination
Table 7b: Area Under the ROC Curve: Change in Work Hours (Reduced)		
Test Result Variable(s)	**Area**	**Interpretation***
RVP Total 'Detecting signal'	.500	Poor discrimination
DMS All Delays	.234	No discrimination
SWMBE 468 Boxes Between Errors	.563	Poor discrimination
SWM Strategy	.750	Acceptable discrimination
Total Recall	.328	No discrimination
Total Plan	.469	No discrimination
Total Perform	.094	No discrimination
Total Perceive	.719	Acceptable discrimination

Table 7: Area Under the ROC Curve: Change in Work Status
*See Methods section for Interpretation levels

Discussion

This study evaluated the PRPP-A as a tool for occupational therapists to assess the cognition of women following breast cancer in relation to work performance and compared findings with neuropsychological testing using the CANTAB. Twelve women were included in the study and cognitive abilities were assessed through clinical interviews using the PRPP-A and online completion of three components of the CANTAB that related to PRPP-A items. Additionally, the study analysed the predictive power of the PRPP-A System and CANTAB for work participation.

Demographic and Employment Changes

The demographic data revealed a heterogeneous group of women with varying ages, education levels, and employment status at the time of their breast cancer diagnosis. Most participants had undergone surgery, chemotherapy, and radiation therapy, reflecting common treatment protocols for breast cancer. The PRPP-A interview provided insights into changes in employment status, with the majority of women moving from full-time to part-time work and 42% changing employers. Some women transitioned to roles with lower responsibility due to difficulties coping with the cognitive demands of their pre-cancer roles. This finding aligns with other studies (Becker et al., 2015; Boykoff et al., 2009; Lange et al., 2024; Lewis et al., 2016; Von Ah et al., 2013) showing women often move from full-time to part-time work post-diagnosis or opt for roles with lower cognitive demands and responsibilities. These changes in workforce participation due to cognitive changes after breast cancer add weight to the call for improved rehabilitation services and workplace policies to support women in their long-term challenges, managing the side effects of cancer diagnosis and treatment (Lange et al., 2024).

PRPP-A

The PRPP-A highlighted that this group of women all had difficulties with 'Continuing' (Flows, Continues, Persists), 'Initiating' (Starts, Stops), 'Attending' (Notices, Modulates, Maintains), 'Facts (Recall)' (Recognizes, Labels, Categorizes), and 'Programming' (Chooses, Sequences, Calibrates). These results are similar to the earlier study by the authors (Lewis et al., 2016), where women in that cohort had difficulty with 'Programming', 'Attending' and 'Continuing'.

However, Lewis et al. (2016) considered ‘Facts’ to be a strength of that group, but in this study, it was found to be a cognitive deficit. This discrepancy may be due to the in-depth but structured interviewing method for administering the PRPP-A in this study, which allowed the therapist to explore work tasks and the cognitive strategy deficits impacting performance. Overall, the ‘Plan’ quadrant, which includes components of ‘Mapping’ (know goal, identifies obstacles, organises), ‘Programming’ (chooses, sequences, calibrates), and ‘Evaluating’ (questions, analyses, judges), and is related to executive function, had the lowest average score. Executive function encompasses a range of higher-order processes that guide goal-oriented behaviours and enable adaptive responses to shifting environmental demands (Balconi et al., 2020). Executive function has continually been assessed and reported by women as a major difficulty post-breast cancer treatment(Lange et al., 2023; Oliva et al., 2024). A meta-analysis of breast cancer survivors identified executive function as the only cognitive domain significantly impaired in chemotherapy-treated survivors when compared to both non-cancer and non-treated controls (Bernstein et al., 2017). All participants in this study had received chemotherapy treatment, but this study design did not allow for causal relationships between treatment type and cognitive assessment outcomes to be evaluated. Research has proposed that executive functions play an essential role in work performance, with successful professionals displaying better social and executive functioning (Balconi et al., 2020). Klaver (2020) identified that executive functioning was a significant concern for people with cancer and their employers when supporting people with cancer return to work (Klaver et al., 2020). Further, the ‘Plan’ quadrant scores for this group had acceptable sensitivity in predicting women not returning to their pre-cancer roles. It could be reasonably explained that women in this study who were in managerial and professional roles at the time of diagnosis were not able to return to these high-functioning roles due to executive functioning difficulties (Lange et al., 2024). This may explain why some of them chose to move to roles in clerical, sales, or service work, which have lower responsibilities and cognitive demands.

Correlation Between CANTAB and PRPP-A Assessments

As far as the authors know, there have been no other studies comparing clinician-administered cognitive assessments and neuropsychological tests in women with breast cancer. A study evaluating the cognitive function of psychiatric patients through neuropsychological tests and clinician-administered questionnaires found only a moderate correlation between the results, with clinicians' assessments failing to ‘pick up’ cognitive deficits identified in objective testing

(Moritz et al., 2004). In clients with psychiatric illnesses, it has been found that clinical interviews alone are insufficient to determine the severity of cognitive impairment. Patients often inaccurately report their cognitive functioning, and clinicians who rely solely on these interviews tend to perform poorly in assessing patients' cognitive capabilities (Bellens et al., 2022). Although this is a different population and involves a small cohort, there was a significant correlation between some CANTAB scores and PRPP-A scores that warrants further testing. Significant correlations were observed in the three PRPP-A areas with corresponding CANTAB tests. There was a significant correlation between the PRPP-A Total Perceive score and the PRPP-A sub-quadrant score for Attending with the CANTAB RVP 'Detecting signal' Score. This implies that difficulties in sustained attention can be detected through the PRPP-A. A significant correlation was also noted between the PRPP-A Total Recall score and the PRPP-A sub-quadrant score for Facts with the CANTAB DMS All Delays Score, indicating that difficulties in visual memory may be captured through the PRPP-A. Moreover, there was a significant correlation between the PRPP-A Plan total score and the sub-quadrant scores for Mapping and Programming, with the CANTAB SWMBE 468 Boxes Between Errors Score, and the SWM Strategy score. This suggests that difficulties in spatial memory tasks and strategies that relate to challenges in planning and executive functions may be detected through the PRPP-A.

The correlation between CANTAB and PRPP-A scores suggests that these assessments measure overlapping cognitive constructs and can be used complementarily to provide a comprehensive evaluation of cognitive function. Additionally, this may indicate that occupational therapists administering the PRPP-A through interviews with women diagnosed with breast cancer can be confident that the assessment evaluates constructs similar to those in neuropsychological tests, while also being subtle enough to identify performance difficulties. However, an additional benefit of the PRPP-A is its ability to help therapists understand the nuances of cognitive difficulties through the analysis of work tasks and workplace environments. This enables the development of individualized strategies and interventions to address the cognitive challenges faced by women with breast cancer, ultimately improving occupational performance and workforce participation. (Bootes & Chapparo, 2010, 2013; Nott et al., 2008; Ranka et al., 2025). In this study, there was no neuropsychological test equivalent to the PRPP-A 'Perform' quadrant. However, it must be acknowledged that women in this study experienced challenges with initiating and sustaining their work performance, potentially related to cognitive fatigue previously described in Lewis et al., (2016). Future research should

consider how employers (i.e., managers and supervisors) may contribute to the PRPP-A findings when occupational therapists interview them about women's performance at work. Although employers' views have been considered in some studies (Klaver et al., 2020), individual feedback about an employee's performance could assist occupational therapists in identifying additional cognitive strategy deficits and provide employment-matched strategies (Lewis & Mackenzie, 2022).

Predictive Power of Cognitive Assessments

The ROC analysis provided valuable insights into the predictive power of the CANTAB and PRPP-A assessments for employment outcomes in women with breast cancer. The PRPP-A Total Perceive and Total Plan scores were able to predict which women did not return to their pre-cancer roles. In addition to cognitive strategy difficulties with executive functioning impacting work performance, this analysis showed that challenges with attention and concentration may also affect women's ability to participate in professional or managerial roles, leading them to change employment to less cognitively demanding positions. This was further validated by the CANTAB RVP 'Detecting signal' test, which assesses sustained attention, demonstrating acceptable sensitivity for predicting women not returning to pre-cancer roles. The PRPP-A Perceive score was also capable of identifying women who did not return to their pre-cancer work hours. In qualitative studies, women have described requiring more time to complete tasks due to increased concentration and attention demands, necessitating them to work longer and harder to achieve the same results as before their breast cancer diagnosis (Boykoff et al., 2009; Chapman et al., 2022; Lewis et al., 2016; Ryan et al., 2015; Von Ah et al., 2013). This could lead to cognitive fatigue and a reduction in work hours. Overall, the PRPP-A Recall or CANTAB DMS All Delays Score had no predictive ability. This may be due to memory compensation strategies being more readily available and supported by technology (Chapman et al., 2022) compared to difficulties with sustained attention, concentration, and executive functioning. Overall, this emphasizes the importance of perceptual and attentional processes in occupational functioning after cancer treatment for women with breast cancer, as well as the significance of assessing these cognitive strategies to identify women at risk of employment challenges. A deeper understanding of the relationship between cognition and work status could facilitate workplace rehabilitation for individuals facing cognitive deficits post-breast cancer treatment. This strategy may help prevent or alleviate work-related difficulties linked to cognitive impairment.

Limitations and Future Research

While the study offers valuable insights, it is constrained by the small sample size, the non-normative data distribution, and the diverse group with varying ages and lengths of time since diagnosis. These factors may limit the generalizability of the results, but they provide a foundation for further research. Future studies should aim to include a larger population and, where ethical considerations permit, involve conducting the PRPP-A with women with breast cancer through the observation of work performance in the work environment, alongside interviews and feedback from an employer representative as part of a comprehensive workplace assessment. As previously mentioned, the assessments chosen for this study were determined by public health regulations during the global pandemic.

Implications for Occupational Therapy

The PRPP-A is effective in evaluating the cognitive challenges faced by women with breast cancer concerning work tasks. It could also indicate that women experiencing perceptual and planning difficulties are at a higher risk of not returning to their pre-cancer work hours or roles, suggesting that earlier and more intensive interventions may be necessary. Occupational therapists should consider using the PRPP-A assessment as a basis for any workplace evaluations with this population. It offers a structured method for presenting data along with standardized terminology and scoring to outline the client's cognitive strategy deficits. For third-party funders and insurers requesting assessments of women's cognitive function related to work performance, the PRPP-A addresses concerns regarding the subjective nature of self-reported cognitive questionnaires and the expensive, time-consuming process of neuropsychological tests.

The PRPP-A assessment can subsequently guide occupational therapists in providing tailored interventions that address cognitive strategy deficits affecting work performance. This study has indicated that for women with breast cancer, there should be a strong focus on addressing difficulties related to attention and concentration. Integrating PRPP-A assessments into routine practices could improve employment outcomes for breast cancer survivors.

Conclusion

This study highlighted the effectiveness of the PRPP-A in assessing cognitive difficulties experienced by women with breast cancer concerning work tasks. Occupational therapists can use this assessment, as it aligns well with similar neuropsychological tests. The findings suggest that women with perceptual and planning difficulties are at a higher risk of not returning to their pre-cancer work hours or roles, indicating a need for earlier and more intensive interventions. The PRPP-A provides a structured and reliable method for occupational therapists to present cognitive strategy deficits, addressing concerns from third-party funders. By integrating PRPP-A assessments into routine practice, occupational therapists can develop tailored interventions that focus on attention and executive function difficulties, ultimately improving employment outcomes for breast cancer survivors. Future research should aim to include larger populations and incorporate workplace observations and employer feedback to further validate these findings.

Authors' Declaration of Authorship Contribution

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Jl as part of her PhD, assisted by LM. The first draft of the manuscript was written by JL, and all authors reviewed and approved the final version.

Conflict of Interest

We declare that no conflicts of interest related to this research/study/project exist. We have no personal or financial relationships that could influence the work. Grants/Funding have been declared in the manuscript.

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Supplementary File

Details about the CATAB assessments

Test	Cognitive Domain tested	Measure	Description	Directionality	Score Range
Rapid Visual Information Processing (RVP)	Sustained attention	Total hits	Number of occasions upon which a target sequence is correctly responded to	Higher is better	0-54
		Total misses	Number of occasions upon which a target sequence is not correctly responded to	Lower is better	0-54
		Probability of detecting target	Measure of how good the subject is at detecting the target sequence	Higher is better	Min = 0 Max = 1
		Mean latency	Mean time take to respond	Lower is better	Min=100 milliseconds Max 1900 milliseconds
		Probability of a False Alarm	Measure combining number of sequences presented and false alarms with correct response.	Lower is better	Min = 0 Max = 1
Delayed Matched Sample (DMS)	Visual memory	Percent correct, all delays, simultaneous, 0s, 4s, 12s delays	Percentage of occasions that a subject selected the correct stimulus across all delays, simultaneous, 0s, 4s, 12s delays	Higher is better	Min = 0 Max = 100
		Probability of Error given Error	Probability that a subject's initial choice is incorrect given the initial box choice immediately preceding on trial was incorrect, calculated on simultaneous and all delays.	Lower is better	Min = 0 Max = 1
Spatial Working Memory (SWM)	Executive Functioning	Total incorrect responses	Number of incorrect options across four, six and eight token trials.	Lower is better	0-153
		Incorrect responses in 4 token box trial	Number of times a subject revisits box across four token trials only.	Lower is better	0-35
		Incorrect responses in 6 token box trial	Number of times a subject revisits box across six token trials only.	Lower is better	0-55
		Incorrect responses in 8 token box trial	Number of times a subject revisits box across eight token trials only.	Lower is better	0-74
		Strategy score	Number of times a subject begins a new search pattern from the same box they started with (same starting point implies employing a planned strategy).	Lower is better	2-14

Floor or ceiling effects identified in PRPP-A scores

A review of the PRPP-A scores for ceiling and floor effects was conducted:

- Min / Max: 33 / 100
- Mean: 69.5
- Median: 67
- Top-band (≥ 89): 24.3% of scores
- Bottom-band (≤ 44): 16% of scores

Overall, there was no evidence of ceiling or floor effect. The data are fairly spread with a slight tendency to mid-to-high values

5.6 Key findings

This chapter evaluated the PRPP-A (PRPP@WORK) via an interview format to assess cognitive changes in women with breast cancer and their impact on work participation. The assessment demonstrated that participants experienced significant cognitive difficulties, particularly in initiating and continuing tasks, attending to work duties, recalling work details, and planning sequences of actions to complete tasks. These challenges were especially evident in professional and cognitively demanding roles. Total quadrant scores for perception, recall, and planning, along with several sub-quadrant scores, were significantly related to corresponding domains in the CANTAB neuropsychological tests, suggesting that both tools measured similar cognitive functions. The PRPP@WORK also effectively predicted which women were unable to return to their pre-cancer work roles and hours, with 'Perceive' and 'Plan' scores being particularly indicative. Women who experienced perceptual (attention) and planning (executive functioning) difficulties appear to require earlier and more intensive interventions to improve work outcomes, as unaddressed impairments in these areas could lead to reduced hours or changes in employment.

Occupational therapists played a crucial role in assessing cognition in this population, with a clear need for early cognitive assessments in secondary health care settings and workplace-based evaluations to support return-to-work planning and rehabilitation. The combined use of PRPP@WORK and neuropsychological testing resembled diagnostic approaches used by psychologists and psychiatrists under DSM-5-TR guidelines. While the PRPP@WORK identified cognitive impacts through general interviews, further research was recommended to assess women directly about their work tasks and performance. Future studies should include larger populations and incorporate workplace observations and employer feedback to strengthen the environmental relevance and clinical utility of the assessment.

CHAPTER 6: DISCUSSION AND CONCLUSION

6.1 Introduction

This final chapter provides a summary of the findings from each of the four research stages, relating them to one another, the broader international literature, and local Australian policies and practices within the healthcare and employment support systems. Drawing on both national and international evidence, this chapter examines how cognitive changes after breast cancer affect women's participation and performance at work, as well as how these effects are currently assessed and supported within Australia's healthcare and employment systems. The chapter uses the cancer care continuum as a framework to identify systemic gaps, missed opportunities for early intervention, and the role of occupational therapy in bridging these gaps. It also discusses the ethical, financial, and practical implications of unaddressed cognitive impairments. Finally, it offers recommendations to improve education, policy, service delivery, and research to better support women with breast cancer in returning to meaningful employment.

6.2 Overview of findings

This research originated from clinical experience in workplace rehabilitation, along with observations and reports about the challenges faced by an occupational therapy academic colleague with breast cancer, who was returning to work with cognitive changes. In 2015, an exploration into this issue revealed limited literature on the role of occupational therapy in helping women with breast cancer or other cancers to return to work, especially those managing cognitive changes affecting their work. Australian-based research was scarce, with no studies specifically focusing on return-to-work rates for women with breast cancer or on supporting women with breast cancer experiencing cognitive changes within the occupational

therapy literature. These gaps led to a series of research questions aimed at addressing the overall research question:

> How do cognitive changes associated with breast cancer influence women's work participation and performance, and how can these effects be measured?

Four sub-questions emerged:

1. What evidence suggests that women with breast cancer have reduced work participation compared to the general population of women in Australia?
2. How do cognitive changes impact the work performance and participation of women with breast cancer during their employment?
3. Which specific cognitive areas are affected in women with breast cancer that could impact their worker roles?
4. How effective is the PRPP-A (PRPP@WORK) in assessing work-related cognitive changes in women with breast cancer?

Four research stages, each employing different methodologies, were developed around these sub-questions. A research project was set up to address each of the four sub-questions. Each research project was conducted, and the findings for each stage were prepared in a manuscript and submitted for journal publication. This is presented in Figure 6.13. Initially, the research stages were seen as linear, with the findings from each stage contributing to the next. However, after completing research Stage Four (presented in Chapter 5), it became evident that the findings from Stage Four addressed some of the unanswered questions from Stage One, as represented by the shaded arrow in Figure 6.13.

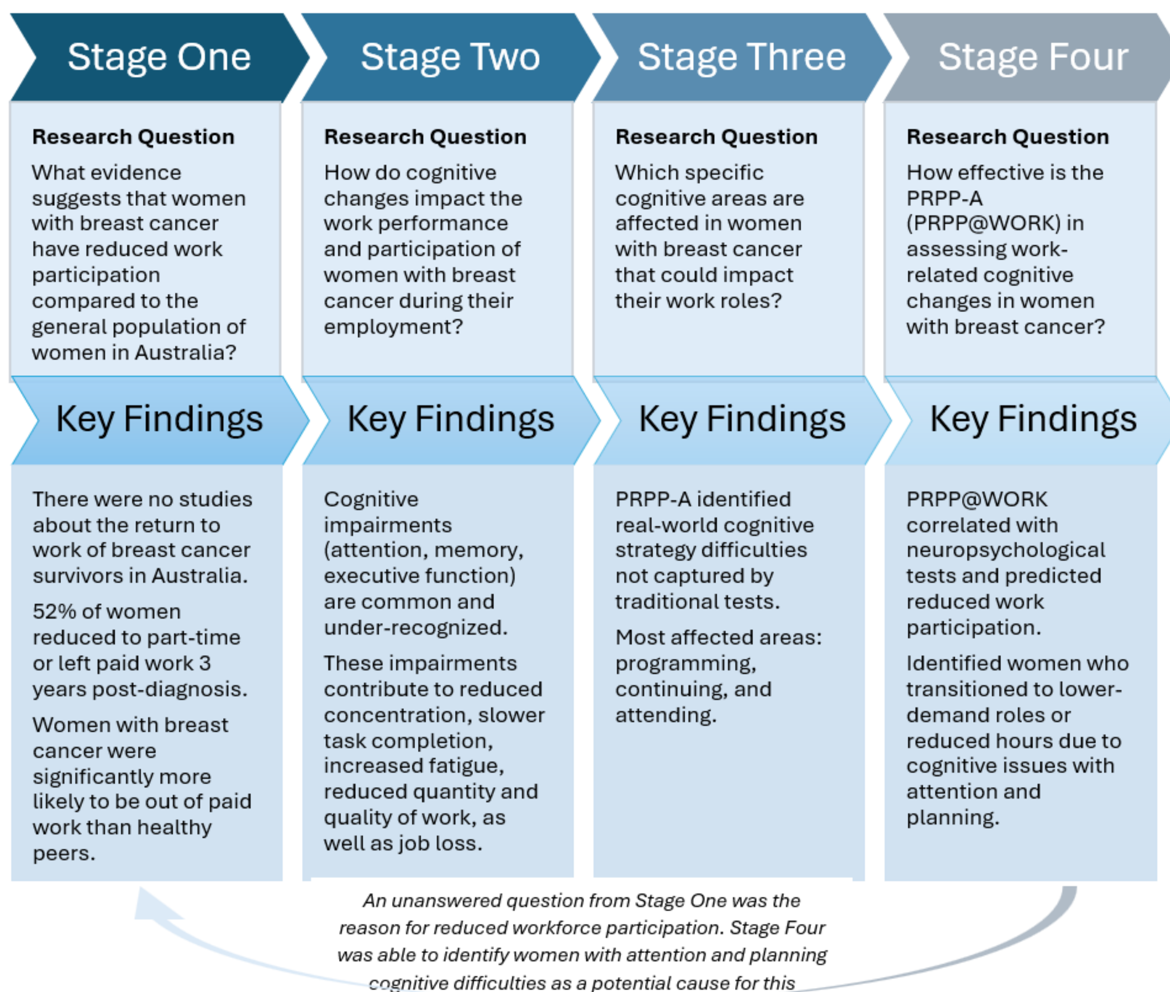

Figure 6.10: Research stages, questions and key findings

6.2.1 Research stage one: Exploring work participation of women with breast cancer in Australia

The large retrospective longitudinal study, conducted as part of Research Stage One, presented in Chapter 2, using data from the Australian Longitudinal Study on Women's Health (ALSWH), provided compelling evidence of the negative impact breast cancer has on women's workforce participation. The research compared women's work status three years before and after their first reported breast cancer diagnosis, with data collected between 1998 and 2010. Of the 448 women with breast cancer, 48% of those who were employed full-time before diagnosis returned to full-time work three years later, while 52% reduced to part-time work or left paid

employment altogether. Comparison of women with breast cancer and healthy, age-matched women using latent class analysis found that women with breast cancer were more likely to fall into the categories of “mostly full-time work" and "mostly not in paid work” compared to healthy, age-matched women. There was a substantial difference in the percentage of women with breast cancer not in paid work compared to healthy, age-matched women. Multinomial logistic regression revealed that women living in remote areas, with lower levels of education, who were partnered or had a chronic health condition, were significantly more likely not to be in paid work. The evidence demonstrates that breast cancer negatively affects women's work participation. In Australia, where women's workforce participation has risen sharply in recent decades, limited support for returning to work after breast cancer remains a concern, especially given projections that between 2022 and 2031, work loss will result in AU$3.26 billion in lost GDP (Lloyd et al., 2025). Before this study, there was no data on the work participation or return-to-work rates of women with breast cancer in Australia. The research by Lewis et al., (2020) was the first in Australia to demonstrate reduced employment participation among women with breast cancer. Once this was established, the next step was to explore the reasons why women did not return to their pre-cancer hours or roles.

6.2.2 Research stage two: Examining the cognitive changes that may impact on work performance and participation of women with breast cancer

Research Stage Two, presented in Chapter 3, used a scoping review methodology to examine one of the possible causes of reduced workforce participation for women with breast cancer - cognitive impairment. The research confirmed that cognitive impairments are prevalent and persistent, with approximately one in three women reporting clinically significant symptoms (Whittaker et al., 2022). These impairments, which include difficulties with attention, memory, and executive functioning, are often invisible, hard to articulate, and difficult to measure,

contributing to their under-recognition in clinical care and employment (Player et al., 2014). The chapter examined the causes of cognitive changes, identifying chemotherapy, endocrine therapy, surgery, radiation, biological markers, genetic predispositions, menopause, aging, and affective disorders such as anxiety, depression, and fatigue as contributing factors (Ahles et al., 2012; Fleming et al., 2023; Janelsins et al., 2014; Wagner et al., 2020). Neuroanatomical imaging studies have provided strong evidence of structural and functional brain changes (Ferguson et al., 2007; Silverman et al., 2007; Vardy et al., 2019), validating the lived experiences of women who report cognitive difficulties. The scoping review and its update revealed consistent links between cognitive impairment and reduced work performance, with women reporting diminished concentration, slower task completion, and increased fatigue (Chapman et al., 2022; Lewis & Mackenzie, 2022). These findings were framed within the ICF Model (World Health Organization, 2001), which contextualises how cognitive changes intersect with personal and environmental factors to influence occupational outcomes. Overall, the urgent need for better recognition, assessment, and support for cognitive changes in breast cancer survivors was highlighted. The importance of developing specific evaluations and interventions that address both the clinical and occupational aspects of survivorship was emphasised, ensuring women with cognitive changes can return to or maintain meaningful employment.

6.2.3 Research stage three: Examining the cognitive areas affected in women with breast cancer that could impact their worker roles

Research Stage Three in Chapter 4 identified cognitive functions most affected in relation to work performance for women with breast cancer, using a unique form of cognitive assessment, the Perceive, Recall, Plan, and Perform (PRPP) System of Task Analysis (PRPP-A). Traditional neuropsychological tests lack ecological validity, especially in capturing the nuanced aspects. cognitive challenges women face after breast cancer in work settings (Calvio et al., 2010;

Ferguson et al., 2007). These assessments are often inaccessible to many and frequently misalign with lived experiences, leading to the dismissal of symptoms (Phan, 2022; Smidt et al., 2016). While self-report tools are practical, they carry risks of priming bias (Australian Bureau of Statistics, 2023c; Oliveira et al., 2022). The PRPP-A was presented as a functional, clinician-administered alternative that evaluates cognitive strategy use in real-world occupational tasks (Chapparo & Ranka, 2014; Ranka et al., 2025a). Using secondary analysis of interview data, the study identified key cognitive strategy difficulties faced by breast cancer survivors in relation to work tasks, in three of the sub-quadrants: programming, continuing, and attending. Programming, which involves selecting, sequencing, and calibrating actions, was the most consistently impaired area, affecting all participants. This aligns with earlier findings that executive functions like planning and problem-solving are particularly vulnerable after treatment (Duijts et al., 2014; Munir et al., 2010). Continuing, which supports task persistence and flow, was also frequently impaired; participants described cognitive fatigue and reduced endurance, echoing findings from Mizuno et al. (2011) and Boykoff et al. (2009). Attending, involving maintaining and shifting attention, was impacted in tasks such as driving and reading, consistent with previous reports of attention deficits among cancer survivors (Ottati & Feuerstein, 2013; Wefel et al., 2004). Despite these challenges, participants showed strengths in recalling procedures, indicating preserved memory for familiar tasks. These findings highlight the utility of the PRPP-A in identifying both deficits and strengths in real-world contexts, providing a more ecologically valid alternative to traditional neuropsychological assessments (Calvio et al., 2010; Nelson et al., 2014).

6.2.4 Research stage four: Effectiveness of the PRPP-A (PRPP@WORK) in assessing work-related cognitive changes in women with breast cancer

Chapter 5, Research Stage Four, expanded on Stage Three findings by using the PRPP@WORK to confirm that women with breast cancer experience cognitive strategy difficulties at work, particularly with initiating and continuing tasks, attending to duties, recalling details, and planning activities. The PRPP@WORK, a workplace-based cognitive assessment tool, aligned closely with neuropsychological results from the Cambridge Neuropsychological Test Automated Battery (CANTAB), indicating both tools assess similar cognitive domains. Notably, the PRPP@WORK demonstrated predictive value, identifying executive function challenges, especially in attention and planning, as potential indicators of reduced work participation. It effectively distinguished women unable to return to pre-cancer roles and hours, with perceptual and planning difficulties being particularly influential. Remarkably, this finding connects back to Research Stage One, which found that women with breast cancer reduced their working hours or left the workforce three years after diagnosis. However, the methodology of that study did not allow for exploration of the reasons behind this trend. Research Stage four offers a possible explanation: cognitive difficulties at work may lead women to reduce their hours, transition to roles with lower cognitive demands, or exit the workforce altogether. These findings highlight the importance of early, targeted interventions to address cognitive impairments and support return-to-work outcomes, as well as the role of workplace assessments in rehabilitation, especially for women with breast cancer who may face subtle but impactful cognitive challenges. Occupational therapists are central to evaluating functional capacity and job demands, yet workplace-based cognitive assessments remain underdeveloped (Innes, 2012; Wolf & Dobson, 2012). The PRPP@WORK was presented as a structured, clinician-administered tool that lies between objective and subjective cognitive evaluations, meeting the calls of allied health professionals and insurers for a balanced method of cognitive assessment.

This approach aligns with the biopsychosocial model and ICF framework, offering a nuanced understanding of how cognitive impairments affect work performance (Shaw & Strong, 2008; World Health Organization, 2001).

6.3 Discussion of findings

This thesis explored the work performance and participation of women with breast cancer, with a particular focus on cognitive functioning. Returning to work is often considered one of the final steps in the rehabilitation process for women with breast cancer. Early rehabilitation typically addresses impairments (ICF body structure), such as lymphoedema, and focuses on managing activities of daily living (ICF activities) (Pergolotti et al., 2016), which may occur during active treatment and immediately afterwards. Once women regain consistency and independence in these areas, many begin to consider participating in the workforce. While returning to work may not be an immediate priority, it is often a later-stage goal aligned with improving quality of life after a life-threatening illness. In Australia, women can access short-term financial assistance through employer-based leave entitlements, income protection, or government benefits (Collie et al., 2019) until they are medically cleared to return to work. However, this trajectory is not universal. In countries such as the United States, where health insurance is tied to employment and protective legislation is limited, women may remain at work during treatment to maintain access to medical care. These financial pressures can necessitate working during treatment, even when not truly fit to do so, and have been linked to higher rates of job loss (Blinder & Gany, 2020; Islam et al., 2014).

Regardless of timing, women frequently describe returning to work as a milestone in reclaiming a sense of 'normalcy' (Duijts et al., 2014; Munir et al., 2010). This reflects not just physical recovery, but re-engagement with valued roles, identity, and social participation. Many women continue to experience physical, psychological, and cognitive challenges long after treatment

ends. known as the 'survivorship' phase of the cancer care continuum. Workplace rehabilitation, which typically occurs several months to a year post-diagnosis, may be considered one of the final aspects of rehabilitation within this phase. The research in this thesis was embedded in the later part of the survivorship phase, focusing on employment. Examining cognitive functioning in women with breast cancer at work highlights the need to consider other stages of the cancer care continuum (Schmidt et al., 2019). Many healthcare professionals are involved during the diagnosis and treatment of breast cancer. Although not the focus of this study, the nature and timing of early healthcare interventions likely influence a woman's eventual return to employment. This research supports the view that cognitive changes often begin early and become more apparent during chemotherapy, suggesting a need for proactive cognitive screening, evaluation, and support throughout the whole cancer care continuum. Accordingly, the discussion of findings will be framed using the cancer care continuum, as presented in Figure 6.14, to explore other contributing factors that may affect women's ability to return to work after breast cancer due to cognitive changes.

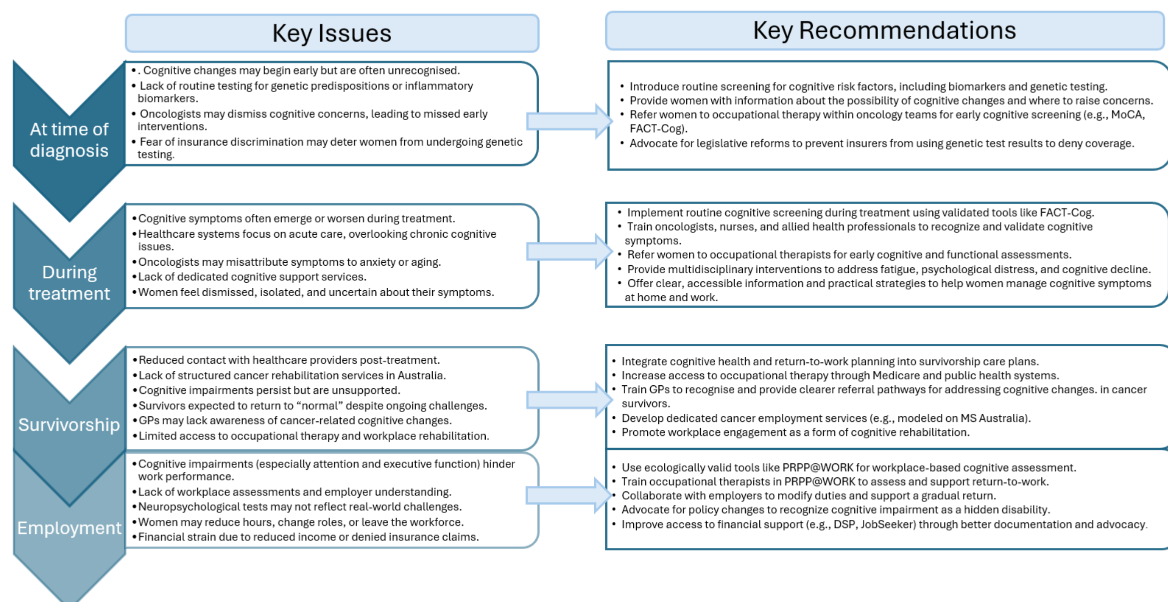

Figure 11: Cancer care continuum approach with key issues and recommendations to support women with breast cancer, cognitive changes and work participation.

6.3.1 At the time of diagnosis

This research has shown that at the time of a breast cancer diagnosis, there are possible health provider acts and omissions and healthcare systemic factors that may contribute to cognitive difficulties impacting a woman's work participation. Genetic factors and inflammation biomarkers detected through blood tests at the time of diagnosis have been linked to cognitive impairments in cancer patients (Argyriou et al., 2011). However, women with breast cancer may be asymptomatic. This, combined with the cost of testing and limited awareness, may mean these blood tests are not routinely conducted. As discussed in Chapter 4, if oncologists are unaware of or dismissive toward cognitive changes (Hamilton et al., 2024; Smidt et al., 2016), they may be reluctant to order these tests. Yet, identifying inflammatory markers or genetic predispositions could lend greater credibility to women's self-reported cognitive difficulties, especially when cognitive impairments affect functioning and employment decisions. Insurers often hesitate to accept self-reports without 'objective' evidence (Phan, 2022). When a woman tests negative for these indicators but later experiences cognitive impairment, there may be a risk that her claim could be denied due to the absence of biological evidence. Although this outcome may seem unlikely, given the well-established role of chemotherapy and other risk factors in contributing to cognitive changes, it remains a possibility.

In an era where genetic testing holds significant promise for improving health outcomes, individuals should not be discouraged from undergoing testing due to fears of discrimination or insurance denial. Predictive genetic testing, which identifies predispositions in asymptomatic individuals, is already being used to support early screening and intervention. Legislative reform is currently underway in Australia, with proposed amendments to the Disability Discrimination Act 1992 (Cth) aiming to prevent life insurers from using genetic test results (Dowling et al., 2022). These changes are intended to empower individuals to pursue testing without fearing impacts on their financial security or access to insurance (Heaney, 2024). For women who test

positive for inflammatory biomarkers or genetic risk factors, early intervention could be beneficial. This may include a referral to occupational therapy within the oncology team within the healthcare system for cognitive screening using tools such as the MoCA (Nasreddine et al., 2005) or the self-reported FACT-Cog (FACIT.org, 2025), helping to detect early cognitive changes and establish a baseline. Occupational therapists could also provide early education on maintaining cognitive health through exercise and participation in meaningful daily roles and activities (Pergolotti et al., 2016). At the current time, the research is not clear as to whether this service is occurring in Australia for all breast cancer survivors at a population level. Taking a continuum of care approach, a lack of assessment (particularly regarding attention and executive planning impairments as found in Chapter 5 of this research), and early intervention at the time of breast cancer diagnosis could potentially impair a woman's cognitive work performance and ability to participate in employment.

6.3.2 During treatment

The research presented in this thesis highlights that during breast cancer treatment, when cognitive changes are most likely to emerge (Fardell et al., 2023; Oliva et al., 2024), there are both systemic healthcare factors and health practitioner actions or omissions that may contribute to cognitive difficulties affecting women's ability to participate in work. These symptoms can persist long after treatment ends, with one study showing 36% of women were still experiencing cognitive issues five years post-treatment (Schmidt et al., 2018) highlighting the chronic nature of the problem. Yet, acute and tertiary healthcare services are generally not structured to address non-critical chronic conditions, which can result in a narrow focus that overlooks the impact of cognitive changes on employment.

Cognitive changes in women with breast cancer are often overlooked or misunderstood in clinical settings. Women may try to raise concerns, but attitudes, perceptions, and the limited scope of practice among oncologists and other healthcare professionals can hinder meaningful

discussion (Hamilton et al., 2024; Smidt et al., 2016). Responses vary widely: some oncologists facilitate assessment and treatment by referring to psychologists, while others dismiss concerns, attributing symptoms to anxiety (Becker et al., 2015; Hamilton et al., 2024; Von Ah et al., 2013) or aging (Boykoff et al., 2009), rather than considering treatment-related causes. This ambiguity creates uncertainty around appropriate referral pathways and management options (Becker et al., 2015; Boykoff et al., 2009). Dedicated services for cognitive impairments are rare within the public healthcare system (Hamilton et al., 2024). These services are often less prioritised in oncology funding, which typically focuses on managing acute symptoms. Consequently, early assessments by occupational therapists are limited, despite their potential to identify attention and executive functioning difficulties during treatment. Early intervention could support return-to-work outcomes and reduce long-term work disability.

The lack of acknowledgment, inadequate explanations, and missed opportunities to educate and support women about cognitive changes related to breast cancer (Kanaskie & Loeb, 2015; Player et al., 2014; Smidt et al., 2016) intensify fears and uncertainty. Many women report not knowing where to seek help (Kanaskie & Loeb, 2015; Munir et al., 2010), not being referred for evaluation (Von Ah et al., 2013), and feeling isolated and unprepared for the unexplained changes they experience (Boykoff et al., 2009; Hamilton et al., 2024; Munir et al., 2010). Concerns that these symptoms might signal dementia, Alzheimer's disease, or brain metastasis further increase anxiety and self-doubt, creating a cycle in which psychological distress worsens cognitive difficulties (Nelson et al., 2014). Without proper recognition, cognitive changes can lead to emotional distress and additional impairments (Hutchinson et al., 2012). These challenges can affect family roles and employment participation (Player et al., 2014). To address this, evaluations during treatment are necessary to differentiate between fatigue, psychological symptoms, and cognitive impairment. Intervention strategies must target these interconnected side effects through a multidisciplinary approach to minimise cognitive decline and its impact on work (Breckenridge et al., 2012; Joly et al., 2019). Early cognitive and

occupational assessments during breast cancer treatment could help identify risks to work performance (Oberst et al., 2010). Supporting women through these cognitive changes is essential to help them accept their situation and move forward in recovery (Kanaskie & Loeb, 2015). Validation is critical, even without a cure or medical intervention, as it helps women manage their condition (Becker et al., 2015; Newman, 2013; Von Ah, Storey, et al., 2013). Providing clear, accessible information about the nature of cognitive symptoms (Von Ah et al., 2016) and practical strategies for managing them at home and work (Hamilton et al., 2024; Munir et al., 2010; The Cancer Council Australia, 2023) empowers women to advocate for themselves and communicate their needs. Such support should be provided during breast cancer treatment.

Therefore, a continuum of care approach involving routine cognitive screening and assessment during treatment is vital to prevent or reduce cognitive difficulties that could negatively affect employment during survivorship. Brief, validated tools like the FACT-Cog (FACIT.org, 2025) can be used during outpatient visits by oncologists, nurses, or occupational therapists for early detection and intervention. Although computerised neuropsychological assessments are often costly and unlikely to be funded locally, accessible tools that can be easily integrated into practice are needed for occupational therapists. Chapter 4 presented research indicating that the PRPP-A effectively identifies cognitive challenges in this population (Lewis et al., 2016), offering a feasible and cost-effective early intervention option. The PRPP-A only requires initial training and has no ongoing licensing fees (Ranka et al., 2025a). Since occupational therapists focus on participation, assessments should consider a woman's pre-illness employment status and include discussions about return-to-work goals. If cognitive or other issues impacting work performance are identified, referrals for workplace rehabilitation should be considered. Women may find it difficult to recognise or express their cognitive difficulties, making it challenging to communicate their needs to employers, who often lack understanding of how post-treatment cognitive symptoms affect work capacity (Tiedtke et al., 2014). Occupational therapists within

the healthcare system should learn about available workplace rehabilitation support options and help women navigate referrals to this specialised area across various funding schemes to promote continuity of care (de Boer et al., 2015).

6.3.3 Survivorship

The research presented in this thesis highlights that during the survivorship phase of breast cancer, which is described as the period after active treatment ends (Clinical Oncology Society of Australia, 2016), women still face many unmet needs related to their physical, cognitive, and mental health (Campbell et al., 2024; Lewis & Mackenzie, 2022). This is mainly due to a lack of services and access to health professionals for support (Lisy et al., 2018) and may contribute to ongoing cognitive difficulties that hinder women's ability to participate in the workforce.

The survivorship phase is characterised by significantly reduced contact with the treating healthcare team, such as nursing and allied health professionals, with women often attending only occasional oncologist appointments. Cancer rehabilitation is not standard care in the Australian healthcare system (Lisy et al., 2018). Consequently, publicly funded outpatient services are limited, and many women report feeling anxious and unprepared for the decreased support (Baxter et al., 2017; Campbell et al., 2024; Lisy et al., 2018). Survivorship aims to improve the health and well-being of women with breast cancer to enable their participation in community and work roles. Although these priorities are outlined in the Clinical Oncology Society of Australia Model of Survivorship Care, there is no recognition of the challenges involved in addressing work issues within a siloed healthcare and employment system (Clinical Oncology Society of Australia, 2016).

There is a common expectation, both self-imposed and from others, that because active treatment has ended, women with breast cancer will return to "normal"(Hatton et al., 2021; Player et al., 2014). However, many continue to struggle with ongoing cognitive and mental

health challenges(Hatton et al., 2021; Tiedtke et al., 2012, 2015). These issues often persist without adequate support or acknowledgment (Baxter et al., 2017; Campbell et al., 2024; Egan et al., 2013; Hamilton et al., 2024). Healthcare professionals, family, friends, employers, and the broader community may assume that being cancer-free means full recovery, including returning to previous roles, activities, and work routines (Hamilton et al., 2024; Hatton et al., 2021). While exercise is now well-supported as an effective intervention for addressing a wide range of cancer-related side effects (Furmaniak et al., 2016) and even reducing the risk of recurrence (Courneya et al., 2025), more subtle, invisible side effects such as cognitive impairment often remain unsupported within the current public and private healthcare systems (Hamilton et al., 2024; Lisy et al., 2018). There is a push toward self-management of ongoing side effects of breast cancer treatment (Clinical Oncology Society of Australia, 2016); however, navigating the transition from healthcare services to return-to-work support is complex in Australia (Collie et al., 2019; Désiron et al., 2016). As demonstrated in Chapter 5 of this thesis, these hidden effects can significantly impact work participation, including reducing the ability to return to pre-illness work roles or hours.

Unaddressed cognitive difficulties during diagnosis and treatment can affect women's self-confidence and self-esteem, often leading them to hesitate to disclose their needs or limitations to employers and question their capacity to work (Hamilton et al., 2024; Lewis & Mackenzie, 2022). The lack of continuity of care during the survivorship phase (Collie et al., 2019) leaves women needing information, support, and guidance on navigating the transition between healthcare services and available return-to-work support programs. General practitioners (GPs) may become the primary point of contact during this phase (Jefford et al., 2020), yet there is little evidence assessing their awareness or understanding of cancer-related cognitive changes, likely creating a significant knowledge gap (Hart et al., 2021). Even when occupational therapy is available through public health outpatient clinics, return-to-work support and services often fall outside the scope of these providers. Accessing specialised

occupational therapy support for cognition, workplace rehabilitation, or formal neuropsychological testing is often costly or logistically challenging, often requiring out-of-pocket expenses or insurance claims. For those with life insurance, coverage may only apply if framed around improving work ability rather than treating health conditions. Health coaching and cognitive assessments might be covered if cognition is linked to work barriers (Daniels, 2023). Some private health insurance policies may include sessions with occupational therapists. A GP could refer a woman for allied health support using the five sessions of the Medicare subsidised Allied Health Services for the Chronic Disease Management Plan (Occupational Therapy Australia, 2025), which could include cognitive assessment and advice for returning to work. Unfortunately, there is limited information on how disability employment services under Australia's social security scheme support women with breast cancer in cognitive assessment, interventions, and return-to-work processes. If women have a supportive employer, this can be one of the most crucial factors in navigating this transition. Once returning to work becomes a consideration, maintaining some connection to the workplace, even minimally, is increasingly recognised as vital for recovery (Australian Faculty of Occupational and Environmental Medicine, 2011; Waddell et al., 2006). Evidence indicates that staying engaged with work acts as a form of cognitive rehabilitation, promoting cognition through routine establishment, habit formation, and skill development (Vance et al., 2016), while also positively affecting mental well-being. Minimising time away from work, even with a reduced workload, is associated with better outcomes for individuals with injury, illness, or disability (Australian Faculty of Occupational and Environmental Medicine, 2011; Waddell et al., 2006).

This thesis highlights that cognitive assessment, rehabilitation, and return-to-work efforts are hindered by fragmented transition processes between cancer care and employment support systems, limited service availability, societal expectations of "normalcy," and the lack of structured evaluation, education, and early intervention for cognitive difficulties. Discussion around the need for improved cancer rehabilitation in Australia only gives token

acknowledgment of the need to return to work, but little if any guidance on the substantial difficulties of incorporating employment into the survivorship model of care. Strengthening the connection across each stage of the cancer care continuum is essential to support what is one of the most challenging transitions: returning to employment (Hamilton et al., 2024).

6.3.3.1 Return to employment

This phase is best considered as a subsection of survivorship, rather than a separate stage, and has been the focus of this thesis. The challenges already present during survivorship are now compounded as women attempt to return to work for the first time. A supportive employer becomes a key enabler of return to work, while an unsupportive employer can be a significant barrier (Greidanus et al., 2018). This is why workplace assessments are essential, with input from both the employer and management (Innes, 2012). Occupational therapists can use this opportunity to discuss the woman's current work capacity, recommend modified duties or reduced hours, and assess the employer's willingness to support a return-to-work program.

While there is strong evidence that returning to work supports health and well-being, women with breast cancer need to return to *good work* (Australian Faculty of Occupational and Environmental Medicine, 2011). This means a workplace that is supportive and responsive to their needs. An unsupportive work environment can add further stress and uncertainty (Islam et al., 2014; Munir et al., 2010; Pryce et al., 2007). Supporting women to remain in the workforce and avoid claim benefits can be aligned with the broader goals of insurers (Daniels, 2023; Phan, 2022). Many insurers are willing to fund neuropsychological assessments to gain insight into cognitive functioning, knowing that prolonged absence from work leads to higher claim costs. Phan (2022) notes that the most expensive claims are those involving complex rehabilitation needs, particularly when cognitive impairment and fatigue affect work functioning.

However, neuropsychological assessments often do not align with women's self-reports of cognitive issues (Whittaker et al., 2022). Despite this, poor scores, especially on self-report

measures, are associated with worse return-to-work outcomes. In Chapter 5, this research demonstrated that both the CANTAB and PRPP@WORK were able to identify women who did not return to work. This is a critical finding. The PRPP@WORK approach adds particular value by supporting a functional, task-based assessment of cognitive performance. It promotes detailed task analysis and provides specific measures of performance in real-world work tasks. The PRPP-A (PRPP@WORK) is a unique tool. Occupational therapists using PRPP@WORK can collaborate with employers to evaluate cognitive demands, recommend strategies to adapt tasks, and build the worker's cognitive capacity using compensatory and functional restoration approaches. Importantly, the PRPP@WORK provides a standardised language for describing cognitive strategy strengths and difficulties, along with a scoring system for monitoring progress. It also offers therapists a clear path for intervention when specific cognitive strategy deficits are identified within the work context. However, the PRPP@WORK is not currently used amongst occupational therapists in workplace rehabilitation.

At this stage of the cancer care continuum comes the ultimate challenge of returning to work. The discussion of the cancer care continuum has shown that there are multiple acts and omissions, as well as systemic and policy issues that could lead to women not being supported in their cognitive and work rehabilitation and ultimately lead to an inability to return to their pre-illness work status, or worse, leave the workforce altogether. The human and financial costs to women with breast cancer and their families are significant (Park et al., 2025). But this also extends to insurers and to governments when women are unable to work due to cognitive changes that remain unassessed and unsupported. Economic evaluations would be helpful to understand the true cost of cognitive impairments for women with breast cancer.

6.4 Implications of research

6.4.1 Work Matters

"Every day we are reminded that, for everybody, work is a defining feature of human existence. It is the means of sustaining life and of meeting basic needs. But it is also an activity through which individuals affirm their own identity, both to themselves and to those around them. It is crucial to individual choice, to the welfare of families and to the stability of societies" (pp. 5- 6). (International Labour Organization, 2001).

This research highlights that cognitive changes can limit work performance and participation for women with breast cancer. Work, and particularly paid employment, is crucial for women with breast cancer as they strive to return to their pre-illness roles. Returning to work is described by women with breast cancer as a step toward 'normalcy,' involving rebuilding their habits, routines, self-esteem, and restoring their identity (McKay et al., 2013; Player et al., 2014). Women with breast cancer also highlight the financial importance of work to fund medical expenses caused by cancer and the resulting financial toxicity, which impacts their family's choices and well-being (Breast Cancer Network Australia, 2017b; Park et al., 2025; Paul et al., 2016). Productivity through paid employment participation is also a government priority, as unemployment can reduce gross domestic product, lead to decreased consumer spending and tax revenue, and increase government spending on social welfare and health costs (Australian Government, 2017; Australian Institute of Health and Welfare, 2009b). Evidence also shows that 'good work' benefits the health and well-being of all people with injuries, illness, or disabilities, making it a goal for all rehabilitation programs (Australian Faculty of Occupational and Environmental Medicine, 2011).

Recent changes in the definition of occupational therapy, as presented by the World Federation of Occupational Therapy, reflect this perspective. The current promoted definition is:

"Occupational therapy promotes health and wellbeing by supporting participation in meaningful occupations that people want, need, or are expected to do" (WFOT, 2025). In public health, social determinants such as education, employment, housing, and social participation significantly influence physical and mental health (Australian Institute of Health and Welfare, 2024b). The revised WFOT definition highlights the role occupational therapy plays in addressing broader social factors to promote health and well-being. This emphasises the key role occupational therapists play in supporting women with breast cancer to return to paid employment, as for many women, work is a meaningful occupation they need and want to do. However, a life-threatening illness like breast cancer may alter the meaning women attach to their jobs and influence their desire to participate in paid work. Changing life priorities may lead them to alter their working hours and the types of roles they perform. Employment changes may be driven by emotional and value-based factors as well as an inability to meet work demands. Complications arise when women need to work for financial reasons, but breast cancer has impacted their physical, cognitive, or psychological function, making it difficult to meet the expectations of their pre-illness roles.

Cognitive impairments may hinder a woman with breast cancer from engaging in employment by impeding task performance and work hours previously expected. Without assessment and targeted intervention for cognitive difficulties, some women in this research reduced their work hours or tasks but remained employed with their pre-illness employer. This could be indicative of a supportive employer, which is a major factor in a positive return-to-work outcome for cancer survivors. However, reduced pay may cause financial difficulties for women and their families and contribute to the financial toxicity that women with breast cancer report. Other women in this study resigned or moved to lower-demand jobs, possibly leaving careers they valued, which impacts the meaning of work in their lives. Adjusting to a new job can serve as a reminder of what breast cancer has taken from them, potentially leading to grief and mental health issues.

Some women may receive financial support when they reduce hours or switch to lower-demand roles if they have insurance coverage. Women without insurance claims rely on personal savings or government social security support. If they are ineligible for the age pension, options include Disability Support Pension (DSP) or JobSeeker Allowance (Collie et al., 2019). This raises an important issue as to whether a cognitive impairment following breast cancer could be significant enough to qualify a woman for a DSP. A media article indicates that in 2021, 3% of those on DSP are people with cancer and states that after reforms were made to the DSP accessibility in 2015, there has been a 13-percentage point increase in denied claims for cancer patients, with approximately 605 of cancer claims for DSP now being denied (Henriques-Gomes, 2021). This indicates it has become harder for women with breast cancer to get the financial support they need when experiencing difficulties with work.

The author of this thesis presented some of this research in two staff development days for Centrelink staff across NSW. Following the presentation, the discussion centred on the need for Centrelink staff to better understand the survivorship challenges, especially the cognitive changes that impact women's ability to work and their awareness of how long these cognitive changes last, which they were previously unaware of. This relates to eligibility for the DSP, which, in addition to income testing, requires an individual to be unable to work more than 15 hours per week for the next two years to be eligible. Women with metastatic breast cancer with a life expectancy of less than two years would automatically meet the medical criteria for a DSP. However, women with Stage 1-3 breast cancer would need to meet other medical rules, including reaching 20 points on assessment tables as evaluated by the ‘government doctor’ (Australian Government Service Australia, 2025). Cognitive impairment alone is unlikely to meet the threshold for a woman with breast cancer, but combined with other medical issues (e.g., lymphoedema or fatigue), it may qualify them. The Social Security Tables for the Assessment of Work-Related Impairment for Disability Support Pension states that self-reported symptoms must be supported by corroborating medical evidence, such as a treating

doctor or specialist's report, results from diagnostic tests (e.g. MRI), cognitive function assessments, and interviews with the individual and their support network (Social Security Tables for the Assessment of Work-Related Impairment for Disability Support Pension Determination, 2023).

Women's ability to access essential financial support to mitigate financial toxicity could be enhanced if oncologists, general practitioners, nurses, and other allied health professionals within tertiary and primary healthcare systems had greater awareness and education about cognitive changes resulting from breast cancer. This should include understanding the financial implications, the need for assessment and intervention, and the impact on employment. As discussed in Chapter 3, MRIs have identified brain volume changes such as reductions in grey matter density and white matter alterations. Functional MRIs can reveal altered brain activation patterns during cognitive tasks. Both could serve as evidence, but they are expensive tests, making them difficult to cover under Medicare and therefore not routinely conducted. It is possible that healthcare professionals applying the DSM-5 TR framework and terminology, including a DSM-5-TR diagnosis of mild cognitive impairment, could help determine eligibility for DSP. Additionally, a PRPP-A could be a potential tool for providing a cognitive assessment for a DSP pension. However, cognitive assessments are not routinely offered to women experiencing cognitive changes due to breast cancer. If women with breast cancer are no longer employed and do not qualify for a DSP, or if they remain employed but have exhausted their leave and need financial assistance, the JobSeeker Allowance would be the benefit provided (Collie et al., 2019). This monetary benefit is significantly less than the DSP and, if a woman is unemployed, would require job-seeking activities to maintain eligibility (Collie et al., 2019). While seeking employment should be viewed positively, the lack of workplace rehabilitation support within the current system is concerning for those aiming to participate successfully in employment with health-related difficulties.

6.4.2 Breast cancer survivors need assistance with addressing cognitive problems and their employment

Cognitive difficulties can significantly impact a woman's ability to work and participate in the workforce, making it challenging to meet expected job demands. Chapters 4 and 5 highlight that women with breast cancer often face specific work-related challenges, particularly those with impairments in attention and executive functioning (such as planning). These women may be at risk of not returning to their previous roles or working hours. The scoping review conducted in Chapter 3 further emphasised these challenges (Lewis & Mackenzie, 2022). To address these issues, women need targeted workplace rehabilitation services that assess how cognitive difficulties affect their work and help develop strategies aligned with job demands and the work environment. For instance, planning difficulties in a fast-paced work setting cannot be resolved by playing online strategy games. Likewise, attention and concentration issues in overstimulating environments will not be solved by doing puzzles at home. While such activities may support general cognitive capacity, effective strategies must be occupation- and environment-specific, which is the foundation of a functional cognition approach (Giles et al., 2020; Ranka et al., 2025). Although this was not the focus of this thesis, the PRPP-A enables specific interventions that support women with cognitive changes post-breast cancer by using adaptive compensatory and restorative strategies to improve daily cognitive functioning in the workplace. Interventions that are specific to the work task and environment may include gradually increasing exposure to concentration-intensive tasks, modifying the environment to reduce distractions, restructuring workflows to support planning, introducing assistive technologies to aid memory, time management and prioritisation, task simplification, and energy conservation training to help with continuing and sustaining work tasks and productivity (Newman, 2013; Pergolotti et al., 2016; Ranka et al., 2025; Ryan et al., 2011). Research and evidence around occupational therapy interventions to support cancer-related cognitive impairments affecting work performance remains limited. This

is primarily due to the ethical complexities discussed in Chapter 5 - the volatile situation many women face when their health impacts their ability to perform at work, and they are at real risk of job termination. Workplace rehabilitation research could amplify these concerns and inadvertently place a woman's employment in jeopardy. However, some studies do suggest that occupational therapy interventions can offer meaningful benefits (Baxter et al., 2017; Hatton et al., 2021; Ryan et al., 2011).

In Chapter 5, none of the women received workplace rehabilitation or occupational therapy support to aid their return to work. As a result, 42.66% were unable to return to their previous work role and only 25% were working full time, compared with 92% before their breast cancer diagnosis. Only one participant had life insurance (income protection), but she did not receive return-to-work support. A 2022 report from Swiss Re Australia & New Zealand estimated that 19% of life insurance claimants (regardless of diagnosis) accessed external rehabilitation services. While the report did not specify the type of rehabilitation, it likely included workplace support. Life insurers often employ internal allied health professionals for straightforward return-to-work programs, but more complex cases are referred to specialised providers offering intensive, tailored support. However, the report stated that rehabilitation referrals typically occur around 12 months after a claim is lodged (Swiss Re Australia & New Zealand, 2022), delaying early intervention and allowing problems to worsen. Swiss Re also reported that for every dollar spent on rehabilitation, insurers save between $24 and $39 on claims (Swiss Re Australia & New Zealand, 2022). This highlights the value of early referral, which enables needs assessment, goal setting, and planning that support recovery, work participation and cost-efficiency. The report identified a disconnect between the healthcare system and other support systems as a significant barrier to early intervention and return to work (Collie et al., 2018, 2019; Swiss Re Australia & New Zealand, 2022). Legislative restrictions currently prevent life insurers from funding medical treatments that are covered by Medicare or private health insurance (Swiss Re Australia & New Zealand, 2022). The report suggests that these restrictions may be

challenged in the future to improve continuity of care for life insurance claimants (Swiss Re Australia & New Zealand, 2022). Additional healthcare funding could help women with breast cancer address cognitive health issues, an area that is currently underserved but increasingly recognised as a barrier to returning to work during survivorship (Lewis et al., 2016; Lewis & Mackenzie, 2022).

Accessing support services for cognitive issues and returning to work for those with cancer in Australia is complex. Collie et al. (2018) provide a detailed overview of how Australia's health and employment systems operate in silos, which contributes to poor workforce participation among individuals with illnesses, injuries, or disabilities. In contrast, other countries have more integrated systems, where vocational and workplace rehabilitation are embedded within outpatient care (Désiron et al., 2016). Returning to work is a significant hurdle within the survivorship aspect of the cancer care continuum. This is ultimately a priority for life insurers, as weekly benefits are costly and increase the overall cost of claims. Life insurers recognise the impact of unresolved health issues during the survivorship phase of cancer care and how they hinder participation in work, prompting efforts within their legislative capacity to address and support these health challenges. The 'Beyond Cancer' program by IPAR offers tailored return-to-work support for women with breast cancer, including health coaching, symptom management, and vocational planning. Whilst there were some early promising results, access has been limited to those with life insurance claims and there was insufficient publicly available information about how cognitive impairments are assessed or managed within workplace contexts through this program (Sheppard et al., 2023).

However, accessing support services for cognitive issues and returning to work for women with breast cancer, without life insurance, is very different, raising issues around equity and accessibility of services. In Chapter 5, 92% of women did not have life insurance claims and relied solely on their medical teams and employers for support. While many spoke

positively about their support networks, none received services specifically designed to target cognitive functioning in the workplace. This lack of support led some to resign, accept lower-demand jobs, or reduce their hours. There have been continued calls for tailored and ongoing employment support for people with cancer in Australia, particularly for those who have undergone chemotherapy, lack a university degree, work for large employers, or live in non-metropolitan areas, factors that are linked to reduced income (Gordon et al., 2014; Koczwara, 2016; Paul et al., 2016). With more people being diagnosed with cancer at younger ages, employment support during survivorship may span many years. Given the complexity and variability of cancer treatments and their side effects, a dedicated cancer employment service that includes allied health professionals specialising in cancer rehabilitation could offer the integrated care that survivors need. As discussed earlier, returning to work after cancer should be considered an essential part of survivorship and is demonstrated in the management of another chronic disease, multiple sclerosis. MS Australia has established a specific Commonwealth-funded Disability Employment Service for people with multiple sclerosis. This program supports individuals in managing a chronic health condition while remaining employed, by helping them navigate changes in their work capacity due to health impacts. Support often begins while they are still working and continues through periods of unemployment, assisting with symptom management, access to healthcare, and identifying suitable job opportunities. MS Australia has received the highest accreditation under the Commonwealth Disability Employment Services star rating system, demonstrating the value of tailored support during key transitions (Collie et al., 2018). A similar model for those with cancer could be considered. With calls for the Australian government to focus on improved productivity and work participation, it is inconsistent with the lack of funding dedicated to services to keep people productively employed (Sathanapally et al., 2025).

With the evidence of the health benefits of work (Australian Faculty of Occupational and Environmental Medicine, 2011) and the possibility that it can be a form of cognitive

rehabilitation (Vance et al., 2016), returning to work after cancer should be considered an essential part of survivorship (Eva & Senior, 2012). In Australia, there is growing momentum to develop survivorship plans for all cancer survivors to support them once active treatment concludes. According to the Australian Cancer Survivorship Centre (ACSC), a survivorship care plan should include monitoring for cancer recurrence, addressing the physical, emotional, social, and practical effects of cancer and its treatment, managing other health conditions, promoting wellness and healthy lifestyles, and ensuring coordinated care among all involved health professionals. (Australian Cancer Survivorship Centre, 2024). While this definition does not explicitly mention work or participation in daily activities, these aspects are implied in the phrase "supporting wellness and healthy lifestyles." The ACSC fact sheet titled *"Dealing with money, work and study (practical issues)"* offers general guidance on these topics and refers cancer survivors to social workers for support. It includes only one sentence about the role of occupational therapists: "You may benefit from external return-to-work advice. You may wish to consult an occupational therapist for advice about managing fatigue and guiding activity levels at work." However, it does not provide contact details or links to help survivors connect with an occupational therapist (Australian Cancer Survivorship Centre, 2024). Importantly, the fact sheet specifies an "external occupational therapist" because Australia's siloed healthcare systems prevent occupational therapists working within public health from conducting workplace assessments as part of survivorship support. The type of occupational therapist needed for workplace rehabilitation must operate outside the public healthcare system. Navigating these services, particularly with cognitive difficulties and worries about financial and employment concerns, further adds to the burden of women with breast cancer.

General practitioners (GPs) play a central role in supporting women with breast cancer during the survivorship phase, particularly as care transitions from oncology-led treatment to long-term health management. Survivorship care plans are designed to guide this process, helping GPs monitor for recurrence, manage ongoing or late side effects, and support

psychosocial and return to work issues (Royal Australian College of General Practitioners, 2024). However, survivorship care plans are not consistently used in general practice, with fewer than 15% of adult survivors reporting receipt of a plan (Hill et al., 2025). While GPs are well-positioned to provide holistic, coordinated care, including chronic disease management and preventive health, many report feeling underprepared to address the complex and evolving needs of cancer survivors (Hill et al., 2025; Royal Australian College of General Practitioners, 2024). Chronic Disease Management Plans provide access to up to five subsidised allied health visits per year; however, this is often insufficient for survivors experiencing cognitive, physical, and emotional challenges (Australian Institute of Health and Welfare, 2022c; Occupational Therapy Australia, 2025). These limitations, combined with fragmented communication between oncology and primary care, can leave GPs without the necessary tools or confidence to fully support the needs of survivors (White et al., 2025). There is growing recognition that GPs require better training, clearer referral pathways, and more integrated models of care to support cancer survivors in the long term effectively.

6.4.3 Occupational therapists have a role to play across the rehabilitation continuum

Workplace rehabilitation following injury or illness has long been a core area of practice for occupational therapists. In North America, research indicates that nurses are increasingly asked about the impact of cancer and its treatment on work, positioning them to offer relevant advice (Munir et al., 2010). However, in Australia, nurses are not automatically accredited to carry out workplace assessments under insurance-based schemes. As a result, insurers often turn to occupational therapists, whose expertise includes evaluating both the occupational and environmental challenges that affect participation (Daniels, 2023; Phan, 2022). While various health professionals, such as doctors, nurses, and allied health workers, may engage with work-related issues, most have limited training in occupational health or medicine. Employment

concerns are often overlooked once a patient is admitted to the hospital. Taking an occupational history in tertiary care settings is uncommon, largely due to the limited scope of practice and funding models. Outside of occupational medicine, few health professionals consider the vocational impact of medical diagnoses, leaving many patients without adequate support for returning to work (Walker-Bone & Hollick, 2021).

Occupational therapists are involved in assessment and intervention across the cancer care continuum, supporting individuals at various stages of the disease (Baxter et al., 2017; Newman et al., 2024; Taylor et al., 2021; Wallis et al., 2020). A scoping review by Wallis et al. (2020) found that, although the roles of occupational therapists in cancer care are diverse, there is little empirical data on treatment outcomes (Wallis et al., 2020). Most studies focused on isolated stages of cancer rather than the full trajectory, highlighting a need for a deeper understanding of how acts or omissions regarding assessment and intervention of cognition may impact the ability to return to work. In particular, the study in Chapter 5 of this thesis indicated that women with breast cancer who have attention and executive functioning difficulties are possibly more at risk of not returning to their pre-cancer work roles and hours of work. Occupational therapists working in hospital and outpatient settings need to be informed about the potential long-term implications of attentional and executive functioning difficulties, as well as how to assess, intervene, or refer patients earlier to address these issues. At this stage of the cancer care continuum, the PRPP-A could be used for the evaluation of other everyday tasks (Lewis et al., 2016; Nott & Chapparo, 2012) with early interventions to develop cognitive strategy abilities and use compensatory and remedial strategies. This may mitigate some of the challenges and help prepare for the complexity of a work environment.

The American Occupational Therapy Association has developed Occupational Therapy Practice Guidelines for Adults Living with and Beyond Cancer (Newman et al., 2024), building on the original 2017 Guidelines (Baxter et al., 2017), which outline the role of occupational therapy

across the cancer care continuum. There is an emphasis on the roles of occupational therapy as part of a multidisciplinary team in supporting return-to-work after cancer, as well as the need for individual and group-based cognitive training to support cognitive difficulties. Australia does not have equivalent guidelines specific to our unique health and employment support systems. Australian-specific guidelines would help occupational therapists working in acute and tertiary care settings understand how unaddressed issues early in the cancer continuum, particularly cognitive concerns, can affect future work performance. Australian occupational therapists providing workplace rehabilitation services for people with cancer have demonstrated their holistic understanding of individuals' experiences (Hatton et al., 2021). The occupational therapists reported that others tend to underestimate the long-term effects of cancer symptoms on return-to-work outcomes. Survivors may struggle with unexpected fatigue, cognitive dysfunction, and psychological distress. Fear of recurrence, concerns about stigma or disclosure, and anxiety about losing treatment-related support further complicate return-to-work efforts (Hatton et al., 2021). By equipping occupational therapists to better support women with breast cancer, we can facilitate smoother and more sustainable transitions back to employment (Eva & Senior, 2012). Given that occupational therapy is defined as enabling participation in meaningful occupations that individuals want, need, or are expected to do, occupational therapists are well-suited to address the complex factors influencing employment. Increased understanding, recognition, and integration of occupational therapists in hospitals, outpatient clinics, community services, and workplace rehabilitation services are critical. It is essential to establish appropriate referral pathways across these settings for women affected by breast cancer, ensuring that all relevant side effects, particularly those affecting function and cognition, are properly addressed.

6.4.4 Occupational therapists can use an ecologically valid cognitive assessment in workplace rehabilitation

There is a growing voice among life insurers about how to best manage the range of survivorship issues caused by cancer that impact work capacity, because statistics show that cancer is among the top causes of claims (Daniels, 2023). Daniels (2023) states that the most common side effects noted in income protection claims are fatigue, chronic pain, and cognitive impairment, which “give rise to questions around subjectivity” (p.2) and create challenging conversations between claims assessors and claimants regarding incapacity. When evaluating work incapacity or cognitive challenges affecting work performance, insurers and occupational therapists require tools that enable accurate assessments of cognition related to work and daily activities. Phan (2022) notes that insurers want occupational therapists to provide cognitive assessments that are reliable and valid to manage return-to-work outcomes, acknowledging that neuropsychological assessments lack ecological validity but also desiring more than just a self-report questionnaire. Chapter 5 presents the PRPP@WORK as a tool that not only identifies cognitive difficulties experienced by women with breast cancer but also potentially predicts those who may not return to their pre-injury roles or hours, especially for women struggling with attention and executive functioning. Insurers would be interested in this, as it could help reduce the potential costs of claims and enable earlier intervention and support to prevent poor long-term work disability outcomes.

The World Rehabilitation Alliance Rehabilitation Package of Interventions for Rehabilitation (World Health Organisation, 2023) offers guidance for all countries on the global need for people with cancer to receive holistic assessments and interventions that promote overall health and well-being. The package is designed to be accessible for developing countries, providing affordable options. This document clearly emphasises that cognitive and vocational assessment and interventions should be integral parts of cancer rehabilitation for

patients, and that occupational therapists are the allied health professionals who should provide these assessments and interventions (World Health Organisation, 2023). Despite Australia's advanced health and work systems, there is limited research within Australia on occupational therapy across the cancer care continuum, particularly addressing cognition (Hatton et al., 2021; Wallis et al., 2020). Internationally, only studies by Ryan et al., (2011) and Newman (2013) conducted in the United States demonstrate the use of cognitive assessments and interventions with the breast cancer population by occupational therapists and connecting them with work-related challenges.

The limited research in this area means there are few, if any, assessment tools for occupational therapists to use in assisting women with breast cancer who have cognitive difficulties related to their work. Occupational therapists working in the cancer and return-to-work field in Australia require a tool with ecological validity, strong utility, and a focus on everyday function that enables standardised reporting of cognitive domain difficulties and strategy use. Because, unfortunately, a bias exists amongst some insurers, who believe that "cognitive assessments may not be a valid reflection of current cognitive capacity but are indicative of deliberate poor performance, exaggeration, and non-credible memory complaints" (Phan, 2022, p.3). The research outcomes in Chapter 5 have demonstrated that the PRPP@WORK can be used to evaluate work tasks and cognitive strategy use. It is unique because it offers occupational therapists an assessment that utilises observation and interview skills, aligning with insurers' preference for a tool grounded in functional cognition that is clinically administered to mediate both objective and subjective aspects of cognitive evaluation. Further research on PRPP@WORK is needed to better understand the specific challenges related to cognitive demands and workplace expectations. There are two examples of occupation-specific studies of female workers that demonstrate how research within a particular field can highlight the unique cognitive challenges faced. Schmalenberger et al. (2012) examined the difficulties experienced by female musicians with breast cancer, while Mao

et al. (2025) focused on healthcare professionals. The female musicians reported that cognitive difficulties affected sight-reading, remembering lyrics, and sustaining the endurance required for performances (Schmalenberger et al., 2012). The healthcare professionals described issues with concentration that impacted their ability to perform non-patient care tasks (Mao et al., 2025). Further studies could be conducted in female-dominated professions (e.g., teaching and education) to better understand cognitive work demands, workplace strategies and accommodations, and how employers either support or hinder the return-to-work process for women with breast cancer. This will help occupational therapists develop guiding principles for women returning to work after breast cancer who experience difficulties with cognitive function.

6.5 Strengths and limitations

Each of the publications for this thesis outlines the limitations of the specific research study.

Exploring the employment rates of women with breast cancer used a large cohort of pre-existing data. Although this provided substantial numbers for the study, the pre-existing data did not allow us to ask participants why they had not returned to work or whether their reasons were related to health and well-being after cancer, such as difficulties with daily activities and functioning, challenges with work demands, or an unsupportive employer. However, the 2022 study explained some of the open-text options women could complete as part of the ALSWH study. These options related to any aspect of the survey, including health, well-being, family, and community participation. Although there were occasional comments about cognitive functioning, there was not enough evidence within the many optional free-text comments, and many participants chose not to complete them, to establish a link between women's employment patterns in Australia and what was written in those comments. If we had designed our own survey, we could have included a specific question, such as, "What is the main reason

you are not working?" with an open comment option, thereby avoiding predetermined choices and preventing priming. However, pursuing this approach might have led to fewer responses, as we would not have access to as many women as in the ALSWH study, which benefits from larger numbers. This trade-off, along with the lack of exploratory questions, is a possible limitation of this study.

In Chapter 4, pre-existing data were utilised in which women discussed their experiences with cognitive changes after breast cancer. Using the PRPP-P-A through coded transcripts, the interview process did not follow a functional cognition approach. Instead, it aimed for a broader understanding of each woman's experience using an ethnographic approach. While this could be seen as a limitation, it enabled an overlay of the PRPP-A to see whether an interview methodology without a focus on functional cognition could identify cognitive strategy difficulties women experienced at work, based on their explanations. The interviews provided sufficient information for the PRPP-A to identify cognitive strategy issues; however, they did not allow for further exploration of these difficulties or an understanding of how the work environment contributed to cognitive challenges.

Chapter 5 already offers insights into some challenges faced during this research due to the COVID-19 pandemic. After the studies described in Chapter 4, plans were made to conduct workplace assessments using a functional cognition approach, specifically the PRPP at Work tool, to evaluate women with breast cancer in the workplace. These assessments would include feedback from employers. However, ethical issues related to the design and methodology posed limitations. When submitting an ethics application, researchers are asked if the research could potentially impact participants' employment. The answer is often yes, especially when a researcher assesses a woman's cognition and performance at work, which may reveal issues unknown to the employer and could jeopardise employment through performance management. Therefore, further research in this area requires robust frameworks for

conducting assessments. It is likely that occupational therapists already performing workplace functional assessments would need to be trained in the PRPP@WORK and incorporate it into their routine practice. This would be the only way to address these ethical concerns.

The inability to conduct face-to-face assessments, both in the workplace and in clinics, using the PRPP@WORK and neuropsychological tests, such as the CANTAB assessments, was initially considered a limitation. Due to COVID-19, many people, including researchers, worked from home, and by 2021, it was uncertain how long this would last. As a result, the final stage of the research was redesigned to use interview methodology to administer the PRPP at Work to women with breast cancer experiencing cognitive issues. Although this was seen as a limitation because it prevented direct observation of women performing tasks at work and limited feedback from employers or managers, the research in Chapter 5 demonstrated that the interview method for the PRPP @WORK effectively identified cognitive challenges experienced by women with breast cancer. It showed a good relationship with neuropsychological testing and might even predict which women are unable to return to their pre-illness roles, tasks, and hours. Since the pandemic, workplaces have become more flexible, with remote work becoming the norm. Occupational therapists have had to adapt their assessment methods, accordingly, ensuring their tools can capture changes in working environments. Another limitation in Chapter 5 was the heterogeneity of the cohort, which made some findings less generalisable because the time since diagnosis varied by several years. Additionally, the study had a small sample size (n = 12), so caution is advised when generalising these preliminary or pilot findings. Further research with larger samples is needed.

6.6 Recommendations

The following recommendations are drawn directly from the research findings presented across the four stages of this thesis. They aim to address the gaps identified in assessment,

intervention, service delivery, and policy related to cancer-related cognitive impairment and its impact on work participation for women with breast cancer. These recommendations are framed within the cancer care continuum and reflect the need for early identification, specific ecologically valid assessments, integrated support, and tailored rehabilitation strategies. They are intended to guide improvements in education, clinical practice, system design, and future research to ensure women are better supported in returning to and sustaining meaningful employment after breast cancer.

6.6.1 Education and training

6.6.1.1 Educate healthcare professionals on cognitive changes and work participation

It is recommended that healthcare professionals, including oncologists, GPs, nurses, and allied health staff, receive targeted education on cognitive changes after breast cancer and its impact on work participation. This education should be embedded across acute, outpatient, and primary care settings, as well as public servants and insurers. It should include practical guidance on cognitive screening tools, referral pathways to occupational therapy, and the financial implications for patients navigating employment during survivorship. Education must also address the emotional and psychological consequences of unacknowledged cognitive symptoms and equip clinicians to validate and respond to these concerns appropriately.

6.6.1.2 Provide specialised training for occupational therapists

It is recommended that occupational therapists working in oncology settings receive specialised training in cognitive assessment and its relevance to employment. Occupational therapists are uniquely positioned to monitor cognitive health across the cancer continuum, given their focus on activity and participation. Training in the use of the PRPP-A as a functional, ecologically valid tool that identifies cognitive strategy difficulties in real-world tasks should be

provided. Training should also include knowledge of employment support systems, funding pathways, and how to assist women in navigating return-to-work challenges. This will enable therapists to intervene early, support cognitive rehabilitation, and promote sustainable participation in work.

6.6.1.3 Train occupational therapists in PRPP@WORK

It is recommended that occupational therapists providing workplace rehabilitation services be trained in PRPP@WORK, a specialised tool designed to assess functional cognition in employment settings. The PRPP@WORK can predict which women are at risk of not returning to pre-illness roles or hours due to cognitive impairments, particularly in attention and executive functioning. Training in this tool will allow therapists to deliver targeted, evaluation-informed interventions that align with job demands and workplace environments, bridging the gap between clinical assessment and occupational performance.

6.6.2. Development of policy and guidelines

6.6.2.1 Develop clinical guidelines for managing cancer-related cognitive impairment

It is recommended that best practice clinical guidelines be developed for managing cognitive changes in individuals with cancer. In NSW, this could be led by expert allied health professionals in collaboration with the Agency for Clinical Innovation Chronic Care Network, similar to the lymphoedema guide. Guidelines would support routine cognitive screening, establish referral pathways, and help bridge gaps between health and employment systems.

6.6.2.2 Integrate cognitive health and work support into survivorship care plans

It is recommended that survivorship care plans explicitly include cognitive health monitoring, return-to-work support, and referrals to occupational therapy. Including work-related goals and cognitive assessments in survivorship planning will ensure that women receive the support they need to re-engage with meaningful roles and maintain employment.

6.6.2.3 Establish clear referral pathways

It is recommended that a formal referral pathway be embedded within survivorship care plans and clinical guidelines. All women treated for breast cancer who were employed at the time of diagnosis should be referred to occupational therapy for an initial review of cognitive challenges and return-to-work planning. Referral pathways should include mapping support systems, building confidence in employer communication, and identifying accessible workplace rehabilitation services to support employment.

6.6.2.4 Development of workplace cancer survivorship policy

It is recommended that the government develop a model workplace cancer survivorship policy that includes guidance on supporting employees with cancer-related cognitive impairment. Amongst all other side effects. This should cover flexible work arrangements, access to rehabilitation services, and recognition of cognitive impairments as a hidden disability, to promote inclusive and sustainable return-to-work outcomes.

6.6.2.5 Access to additional support under the Chronic Diseases Management Plan

It is recommended that the current Medicare-subsidised Chronic Disease Management Plan be reviewed to allow additional or fully subsidised allied health sessions for cancer survivors experiencing cognitive and functional challenges. The existing five-session limit is insufficient to address the multiple, complex and long-term rehabilitation needs of women with breast cancer, particularly when returning to work. Increasing access would support continuity

of care and improve outcomes across the survivorship phase. Evidence shows that cognitive and physical impairments can persist for years after treatment, requiring ongoing multidisciplinary support. Without adequate access to allied health services, survivors risk delayed recovery, reduced quality of life, and barriers to workforce participation.

6.6.3. System changes

6.6.3.1 Establish cancer-specific government-funded Disability Employment Services

Dedicated employment government-funded support services for cancer survivors should be established, particularly for those without insurer-based support. These services should be modelled on successful programs, such as MS Australia's employment service, which offers long-term, tailored support for cognitive and functional challenges in the workplace.

6.6.3.2 Educate employers on cancer-related cognitive changes

Employers should be educated on the long-term health needs of cancer survivors, particularly the impact of cognitive impairments, which often present as a hidden disability. Awareness and understanding among employers are crucial to creating supportive and flexible work environments that facilitate successful return-to-work outcomes.

6.6.4. Research and evidence building

6.6.4.1 Conduct longitudinal studies on cognitive impairments and employment

It is recommended that longitudinal research be conducted to build on current findings and strengthen the evidence base for occupational therapy interventions in assessing cognitive

changes. Studies should include diverse cohorts and explore the predictive value of tools like PRPP@WORK in supporting return-to-work outcomes.

6.6.4.2 Further development of the PRPP@WORK assessment tool

It is recommended that a follow-up study be conducted to address the limitations identified in the PRPP@WORK research, including small sample size, lack of direct workplace observation, and ethical concerns around employer involvement. Future research should explore how PRPP@WORK performs using observation in workplace settings, including employer feedback, and examine its predictive value across diverse occupations and timeframes. This will strengthen the evidence base and support broader implementation of the tool in workplace rehabilitation.

6.6.4.3 Investigate intervention programs from the PRPP@WORK assessment

It is recommended that future research explore how PRPP@WORK assessment outcomes can be used to design and implement targeted cognitive intervention programs for women with cancer in the workplace. This would help make cognitive rehabilitation strategies more explicit and strengthen the role of occupational therapy in supporting return-to-work outcomes.

6.6.4.4 Investigate occupation-specific challenges

Further research should explore the impact of cognitive impairments on women working in professions with various levels of cognitive demands. Occupation-specific studies, such as those focused on teaching, can help develop targeted strategies and interventions that support sustained employment and role retention, as well as understanding how employers support the employment of women with cancer.

6.7 Significance of research

6.7.1 Empirical contribution

This thesis provides robust empirical evidence demonstrating the significant impact of breast cancer on women's workforce participation in Australia. Using longitudinal data from the Australian Longitudinal Study on Women's Health (ALSWH), it confirms that women with breast cancer are more likely to experience reduced work hours or exit the workforce entirely compared to healthy controls. The findings also highlight those cognitive impairments, particularly in attention, memory, and executive functioning, are key contributors to reduced work performance and participation. Data generated during this research adds to the empirical evidence supporting the proposition that cognitive strategy use is impacted in women with breast cancer and significantly inhibits return to work. These findings provide a foundation for future studies into other aspects of women's daily lives that may be similarly affected by reduced efficiency in cognitive strategy use, such as household management, parenting, community participation, or specific work occupations. By integrating both quantitative and qualitative data, this research offers a comprehensive understanding of the lived experiences of breast cancer survivors, reinforcing the need for targeted support to manage their cognitive impairments and facilitate their return to work.

6.7.2 Methodological contribution

This study advances occupational therapy research by adapting and validating the PRPP@WORK, a workplace-based version of the Perceive, Recall, Plan, and Perform System of Task Analysis (PRPP-A) as a tool for assessing cognitive strategy use in women with breast cancer. The methodology was responsive to ethical and practical constraints, particularly during the COVID-19 pandemic, which necessitated a shift from onsite assessments to

structured online interviews. The integration of PRPP@WORK with CANTAB neuropsychological testing represents a novel mixed-methods approach, enabling comparison between clinician-administered and computerised assessments. The methods employed in this research contribute to the growing body of evidence supporting the use of the PRPP-A to explore real-world difficulties with cognition, through everyday occupational performance. Pilot studies conducted as part of this research are necessary at the initial stages of larger research pathways. This research is considered the beginning of a broader program of inquiry that will expand into larger studies. These will incorporate the PRPP@WORK as part of the workplace assessment, including direct observation and employer feedback. Other studies include examining cognitive difficulties in specific occupations and assessing cognitive challenges faced by other cancer groups, with the potential to inform intervention strategies and long-term outcomes.

The scoping review conducted as part of this research included a critical analysis of each study. This is not an approach typically required in scoping reviews, but it was undertaken to enhance methodological rigour. A unique scoring system was developed, and each article included in the review was assessed using this system to strengthen the application of the JBI tools for evaluating study quality. This allowed for meaningful comparison across studies, even though different checklists with varying numbers of items were used. The scoring system, developed by Lewis & Mackenzie (2022) has since been adopted by another author to strengthen their own scoping review (Bock et al., 2022).

6.7.3 Practical contribution

The findings of this thesis have direct implications for clinical practice and workplace rehabilitation. Occupational therapists play a crucial role in identifying and addressing cognitive challenges that affect work participation among breast cancer survivors. The PRPP@WORK provides a practical, structured tool for assessing functional cognition in workplace settings,

even when direct observation is not possible. The study emphasises the need for early cognitive assessments and tailored interventions within both healthcare and employment systems. It also highlights gaps in service provision and underscores the importance of integrating occupational therapy into survivorship care plans to support sustainable return-to-work outcomes. The clinical utility of the processes used in this research lies in their ability to be replicated. The research presents a measurement model that may meet various outcome measurement needs for therapists seeking to evaluate the impact of cancer and its treatments on daily life in both adults and children. Furthermore, this research shows how the PRPP-A can be added to the range of assessments available to occupational therapists, particularly compared to traditional cognitive tests, and helps resolve the paradox of assessing specific occupations using tools that are removed from any functional context.

6.7.4 Theoretical contribution

This research contributes to the theoretical understanding of functional cognition in occupational therapy by applying the PRPP-A within a cancer population, which is a novel context for this framework. It challenges traditional neuropsychological models, which often lack ecological validity, and proposes a more client-centred, performance-based approach to cognitive assessment. The research was grounded in the conceptual and philosophical position of the Occupational Performance Model (Australia), which asserts that occupational performance is based on the capacity to apply cognitive strategies to 'in-the-moment' everyday tasks, such as work. The findings of this study provide evidence of how this occurs in the context of employment, particularly for women with breast cancer. Specific areas of cognitive strategy use, such as attention and executive functioning, were shown to be impacted, extending the conceptual knowledge base of information processing and highlighting the distinct roles of its components in everyday performance. The use of the PRPP-A reinforces the

importance of assessing cognition through the lens of occupational participation, offering a theoretical model that aligns with the dynamic nature of real-world functioning.

6.8 Conclusion

This thesis has highlighted the significant and often under-recognised impact of cognitive changes on women with breast cancer, particularly in relation to their ability to return to and sustain employment. Across the cancer care continuum, from diagnosis through treatment, survivorship, and return to work, cognitive impairments such as difficulties with attention, planning, and executive functioning have emerged as critical barriers to participation in employment. These challenges are compounded by systemic gaps in healthcare, limited access to cognitive assessment and intervention, and a lack of integration between health and employment support systems.

The findings underscore that cognitive changes are not merely transient side effects but can persist long after treatment ends, affecting women's confidence, identity, and financial security. Despite this, cognitive concerns are frequently dismissed or misunderstood by healthcare professionals, leaving women without validation or support. The absence of routine cognitive screening, early intervention, and structured return-to-work planning contributes to a cycle of unmet needs, reduced work capacity, and, in some cases, premature withdrawal from the workforce.

Occupational therapists are uniquely positioned to bridge this gap. Their expertise in functional cognition and workplace rehabilitation enables them to assess real-world cognitive performance and develop tailored strategies that align with job demands. Tools such as the PRPP@WORK offer a promising, ecologically valid approach to identifying and addressing cognitive barriers to employment. However, these tools remain underutilised, and occupational therapy services are often siloed or excluded from survivorship care planning.

This research also highlights the broader societal and economic implications of unaddressed cognitive changes. When women are unable to return to work due to cognitive impairments, the consequences extend beyond the individual to include increased financial strain on families, higher insurance and social welfare costs, and lost productivity. Conversely, timely and targeted support can facilitate successful return-to-work outcomes, enhance quality of life, and reduce long-term costs for insurers and governments.

Ultimately, this thesis calls for a paradigm shift in how cognitive changes after breast cancer are understood and managed. It advocates for early identification, integrated care pathways, and the inclusion of occupational therapy in survivorship planning. By recognising work as a meaningful occupation and a form of cognitive rehabilitation, we can better support women with breast cancer to reclaim their roles, rebuild their lives, and thrive beyond cancer.

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Appendix A: ALSWH Ethics

Document D
February 2013

Statement Governing the Analysis, Use and Publication of Data

between

Julie Byles
The University of Newcastle

and

Joanne Lewis, Lynette Mackenzie and Rob Heard
of
The University of Sydney

and

Tazeen Majeed
of
The University of Newcastle

Stating terms and conditions for collaboration on the Australian Longitudinal Study on Women's Health (ALSWH)

1. The research covered by this statement includes research into:

   Workforce participation patterns in middle age women with breast cancer as detailed in Proposal ID *A631*.

   Joanne Lewis, Tazeen Majeed, Lynette Mackenzie and Rob Heard will be accorded Collaborator status on the Australian Longitudinal Study on Women's Health (ALSWH) project, limited to the research described in Clause 1, in this instance.

2. In this instance, Julie Byles will liaise regularly on behalf of the ALSWH researchers.

3. All Collaborators will abide by the "PSA Policy and Procedures for Data Access, Analysis and Publication" (Document B), "PSA Policy and Procedures for Substudies" (Document C) and 'Privacy Protocol' (Document E), that govern all ALSWH projects.

4. The results of the research specified in clause 1 will not be used to seek funding for any further research using ALSWH without a new proposal to the PSA.

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5. All quantitative and qualitative data collected as part of a substudy will be provided to ALSWH for secure electronic archiving. These data may be used in future projects, and the project leader who collected the data will always be invited to participate in these future analyses. Hard copies of data will be the responsibility of the project leader and must be stored and disposed of in accordance with HREC and NHMRC guidelines http://www.nhmrc.gov.au/publications/synopses/r39syn.htm

6. Access to data from the following listed external datasets [*not applicable*] will be restricted to [*not applicable*]. No other collaborator named on this EoI will have access to these data.

7. Access to both ALSWH data and data from any external datasets (such as MBS, PBS, Perinatal, Cancer Registry and Admitted Patients Data Collections) will be available for two years from the date of data release. After this time, researchers must follow the guidelines set out in "PSA Policy and Procedures for Data Access, Analysis and Publication" (Document B), section II.5.

I have read the above terms and conditions and I agree to them.

Julie Byles
The University of Newcastle

Date ....

Joanne Lewis
The University of Sydney

Date 24th May 2016

Tazeen Majeed
The University of Newcastle

Date 30-5-16

Lynette Mackenzie
The University of Sydney

Date 25/5/2016

Rob Heard
The University of Sydney

Date 26-5-2016

Appendix B: Supplementary File 1 from Research Stage One

Supplementary File 1: Association between workforce participation patterns of n=6589 middle-aged women (healthy and breast cancer) in the final adjusted model, with odds of being in Class 4 'Mostly in Full Time Work'

	Mostly Not in Paid Work (Class 1)		Mostly in Part-Time Work (Class 2)		Moving From Part-Time Work To No Paid Work (Class 3)		Moving From Full-Time Work to Non-Paid Work (Class 5)	
	Odds Ratio (95% CI)	p	Odds Ratio (95% CI)	p	Odds Ratio (95% CI)	p	Odds Ratio (95% CI)	p
Area of Residence								
• City / Metro *(reference)*	1		1		1		1	
• Rural	1.088 (0.903 - 1.311)	0.378	1.084 (0.931 - 1.264)	0.299	0.778 (0.649 - 0.932)	0.007*	0.912 (0.772 - 1.077)	0.279
• Remote	0.647 (0.441 - 0.950)	0.026*	0.731 (0.536 - 0.997)	0.048*	0.733 (0.516 - 1.042)	0.084	0.826 (0.595 - 1.146)	0.253
Partner Status								
• Yes *(reference)*	1		1		1		1	
• No	0.367 (0.285 - 0.472)	< 0.001*	0.455 (0.375 - 0.552)	< 0.001*	0.272 (0.207 - 0.359)	< 0.001*	0.641 (0.524 - 0.784)	< 0.001*
Education								
• No school education *(reference)*	1		1		1		1	
• School Level	0.466 (0.366 - 0.594)	< 0.001*	1.005 (0.795 - 1.272)	0.964	0.793 (0.613 - 1.026)	0.077	0.942 (0.723 - 1.228)	0.657
• Post School	0.320 (0.239 - 0.427)	< 0.001*	0.949 (0.735 - 1.225)	0.687	0.570 (0.426 - 0.763)	< 0.001*	0.802 (0.604 - 1.064)	0.126
Occupation								
• Professional/Management *(ref)*	1		1		1		1	
• Never Work	85.217 (26.016 – 279.140)	< 0.001*	6.477 (1.837 – 22.834)	0.004*	4.746 (1.111 – 20.281)	0.036*	1.276 (0.255 – 6.376)	0.767
• Other	12.778 (6.107 – 26.738)	< 0.001*	2.859 (1.338 – 6.108)	0.007*	3.296 (1.427 – 7.614)	0.005*	0.583 (0.197 – 1.723)	0.329
• Trade / Manual Work	4.856 (3.656 – 6451)	< 0.001*	2.449 (1.941 – 3.092)	< 0.001*	3.159 (2.416 – 4.132)	< 0.001*	0.976 (0.748 – 1.275)	0.861
• Admin / Sales	3.414 (2.698 – 4.320)	< 0.001*	1.857 (1.559 – 2.211)	< 0.001*	1.945 (1.570 – 2.409)	< 0.001*	0.867 (0.717 – 1.049)	0.141
Caring								
• No *(reference)*	1		1		1		1	
• Yes, regularly	1.086 (0.809 - 1.458)	0.583	1.094 (0.851 - 1.408)	0.483	1.532 (1.102 - 2.130)	0.011*	1.171 (0.887 1.547)	0.266
• Yes, occasionally	1.012 (0.772 - 1.327)	0.929	1.309 (1.038 - 1.650)	0.023	1.944 (1.434 - 2.636)	< 0.001*	1.267 (0.979 - 1.641)	0.072
Arthritis								
• No *(reference)*	1		1		1		1	
• Yes	1.450 (1.212 - 1.735)	< 0.001*	1.342 (1.156 - 1.558)	< 0.001*	1.497 (1.255 - 1.786)	< 0.001*	1.157 (0.981 - 1.364)	0.083
Asthma								
• No *(reference)*	1		1		1			
• Yes	0.958 (0.777 – 1.181)	0.689	0.817 (0.684 – 0.975)	0.025*	0.895 (0.726 – 1.103)	0.298	0.879 (0.725 – 1.067)	0.193
Depression								
• No *(reference)*	1		1		1		1	
• Yes	1.537 (1.259 - 1.875)	< 0.001*	1.176 (0.991 - 1.396)	0.064	1.309 (1.071 - 1.599)	0.008*	1.205 (1.000 - 1.453)	0.05
Diabetes								
• No *(reference)*	1		1		1		1	
• Yes	1.376 (1.047 - 1.808)	0.022*	0.876 (0.679 - 1.131)	0.311	1.111 (0.837 - 1.475)	0.466	0.994 (0.745 - 1.310)	0.964

Appendix C: Supplementary File 2 from Research Stage One

Supplementary File 2: Demographics of healthy group and breast cancer group for latent class analysis

		Healthy (n=5756)	**Breast Cancer (n=833)**	**p value**
Partnered	Yes No	85.9% 14.1%	81.6% 18.4%	p = 0.001
Geographical Location	City / Metro Country / Rural	35.3% 64.7%	36.3% 63.7%	p = 0.738
Education	None School Certificate Post School Qualifications	16.7% 50.4% 32.9%	16.1% 49.5% 34.3%	p = 0.705
Occupation	No paid work Professional / Management Administration / Sales Trade Manual Work Other	1.5% 37.7% 41.1% 3.7% 14.7 1.4%	0.8% 41.8% 38.6% 4.1% 13.0% 1.8%	p = 0.09

Appendix D: PRPP-A used in Research Stage Three

PRPP Stage Two Assessment: Descriptor Glossary (2018)

PERCEIVE	**ATTENDING** **Notices** Awareness of sensory events demonstrated by spontaneous reactions to it, eg. head turning, shifting gaze, reaching toward. **Modulates** Spontaneous narrowing and broadening of the focus of attention, shifting attention from one part of the task to another. **Maintains** Sustains attention for the duration of the task.	**SENSING** **Searches** Active and systematic seeking of sensory information by looking, listening, feeling, smelling, tasting. **Locates** Finds objects, body parts and contexts that are needed for performance. **Monitors** Detects central and peripheral sensory changes within the task, body or context, and when required, responds by action.	**DISCRIMINATING** **Regulates** Discriminates and suppresses the magnitude of sensory input in order to generate behaviours that are in line with the type and amount of input. Freedom from hyper-responsivity **Discriminates** Differentiates between sensory characteristics of objects, faces, body parts, and task elements. Differentiates between details. **Matches** Actively associates sameness of sensory features, eg. size, shape, colour, sound, etc.
RECALL	**RECALLING FACTS** **Recognises** Correctly interprets familiar objects, materials, body parts and sensory events to be what they are. **Labels** Names objects, materials, body parts and sensory events. Understands words, instructions and symbols. Uses words, language and symbols effectively. **Categorises** Groups items, objects, symbols, body parts for a functional purpose. Parts are actively grouped with the whole or lead to recall of knowledge about the whole.	**RECALLING SCHEMES** **Contextualises to time** Uses knowledge of time to perform or speak at the right time. Remembers when it is time to do things. **Contextualises to place** Uses knowledge of place to perform or speak in the right place. Remembers where to put or do things. **Contextualises to duration** Uses knowledge of duration to perform or speak for the right amount of time. Knows how long things happen for or how long things are taking.	**RECALLING PROCEDURES** **Uses objects** Interacts with and uses known objects for their intended purpose. **Uses body** Uses the body to move, act or behave in a manner that is consistent with what the body is designed to do and meets task or situation requirements. **Recall steps** Performs the general and specific steps, tasks and routines needed to complete known occupations. Remembers instructions. Remembers steps, tasks, routines or work completed.
PLAN	**MAPPING** **Knows goal** Acts with an agreed outcome in mind. Formulates an outcome. Keeps outcome in mind during performance. **Identifies obstacles** Detects constraints to task completion. **Organises** Gets ready to perform. Arranges self, thoughts, objects, people and/or space to begin. Rearranges as performance progresses.	**PROGRAMMING** **Chooses** Selects a strategy, items, body parts, actions, words, people, places. Re-selects when necessary. **Sequences** Pre-plans in order to perform in a thought out progression. One step, task or routine leads to the next without unnecessary time to think. **Calibrates** Pre-plans to grade the force, speed, and extent of actions, verbal expression or emotional display to ensure performance is precise.	**EVALUATING** **Questions** Verbally inquires about the location of missing items. Hesitate, looks or examines aspects of the task momentarily to check progress. **Analyses** Makes a closer inspection of a constraint. Takes time to think about and determine real or potential impact on task performance prior to making appropriate changes. **Judges** Makes informed decisions. Takes into consideration physical capabilities, external expectations and contextual factors to make the best decisions.
PERFORM	**INITIATING** **Starts** Begins performances. Restarts after interruption or stopping **Stops** Stops self when desired. Stops self when the task requires stopping or when requested to do so.	**CONTINUING** **Flows** Even performance. Easy transitions between tasks and parts of tasks. NO stop/start variations or inconsistency. **Continues** Keeps performing under one's own direction. **Persists** Keeps going when performance is difficult or when problems arise. Applies effort in attempting to finish.	**CONTROLLING** **Times** Correct and even speed as demanded by the task. Performs within expected or functional time frame. **Coordinates** Smooth execution. Freedom from tremor or dyskinesis. **Adjusts** Makes changes to actions during execution to match the plan (top down), or automatically in response to muscle stretch (bottom up).

THE PRPP SYSTEM SCORING SHEET

Client Name:	Date:	Task:

3(--) = Performance of this descriptor meets criterion expectations; reasonable time, without assistance; without prompts

2(?) = Performance of this descriptor meets criterion expectations but indicates concern due to timing or prompts needed

1(X) = Performance of this descriptor does not meet criterion expectations; inhibits performance

STAGE ONE ANALYSIS: CRITERION %______________.

STEPS	ERRORS Acc	Rep	Om	Ti

PERCENTAGE SCORE:____________________.

STAGE TWO ANALYSIS RATING

		1(X)	2(?)	3(--)
PERCEIVE	**ATTENDING**			
	Notices	1	2	3
	Modulates	1	2	3
	Maintains	1	2	3
	SENSING			
	Searches	1	2	3
	Locates	1	2	3
	Monitors	1	2	3
	DISCRIMINATING			
	Regulates	1	2	3
	Discriminates	1	2	3
	Matches	1	2	3
RECALL	**RECALLING FACTS**			
	Recognises	1	2	3
	Labels	1	2	3
	Categorises	1	2	3
	/ SCHEMES			
	Contextualises to time	1	2	3
	/ place	1	2	3
	/ duration	1	2	3
	/ PROCEDURES			
	Uses objects	1	2	3
	Uses body	1	2	3
	Recall steps	1	2	3
PLAN	**MAPPING**			
	Knows goal	1	2	3
	Identifies obstacles	1	2	3
	Organises	1	2	3
	PROGRAMMING			
	Chooses	1	2	3
	Sequences	1	2	3
	Calibrates	1	2	3
	EVALUATING			
	Questions	1	2	3
	Analyses	1	2	3
	Judges	1	2	3
PERFORM	**INITIATING**			
	Starts	1	2	3
	Stops	1	2	3
	CONTINUING			
	Flows	1	2	3
	Continues	1	2	3
	Persists	1	2	3
	CONTROLLING			
	Times	1	2	3
	Coordinates	1	2	3
	Adjusts	1	2	3

Appendix E: Letter for Judith Marsham Farrell Grant

25 June 2020

Joanne Lewis

By email: jo.lewis@sydney.edu.au

Dear **Joanne**

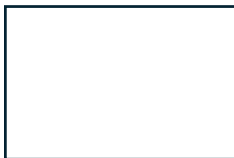
Judith Marsham Farrell Grant

We are delighted to advise that you have been successful in your application for the Judith Marsham Farrell Grant for which you will receive an amount of $4500 towards your project.

Please sign the attached documents to confirm your compliance with the Terms and Conditions of the grant.

Congratulations again on being awarded this grant, we look forward to seeing the results of your project.

Yours sincerely



Samantha Hunter
CEO
Occupational Therapy Australia

Appendix F: CANTAB Assessments purchased for Research Stage Four

Estimate

#18519

Date Issued: 29-Mar-2021

Bill To
The University of Sydney
Central Accounts Payable, Margaret Telfer
Bldg (KO7)
71-79 Arundel Street
Glebe NSW 2037
Australia

Cambridge Cognition Limited
Units 9/10 Tunbridge Court
Tunbridge Lane
Bottisham
Cambs. CB25 9TU, UK
e:info@camcog.com
w:www.cambridgecognition.com
t:+44 (0) 1223 810 700
f:+44 (0) 1223 810 701

Estimate Expires	Sales Contact	Currency	Shipping Method
10-May-2021	Emma C Dominic	USD	

Quantity	Item	Price Level	Rate	Amount
1	CANTAB Web-Based Testing functionality for duration of licence	Base Price	$3,080.00	$3,080.00
	Discount to match budget available		-35%	($1,078.00)

Tests	EBT RTI RVP SWM

Discount Total	
Subtotal	$2,002.00
Shipping	
Tax Total (%)	$0.00
Total	$2,002.00

NB: The above prices do not include import duty or local taxes (if relevant)

Validity:	This quotation is valid for 30 days from the date of issue of this quotation (unless overwritten by supporting documentation).
Dispatch:	Dispatch of software will occur 5 working days after acceptance of order. Hardware and software keys will be dispatched on receipt of Purchase Order. Please note the dispatch of hardware is dependent on availability of stock.
	This software is supplied subject to our Terms & Conditions a copy of which is sent with this estimate & is available: HERE

Company registration number: 04338746 VAT number: GB176522203

1 of 1

Appendix G: Ethics Approval for Research Study Stage Four

Research Integrity & Ethics Administration
HUMAN RESEARCH ETHICS COMMITTEE

Wednesday, 11 May 2022

Assoc Prof Lynette Mackenzie
Ageing Work and Health Unit; Faculty of Medicine and Health
Email: lynette.mackenzie@sydney.edu.au

Dear Lynette,

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

I am pleased to inform you that after consideration of your response, your project has been approved.

Details of the approval are as follows:

Project No.:	**2022/206**
Project Title:	**Assessment of cognitive changes for women after breast cancer and the impact on work performance.**
Authorised Personnel:	**Mackenzie Lynette; Chapparo Christine; Lewis Joanne; Ranka Judy;**
Approval Period:	**11/05/2022 to 11/05/2026**
First Annual Report Due:	**11/05/2023**

Documents Approved:

Date Uploaded	Version Number	Document Name
25/04/2022	Version 2	PIS V2
11/03/2022	Version 1	Email Communication with participants
11/03/2022	Version 1	PRPP@WORK v2 Assessment Tool
11/03/2022	Version 1	Flyer to be used for recruitment

Condition/s of Approval

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
  - Serious or unexpected adverse events (which should be reported within 72 hours).
  - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.

Research Integrity & Ethics Administration
Research Portfolio
Level 3, F23 Administration Building
The University of Sydney
NSW 2006 Australia

T +61 2 9036 9161
E human.ethics@sydney.edu.au
W sydney.edu.au/ethics

ABN 15 211 513 464
CRICOS 00026A

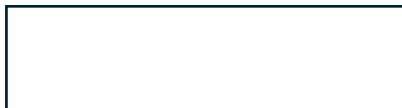
THE UNIVERSITY OF SYDNEY

- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of Research*, applicable legal requirements, and with University policies, procedures and governance requirements.
- The Ethics Office may conduct audits on approved projects.
- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely,



Professor Michael Skilton
Chair, Health Review Committee (Low Risk)

The University of Sydney of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2018) and the NHMRC's Australian Code for the Responsible Conduct of Research (2018)

Appendix H: Participant Information Sheet (PIS) for Research Stage Four

Discipline of Occupational Therapy
School of Health Sciences
Faculty of Medicine and Health

ABN 15 211 513 464

PROFESSOR LYNETTE MACKENZIE
Chief Investigator

Level 7
Susan Wakil Health Building (D18)
The University of Sydney
NSW 2006 AUSTRALIA
Telephone: +61 2 9351 9832
Email: lynette.mackenzie@sydney.edu.au
Web: http://www.sydney.edu.au/

Project Title: Assessment of cognitive changes for women after breast cancer and the impact on work performance.

Project number: 2022/206.

PARTICIPANT INFORMATION STATEMENT

(1) What is this study about?

You are invited to take part in a research study that is examining the cognitive difficulties experienced by women during and after breast cancer at work. This study aims to identify if the cognitive problems experienced are similar or different amongst women and determine the best way to assess the cognitive changes.

This Participant Information Statement tells you about the research study. Knowing what is involved will help you decide if you want to take part in the research. Please read this sheet carefully and ask questions about anything that you don't understand or want to know more about.

Participation in this research study is voluntary.

By giving your consent to take part in this study you are telling us that you:
- ✓ Understand what you have read.
- ✓ Agree to take part in the research study as outlined below.
- ✓ Agree to the use of your personal information as described.

You will be given a copy of this Participant Information Statement to keep.

(2) Who is running the study?

The study is being carried out by the following researchers at the Faculty of Medicine and Health at the University of Sydney:
- Joanne Lewis, Associate Lecturer, Discipline of Occupational Therapy
- Chris Chapparo, Associate Professor, Discipline of Occupational Therapy
- Lynette Mackenzie, Professor, Discipline of Occupational Therapy

Joanne Lewis is conducting this study as the basis for a Doctor of Philosophy degree at The University of Sydney. This will take place under the supervision of Professor Lynette Mackenzie and Associate Professor Chris Chapparo.

(3) What will the study involve for me?

The study will require you to complete two things:

1. Perceive Recall Plan and Perform (PRPP) @WORK Interview
   The researcher will organise a mutually convenient time for a recorded video call. During this time, the researcher will ask you some semi-structured questions about your work duties, work environment and how you have been managing your work after your breast cancer diagnosis. The questions will have a particular focus on the cognitive aspects of your work functions. You will not be required to tell the researcher the name of your employer.

2. Cambridge Neuropsychological Test Automated Battery (CANTAB).
   The University of Sydney researchers will email you a link to an online survey and a battery of neuropsychological tests to complete at a time and location that is convenient to you. The online survey will ask you to complete a demographic data sheet (with no identifying information such as name, address or contact details) indicating age, diagnosis and the type of treatments received. There will also be some boxes to tick, to indicate your consent to participate in the study. After this, there will be five (5) short neuropsychological tests to evaluate your attention, memory and executive function on a PC, laptop or iPad. You will need an internet connection to complete these tests.

(4) How much of my time will the study take?

The PRPP@WORK interview will take approximately 1 hour with the researcher. The three (3) short CANTAB tests can be performed independently and will take approximately 25 minutes to complete. These tests are:

1. Rapid Visual Information Processing (RVP) 7 minutes
2. Delayed Matching to Sample (DMS) 7 minutes
3. Spatial Working Memory (SWM) 4 minutes

(5) Who can take part in the study?

We would like to invite the following women into our study:

- Women that have been diagnosed with breast cancer
- Aged 18 years to 67 years of age
- Employed (either full time or part-time) and have returned to work in some capacity
- If diagnosed with mental illness – nil hospitalization
- Fluent in written and spoken English

Sometimes people with mental illness will have cognitive difficulties, and as this study is assessing cognitive problems due to cancer-related factors, those with a previous mental illness that have been hospitalised may not be suitable for the study. The CANTAB online assessments are in English, so it will be important that participants can read and understand the online instructions.

(6) Do I have to be in the study? Can I withdraw from the study once I've started?

Being in this study is completely voluntary and you do not have to take part. Your decision whether to participate will not affect your current or future relationship with the researchers or anyone else at the University of Sydney.

If you decide to take part in the study and then change your mind later, you are free to withdraw at any time. You can do this by sending an email to Joanne Lewis at jo.lewis@sydney.edu.au.

If you decide to withdraw from the study, we will not collect any more information from you. Please let us know at the time when you withdraw what you would like us to do with the information we have collected about you up to that point. If you wish, your information will be removed from our study records and will not be included in the study results, up to the point that we have analysed and published the results.

(7) Are there any risks or costs associated with being in the study?

The overall process of returning to work and discussing personal and work-related difficulties due to a breast cancer diagnosis and treatments may be distressing. Should this occur, the researcher will provide you with details on how to get support through the Cancer Council https://www.cancer.org.au/support-and-services Ph: 131120 or Beyond Blue Ph: 1300 224 636.

Aside from giving up your time and using data through your internet connection to complete the demographic data survey and CANTAB tests, we do not expect that there will be costs associated with taking part in this study.

(8) Are there any benefits associated with being in the study?

You will receive a $30 gift voucher as a token of appreciation for your participation in the study.

(9) What will happen to information about me that is collected during the study?

By providing your consent, you are agreeing to us collecting personal de-identified information about you for this research study. Your information will only be used for the purposes outlined in this Participant Information Statement unless you consent otherwise.

The PRPP@WORK interview will be conducted via zoom. The researcher will only save a copy of the audio file of the interview so it can be transcribed for analysis. All other files will be deleted. The audio file of the interview and the transcript of the interview will be stored on the University's Research Data Store (RDS) during the project. The RDS is a secure, enterprise-grade Network Attached Storage device located within NSW.

Only the researchers will know the results of the CANTAB assessments. The research team will set up a CANTAB study on the Cambridge Cognition secure cloud server using a license that has been issued to Professor Lynette Mackenzie (201481 University of Sydney). CANTAB assessments will be kept on the CANTAB secure cloud servers, which will be password protected for the individual study. The

three researchers identified on the PIS will have password access to the CANTAB. Cambridge Cognition, an ISO 9001 certified company and ensures the highest levels of data security. All CANTAB study data is synchronised between devices and centralised through secure cloud servers. Cambridge Cognition keeps data secure by:

- Encrypting data at rest
- Using HTTPS encryption for all data transfers
- Only permitting authorised users access to study data
- Secure servers in HIPAA/GDPR compliant private cloud

When you complete the CANTAB assessments using your own PC or tablet, no information about your IP addresses, cookies or online server logs are collected. Cambridge Cognition commission an independent security check on the system each year. Cambridge Cognition and the CANTAB platform have been audited by the Medicines and Healthcare products Regulatory Agency and British Standards Institute, as well as external audits arranged by customers.

We are hoping to recruit 50 women for this study. After all the CANTAB data has been collected and analysed, the researchers will provide a summary of the findings if you would like, the group results can be emailed to you for review, before any publications. Study findings may be published, but you will not be individually identifiable in these publications.

We will keep the information we collect for this study, and we may use it in future projects. By providing your consent you are allowing us to use your information in future projects. We don't know at this stage what these other projects will involve. We will seek ethical approval before using the information in these future projects.

(10) Can I tell other people about the study?

Yes, you can tell other people about the study.

(11) What if I would like further information about the study?

When you have read this information, Joanne Lewis will be available to discuss it with you further and answer any questions you may have. If you would like to know more at any stage during the study, please feel free to contact Joanne Lewis, Associate Lecturer, PhD student, jo.lewis@sydney.edu.au Ph: 93519209.

(12) Will I be told the results of the study?

If you choose, you can be sent a copy of the transcribed PRPP@WORK assessment to review. We are hoping to recruit 50 women for this study. So, after all the PRPP@WORK and CANTAB data has been collected and analysed, the researchers will provide a summary of the findings and send it through to you for review before any publications.

(13) What if I have a complaint or any concerns about the study?

Research involving humans in Australia is reviewed by an independent group of people called a Human Research Ethics Committee (HREC). The ethical aspects of this study have been approved by the HREC of the University of Sydney : **Project Title: Assessment of cognitive changes for women after breast cancer and the impact on work performance. Project number: 2022/206**.

As part of this process, we have agreed to carry out the study according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect people who agree to take part in research studies.

If you are concerned about the way this study is being conducted or you wish to make a complaint to someone independent from the study, please contact the university using the details outlined below. Please quote the study title and protocol number.

The Manager, Ethics Administration, University of Sydney:

- **Telephone:** +61 2 8627 8176
- **Email:** ro.humanethics@sydney.edu.au
- **Fax:** +61 2 8627 8177 (Facsimile)

****This information sheet is for you to keep* ****

Appendix I: PRPP@WORK Workplace Assessment used in Research Stage Four

PRPP@WORK: Workplace Assessment

Client Details
- Name:
- Date of Birth:
- Age:

Breast Cancer
- Date of Diagnosis:
- Type of Breast Cancer:
- Stage of Breast Cancer:
- Treatments: Surgery (Lumpectomy or Mastectomy) / Chemotherapy / Radiation / Hormone Therapy

Perceived Functional Abilities
- Main symptoms (current): Pain / Fatigue / Lymphoedema / Cognitive Changes / Nausea / Peripheral Neuropathy / Psychological Distress / SOB / Other:
- Pre-illness IADLS:
- Current IADLS:
- Reason for changes:
- Driving Capacity:

Cognitive Function
- Main difficulties: Memory / Concentration / Planning / Organising / Word finding difficulties / Learning New Information / Speed of Thinking / Other:
- Examples of how this affects everyday life (not work):
- When were changes in cognition first noticed?
- Do family/friends notice changes / Have they commented?
- Were cognitive changes reported to a health professional?
- Did the health professional explain how and why cognitive changes might occur after breast cancer?
- Did a health professional assess your cognitive symptoms?
- Did a health professional refer you to anyone (another health professional) for help?
- Did anyone inform you before your treatment about the possibility of experiencing changes in cognition?
- Do you think your cognitive changes have improved, stayed the same or gotten worse since they first started?

Employment and Work
- Employer:
- Job Title:
- Role:
- Length of Time with Employer:
- Pre-Illness Days and Hours of Work:
- Location of workplace:
- Flexibility of workplace: (i.e., home and workplace)
- Travel to and from work:
- Manager:

About work since breast cancer diagnosis...

- Date returned to work:
- Current Days and Hours of Work:
- Main reason not working pre-illness hours:
- Same role or different role? Same duties or different duties?
- Main reason not performing pre-illness role or duties:
- Has your employer been supportive of your return to work? Yes / No.... How?
- Do you feel physically comfortable performing your duties? Yes / No....Problems
- Do you think you will be able to return to your pre-illness hours and duties? Why not?
- What do you think will help you return to your pre-illness hours and duties?
- What are the main concerns you have with your work duties?
- Can we please take some time to make a list of your main duties and the tasks that you need to do within each of those duties?

<table>
<tr><td rowspan="2">Main Duties</td><td>Client Reported Feedback</td><td>Employer Reported Feedback</td></tr>
<tr><td colspan="2">• Output (Quality and quantity of work)
• Pre vs post-performance
• Difficulties experienced (Physical / Psychosocial / Cognitive)
• (SCORE PRPP SHEET FOR EACH DUTY re cognitive performance components)
• Any opportunity for observation? Please indicate where.</td></tr>
<tr><td>1.</td><td></td><td></td></tr>
<tr><td>2.</td><td></td><td></td></tr>
<tr><td>3.</td><td></td><td></td></tr>
<tr><td>4.</td><td></td><td></td></tr>
<tr><td>5.</td><td></td><td></td></tr>
<tr><td>6.</td><td></td><td></td></tr>
</table>

SCORING THE PRPP@WORK

Score	Performance Descriptor
3	**Meets duty/task/workplace criterion expectations (qualitative and quantitative outputs) with performance that:**
	- Is completed within a reasonable time - Shows no difficulty in performing the task - Requires no additional assistance or prompts - Is safe for the individual, co-workers, and others - Is consistent with the expectations, rules, policies, and procedures of the workplace
2	**Almost meets duty/task/workplace criterion expectations (qualitative and quantitative outputs) with performance that:**
	- Takes additional time to complete tasks - Shows minimal difficulties in performing the task - Requires minimal support or prompting to perform work tasks - Raises minor concerns about safety to the individual, co-workers, or others - Is mostly consistent with the expectations, rules, policies, and procedures of the workplace
1	**Does not meet duty/task/workplace criterion expectations (qualitative and quantitative outputs) with performance that:**
	- Takes significant additional time to complete tasks - Shows significant difficulty in performing the task - Requires moderate assistance, support, or prompting to perform tasks - Is unsafe (or potentially unsafe) for the individual, co-workers, or others - Is inconsistent with the expectations, rules, policies, and procedures of the workplace - Has consequences that are inconsistent or contradictory to the employer's mission, goals, or values

Duty:

PERCEIVE

ATTENDING

Notices /general awareness of work environment and people

SCORE	1	2	3

Modulate attention between parts of the job, tasks and people

SCORE	1	2	3

Maintains attention and concentration – job and tasks

SCORE	1	2	3

SENSING

Actively **search** (sensory input) look / listen, smell or feel for required items

SCORE	1	2	3

Locate all required job items/people

SCORE	1	2	3

Monitor (notice) sensory changes of the job, environment (including coworkers and clients)

SCORE	1	2	3

DISCRIMINATING

Tell difference (**discriminate**) between relevant/irrelevant equipment, environment, behaviours, communication, emotions and materials, required for the task

SCORE	1	2	3

Match / fit together equipment, environment, behaviours, communication, emotions and materials, required for the task equipment, *materials*, environment to job

SCORE	1	2	3

Regulates sensory input in a way that matches environmental and social expectations, without being overly sensitive or reactive.

SCORE	1	2	3

RECALL

RECALLING FACTS

Remembers objects/ equipment, people, language, task and environment requirements.

SCORE	1	2	3

Remembers and uses labels and names **(labels)**

SCORE	1	2	3

Remembers what goes together **(categorises)**

SCORE	1	2	3

RECALLING SCHEMES

Knows when (correct **time**) task should be performed

SCORE	1	2	3

Knows where (**place**) a task should be performed

SCORE	1	2	3

Knows how long (**duration**) a task should take to perform

SCORE	1	2	3

RECALLING PROCEDURES

Use objects / equipment / forms / people in accordance with procedures

SCORE	1	2	3

Use body, language, behaviour, emotions following procedures

SCORE	1	2	3

Recall and use specific and general steps/**procedures** needed for known tasks, routines and roles

SCORE	1	2	3

PLAN

MAPPING (action plan)

Know / formulate / store **goal**/s

SCORE	1	2	3

Identify and explore potential **obstacles**

SCORE	1	2	3

Organise/schedule the task, equipment, environment and body

SCORE	1	2	3

PROGRAMMING

Chooses appropriate information, materials, environment, behaviour, action or language.

SCORE	1	2	3

Sequence task/routine, materials, interactions, behaviours in logical progression of steps.

SCORE	1	2	3

Calibrate actions, thinking, behaviours and emotions.

SCORE	1	2	3

EVALUATING

Question what is happening so inaccuracies are found

SCORE	1	2	3

Analyse specific task / routine limitations

SCORE	1	2	3

Judge- make safe and informed decisions considering all limitations

SCORE	1	2	3

PERFORM

INITIATING

Start / re-initiate a task / action

SCORE	1	2	3

Stop a task / action

SCORE	1	2	3

CONTINUING

Flow smoothly during tasks / actions

SCORE	1	2	3

Continue tasks / actions until finished

SCORE	1	2	3

Persist with task/s (motivated to try)

SCORE	1	2	3

CONTROLLING

Use **correct** and even **speed** as demanded by the task

SCORE	1	2	3

Coordinate musculoskeletal communication / receptive and expressive language (non/verbal) performance.

SCORE	1	2	3

Adjust psychomotor, communication, behaviour

SCORE	1	2	3

	PERCEIVE		
ATTENDING	**Notices** • Notices all sensory information and input • Aware of all job and body components • Alerted spontaneously reacts, orienting by head turning, looking, reaching, adjusting body position, listening to stimuli that should be attended to • Examples: hears photocopier buzzer, sees light flashing, smells something is burnt, sees blank sections in spreadsheet or document, looks at a customer entering shop); hyper-alertness, feeling overwhelmed in novel situations, restlessness,	**Modulates** • Flexible attention by spontaneously narrowing and broadening focus • Shifts and divides the allocation of attention between two or more tasks that need to be performed, or when interacting with more than one person, over the same time interval • Deferring and restarting tasks after noticing the need for change. • May shift attention too often or not enough. • Examples: monitoring email enquiries whilst answering phone calls; working on four different tenders whilst keeping reports up to date; dividing attention between various people and themself during conversation and in meetings	**Maintains** • Concentrates long enough for job completion (quality and quantity) without getting distracted • Distraction allowed will depend on context • Examples: Focuses on meetings and conversations without being distracted
SENSING	**Searches** • Actively and systematically gathering sensory information using vision, hearing, smell, taste, and touch • Uses cues, gathers items needed to match demands of the job including past, current, or new tasks or to recommence deferred task component. • Searches in a methodically way so doesn't miss anything. • Example: searches hand to find splinter; searches email to find detailed information; searches folders in systems to find document, reading facial expressions / verbal tone and body language accurately to match interaction demands of the job or social aspects of work	**Locates** • Finds all job components, cues, objects, equipment, body movements, environmental aspects and information, including those for past, current or new tasks or to recommence deferred task. • Example: may c/o being unable to find equipment, documents, files etc.	**Monitors** • Keeps track of sensory information and changes and then actively responds to these. • Makes changes to the task to account for sensory information. • Example: turns off overheating machinery; Changes body posture or equipment if in pain; changes writing style to meet needs of client; changes tone of voice to match work environment; aware of and changes emotions and behaviours to match demands of tasks, to have an accurate task performance or ensure safety of others of self.
DISCRIMINATING	**Discriminates** • Can tell the difference between relevant and irrelevant sensory details including cues, information, environment, equipment and body required to do task. • Can tell the difference between relevant and irrelevant goals, rules, policies or procedures to assist with priorities and performance of specific tasks. • Example: can tell the difference between letters, words and numbers, weights of loads, different body posture,	**Matches** • Fits together and can associate equipment, information, environment, and body required to a task. • Can match specific information for the task and disregards irrelevant details and cues • Example: can match product code numbers to order dockets, can match claim numbers, can match figures in correct columns for budget sheet	**Regulates** • Discriminates and suppresses the magnitude of sensory input in order to generate behaviours that are in line with the type and amount of input. • Freedom from hyper-responsivity. • Over responsiveness to sensory information • Example: Hypertensive to sound or light and response to this is not modified or graded or consistent with environment or social expectations.

RECALL			
RECALLING FACTS	**Recognises** • Remembering what the correct facts and concepts are to do the job • Recalling correct facts and concepts • Correctly interprets familiar objects, materials, body parts and sensory events to be what they are. • Recognises known people, emotions, expressions, and behaviours. • Recognise own feelings, and emotions • Example: can recognise frustrated voice or body language of customer or colleague; can recognise an allocated task that has been completed, can recognise own fatigue	**Labels** • Remembering the names of tasks, equipment, objects, materials, body parts relevant to the job • Recalls and understands words, instructions, and symbols. • Uses words, language, and symbols effectively during tasks and job. • Examples: Remember and use client and colleagues' names; saves files according to requirements	**Categorises** • Groups and classifies tasks, procedures, equipment, items, objects, symbols, body parts according to function • Demonstrates knowledge of classification, concepts, constructs, and part / whole relationships to meet job requirements • Example: sterile and non-sterile equipment; debits and credits spread sheet; can group people according to function at work;
RECALLING SCHEMES	**Contextualises to time** • Remembers the correct time principles of task performance to know when to perform a task or when to speak. • Uses knowledge of time (date/time) to perform task – from a procedural perspective to prioritise tasks • Uses knowledge of time (generally hours / minutes) to start a task or return to deferred tasks – so using correct information and rules • Examples: follows up customers and client's requests; can write a priority list of tasks based on deadlines, not moving to next step in process	**Contextualises to place** • Remembers the correct place principles of task performance to know where to perform a task or speak at the right time. • Uses knowledge of place (environment / location) to perform or speak in the right place. • Uses knowledge of place (position / setting /situation) to know where things should be or occur • Remembers where to put or do things. • Example: Knows what task is performed in specific environment; Knows where information used within a report. Knows where up to in task. Knows where rules used in assessment or communication with clients.	**Contextualises to duration** • Remembers the correct duration principles of task performance to know how long to perform task or speak for the right amount of time. • Knows how long tasks or components of tasks did take, should take, will take or are taking, to perform or speak for the right amount of time. • Examples: Speaks for correct length of time in meetings or phone calls; assessments conducted in timely manner; check billing and time recording practices in accordance with employer expectations.
RECALLING PROCEDURES	**Uses objects** • Remembers the correct procedures when using objects and equipment appropriately to perform tasks. • Interacts with and uses known objects for their intended purpose. Examples: Ergonomic set up of computer and chair. computer programs, trolleys, clothing for safety to meet job requirements.	**Uses body** • Remembers the correct procedures when using body to move, act or behave in a manner that is consistent with what the body is designed to do and meets task or situation requirements. • Demonstrates general and specific body movements necessary to place self safely in positions. • Examples: Safe manual handling techniques, position of upper limbs to type.	**Recall steps** • Remembers the correct procedures when performing general and specific steps, tasks and routines needed to complete known occupations. • Remembers known rules and instructions required to perform components of each task (e.g., WHS safety requirements, lifting safely) • Remembers known steps, tasks, routines, or work completed. • Example: Problems with retention of information, gaps in knowledge, recall of a bad or negative experience overrides positive (PTSD, chronic pain)

PLAN			
MAPPING (action plan)	**Knows goal** • Acts in a way that demonstrates focusing on the goal, both individually, for the team and role. • Formulates and re-formulates goals and outcomes for what needs to be achieved with objects, equipment, information, staff, and environment. • Formulates and re-formulates goals and outcomes for what needs to be achieved individually and within a teamwork environment. • Keeps outcomes in mind during performance. • Example: Actions are oriented and remain focused on following, no ideas, or plans, so it relies on known facts, and doesn't try different options. Are the goals realistic, incomplete, or do ot align with the employer?	**Identifies obstacles** • Identifies barriers that will prevent the outcome from being achieved or the task from being completed. • Examines the plan of action for potential difficulties. • Explores and identifies potential barriers (e.g., task procedures, staff and equipment limitations, environmental constraints, self) to complete the task, routine, and role. • Note that they might see too many obstacles or miss obstacles. • Example: Everything is too hard; taking too many risks, doesn't have the knowledge needed to do the task, not enough time or money, or resources.	**Organises** • Gets ready to perform. • Arranges self, thoughts, ideas, body, objects, equipment, people, and environment to begin the task. • Rearrange ideas, thoughts, equipment, and environment as the task progresses to deal with changes. • Example: Lack of preparation before the task takes place. Missing equipment or a step in the process before performance. OR over-organised, where organisation becomes the task. • This is about novel situations – may use some recall, but usually in situations where not enough is known, or unexperienced.
PROGRAMMING	**Chooses** • Selects a mental strategy/action plan to meet the goal. • Re-selects a new strategy/action plan if/when necessary. • Selects appropriate objects/equipment, information, people, and body action and environment to meet job requirements. • Selects rules, action steps, and behaviours for a specific task/ routine schedule to meet job requirements. • Example: Can provide a reason for their decision making, • doesn't make a choice, chooses incorrectly, does not re-choose a different strategy when the original choice is ineffective.	**Sequences** • Perform task/ routine in logical progression. • Each step leads into the next without unnecessary time to think. • Acts with an action plan in mind to achieve a novel or difficult goal. • Makes changes from experience (e.g., mixing up or rearranging steps) to achieve a successful outcome. • If not sequencing, will drop back to recall of steps (that are known). • Examples: Solving novel problems; writing or describing information in a logical order appropriate to the context required, difficulty in stringing together an argument.	**Calibrates** • Pre-planning body's response to perform action plan. • Develops a motor plan 'picture' of how task will be performed'. • Involves modifying the force, speed, timing and extent of actions, verbal expression, or emotional display to ensure performance is precise. • Adjustments to the above are made to meet demands of job, task urgency, work environment or expected social norms and flexibly accommodates changes. • Examples: Managing emotions in sensitive situations at work, Performance is inefficient, lacking motivation.
EVALUATING	**Questions** • Throughout task performance, when making decisions, and at the end of performance, question about performance of steps is constantly being made. • Verbally asking questions about missing equipment, items, ideas working or not and progress being made. • Where necessary, seeking other's opinion or advice to discuss aspects of the job to improve work performance. • Hesitate, looks, or examines aspects of the task momentarily to check progress before making appropriate changes. • Checks and monitor own performance and others work to ensure meeting goal. • Demonstrating insight into task performance. • Example: Asks too many questions preventing task progressing (anxiety); Does not question enough and just 'does it' making mistakes. Asking questions like: 'How is it going? Are you keeping track of what's happening?"	**Analyses** • Makes a closer inspection of a barriers to performance. • Takes time off task and puts an effort into problems solving through task potential or actual barriers. • Synthesizes all information and thinks of possible better alternative task options or strategies. • Example: Could over analyse and not achieve outcome; Does not analyse enough and repeated barriers in performance. Asking questions like: 'What is going well? What is going wrong? Why did it go wrong? What got in the way? How big a problem was it?"	**Judges** • Makes informed decisions, drawing conclusions about performances. • Decision is the best option or strategy, given physical, cognitive, and psychological capabilities, • Takes into consideration physical capabilities, external expectations, and contextual factors (limitations in resource, environment etc) to make the best decisions. • Example: Asking questions like 'Is that the best decision? Am I happy with that? Did I do a good job? Is the outcome acceptable in terms of quality and quantity for me and employers' expectations?

	PERFORM		
INITIATING	**Starts** • Begins task performance. • Commences expected part of the task or whole task/ routine on time to match expected performance / criteria at work/ rule use. • Restarts after interruption or stopping. • Examples: Leaves tasks unfinished, other people having to complete tasks; Does not start tasks on time or there is hesitation; needs prompts and cues of when and how to start.	**Stops** • Stops task performance or routine. • Stops at appropriate time – when needed for safety, to evaluate, according to rules, to match plan, when requested to do so. • Example: Stops before task is dangerous to self or others; linked to restart – may stop for too long. Stops at the wrong time before a task is completed. Not stopping to prevent fatigue.	
CONTINUING	**Flows** • The performance of work tasks flows and has even performance through the work hours. • There are easy transitions between tasks and parts of tasks. • There are no stop/start variations or inconsistency. • This is about the cognitive flow of tasks, rather than just the motor performance. • Examples: Frequently stopping during work task. One task is performed at a higher output than another (compared to pre-illness). Errors in performance. Poor quality of work.	**Continues** • Keeps performing using self-directed prompts. • Completes tasks and allocated hours of work to expected level without undue prompting to keep going. • Returns to finish tasks and duties when interrupted, monitoring tasks or priorities change. • Example: Leaving work early, not finishing allocated work tasks, requires prompting from team members to complete tasks. Errors in performance. Poor quality of work.	**Persists** • Keeps going with work tasks and hours, even when performance is difficult or when problems arise, or mistakes are made. • Applies effort in attempting to finish tasks and hours of work. • Does not need prompting to generate the cognitive effort to try. • Motivated to engage in the work to the best of their ability throughout the task and the hours of work required. • Example: Work performance is not consistent with ability; rejection of work goal and tasks; expresses lack of motivation; Gets defeated; Needs prompting to generate the cognitive effort to try. Errors in performance. Poor quality of work.
CONTROLLING	**Times** • Uses correct and even speed as required by the task. • Performs within expected or functional time frame. • This is more about the motor control strategies. • Examples: Errors in timing of task performance.	**Coordinates** • Smooth musculoskeletal execution of task for final output of work task. • Free from tremors (dyskinesis), ow tone, flaccidity, hemiparesis, ataxia, dyspraxia, dysarthria. • Examples: clumsiness, dropping objects, muscle fatigue and weakness, incoordination from stress	**Adjusts** • Makes small or large musculoskeletal adjustments to match the plan (linked to calibrates). • Makes small or large musculoskeletal adjustments to match own body demands. • Examples: Stretch if uncomfortable in one position, breath deep if in stressful situation.