UNDERSTANDING ESSENTIALIST BELIEFS THROUGH THE CULTURAL EVOLUTIONARY FRAMEWORK

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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August 2018
Abstract

This research applied a cultural evolutionary framework in addressing two essentialist beliefs related to health and gender. The first part of the thesis focused on whether genetic essentialist cognition translates to biased transmission of genetic etiological information, using a generational learning experimental method. The second study extended this question to include individual factors (e.g., perceived vulnerability to diseases) that may influence the retention and transmission of genetic-based etiological information. Both studies showed that disorder framing affected which etiology is recollected and transmitted, with the recollections of genetic etiology demonstrating stronger sensitivity to the type of disorder, particularly those that were self-relevant. The second part of the thesis examined gender essentialist cognitions in the context of gender inequality and social influence. First, findings regarding gender essentialist cognition and social status in the long-term maintenance of gender inequality were reviewed. Then, in three studies of diverse samples, the effects of gender on whether individuals preferred to socially-learn from expert women versus men was tested. In Study 3 (when given a choice), a female expert was chosen more often, but this did not translate to more social learning, unlike when the expert was a man when social learning was higher (particularly when the learners were men). In Study 4 (when assigned a model), expertise and gender cues played important roles in the social learning of women compared to men, especially when the role model was a man. In sum, the studies examined whether genetically-based essentialist beliefs are preferentially transmitted and whether social status of male and female experts influenced social learning. The findings provide novel insights into cultural transmission and social learning, which in turn has potential to impact the transmission of cultural mores of large-scale cooperative groups.
Acknowledgments

The journey to completing this thesis was a time for my own growth, but most of it would not have been possible without the many individuals in my life, both near and far.

First, Ilan Dar-Nimrod, for seeing something in me in our first, brief interaction. I am so very thankful that our paths crossed when they did. I wouldn’t have been at Sydney if you hadn’t encouraged it! Over the ups and downs of my PhD, I have come to appreciate your steadfast support, advice, and encouragement in all of my undertakings. I am fortunate to have you as an academic and life mentor as well as a friend, a relationship that I hope will continue on for many years to come, with more collaborations. I will dearly miss our chats!

To Rob Boyd and Yoshi Kashima, who despite the distance, have supported my work and helped me become a better researcher. I really appreciated the discussions we had about social psychology and evolution, especially during the early stages of my projects.

The wonderful Karen Gonsalkorale – you played a big part in further fuelling my interests in gender. Thank you for your generosity, support, and friendship. I am particularly grateful for gaining insight into what kind of a researcher I hope to be, based on your perspectives.

To my family, for being my home, no matter whether I am near or far. In particular, to my mother, Annapoorni Sivaswamy. Your unwavering support was instrumental in me pursuing my dreams without limitations.

Having moved around, I am grateful for all the wonderful friendships I have. To my closest friend, John Kiat. So much of who I am, as a person and as a researcher, was shaped by you and your friendship. You were one of the first people to see me, made me see more in
myself, and pushed me to dream big (and still doing it!). That is something that will I always be grateful for. Here’s to many more years of a lovely friendship!

To Ai Rene Ong – so glad to have shared this journey, over these years, with you! To all my Sydney, Sydney Uni, and SCID Lab friends who made this soul feel a little less lonely when I needed it. In particular, to Ruth Kuntzman and James Morandini. Ruth, your friendship was an unexpected surprise and I will cherish the times we have together. James, I very much appreciate all of our time together, whether we’re debating or just shooting the wind. I think our friendship is a great indication that people who disagree often can still be good friends! Special shout out to Sumitra Sankar, Hema Priya, Sunnil Mohandas, and CG Cheah.

A huge thanks to the School of Psychology academic and admin staff for their support, either with a quick chat in the hallway or with financial support. In particular, to Rebecca Pinkus for helping me tread the waters of writing more complex statistics. Finally, a very special thanks to my hardworking research assistants, who often made a tedious task more fun.
Author’s Declarations

I hereby certify that:

I. The intellectual content of this thesis is the product of my own work and all the assistance received in preparing this thesis, and sources have been acknowledged, under the supervision of Dr. Ilan Dar-Nimrod and auxiliary supervision of Prof. Rob Boyd and Prof. Yoshihisa Kashima.

II. 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.

III. All studies presented were ethically approved by The University of Sydney Human Research Ethics Committee.

Asha Ganesan, 30th August 2018

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

Ilan Dar-Nimrod, 30th August 2018
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Chapter 1: General Introduction

The notion that individuals’ responses to the same experiences often vary depending on cultural and historical contexts is widely accepted in most fields of psychology. In social and cultural psychology, there is a large body of work aimed at investigating the influences of cultural identity and cultural contexts on social cognitions related to learning (Boyd & Richerson, 1995), intergroup relations (Verkuyten & Yogeeswaran, 2016), and rational and irrational beliefs (Henrich, 2009). Work in these areas is guided primarily (but not necessarily exclusively) by the building, usage, and flexibility of knowledge structures. In fact, many established concepts within social psychology were derived from or are influenced by a long line of empirical research on contextual factors and knowledge structures. For example, research on women’s and men’s expression of sexist beliefs is largely situated within the framework of existing knowledge structures (e.g., stereotypes) and contextual factors (e.g., cultural identity). Consequently, the last two decades have witnessed an abundance of research focused specifically on culture and social cognition (see Henrich, Heine, & Norenzayan, 2010; Lehman, Chiu, & Schaller, 2004).

Though this line of work highlighted the need for multidimensional consideration for contextual factors (Verkuyten, Yogeeswaran, & Adelman, 2019), it has been invigorated further by the subfield of cultural evolution – an area also focused on the influences of knowledge structures and contextual factors on social cognitions. Whereas most social and cultural psychological experiments concerning social cognitions are conducted with undergraduates from urban, industrialised populations, cultural evolution examines these phenomena with an additional but important consideration – the evolutionary and historical trajectories of the individuals themselves with non-typical populations (Henrich et al., 2010).
Cultural Evolution and Social Cognition

Most social psychological and social cognition students would agree that people often have different responses to similar experiences because humans are developmentally and cognitively plastic (see Pluess & Belsky, 2013). Cultural evolution provides an additional layer to this perspective – cognitive plasticity (or flexibility) evolved to facilitate reproductive fitness or successful spreading of genes to future generations. Our human ancestors responded to experiences in their environments and these responses, over time, shaped to fit the needs of the environment that these ancestors were likely in (e.g., Henrich & McElreath, 2003). Where social psychology takes a short-term approach focusing on emphasising contextual factors and knowledge structures in immediate social, psychological, and behavioural terms, cultural evolution conceptualises these factors in relation to survival and reproductive success.

Ancestral humans’ abilities to construct knowledge structures is an essential factor in how they responded to their environment (Boyd & Richerson, 1995). For pre-historic humans, learning about their world was important in ensuring their and their offspring’s survival. Based on knowledge, experiences, and preferences acquired over time, these categories expand into meaningful social categories such as gender (Liberman, Woodward, & Kinzler, 2017). Social learning, particularly through observation of adults, aids young children in navigating their environment (Rhodes, Leslie, & Tworek, 2012), especially in identifying dangers. Furthermore, knowledge structures provide the foundation to learn more complex information such as languages (Smith & Kirby, 2008), taboos and religious information (Norenzayan et al., 2016), and engaging with more sophisticated tools and devices (e.g., cooking a meal; Henrich, 2004). Broadly, these knowledge structures represent basic cognitive functions relevant to social
psychological research, such as heuristics and memory (Norenzayan, Atran, Faulkner, &
Schaller, 2006).

In addition to these examples of the functions of knowledge structures, further
consideration can be given to flexibility in response to challenges in one’s environments. The
cultural evolutionary framework proposes that such flexibility is rooted in an interaction between
genetic evolution and cultural evolution (commonly termed gene-culture coevolution; Laland,
2008). Genetic evolution represents genetic predispositions throughout a person’s development,
and such predispositions influence what that person learns as a part of their knowledge structure
(Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981). When facing the challenges in a
particular environment, developmental predispositions toward flexible knowledge structures are
further facilitated by socially learning from one’s environment. Our nomadic, hunter-gatherer
ancestors had higher chances of surviving a particular environment if they showed flexibility in
responding to challenges arising (Chudek, Zhao, & Henrich, 2013). Social learning helped
humans, as a species, to efficiently acquire knowledge that was adaptive to specific locales,
either socially learnt from more experienced others in those environments or at the least, by trial-
and-error attempts (though these attempts are costly in terms of time and effort with higher
chances of failure than imitation; Whiten, Allan, Devlin, Kseib, Raw, & McGuigan, 2016).

As humans went from small, hunter-gatherer groups to thriving, large-scale societies of
diverse individuals, they also adapted to the needs of changing environments, as evidenced by
continuing reproductive success (e.g., Boyd & Richerson, 2009; Hansen, Jensen, & Skovsgaard,
2015). For example, one of the most established lines of work that intersects cultural evolution
and social psychology focuses on cooperative behaviours. Much of the work from this area
showed that over tens of thousands of years, large-scale societies around the world
overwhelmingly engaged in cooperation with people who were not their genetic kin, though the level and intensity of cooperation varied depending on social norms of particular environments (Chudek et al., 2013; Richerson & Boyd, 1999). Similarly, we know that prehistoric humans engaged in gendered division of labour, which shaped modern human’s (at least, until our very recent history) strict gender roles (Wood & Eagly, 2012). However, not all prehistoric humans engaged in gendered division of labour (Alesina, Giuliano, & Nunn, 2013; Hansen, Jensen, & Skovsgaard, 2015; Lew-Levy et al., 2017), suggesting differentiated cultural adaptations in the face of different environmental challenges.

What we understand as culture is based on shared, collectively agreed on social information acquired by individuals through observation, copying, trial-and-error, and innovation over many generations – termed cultural transmission (Martin, Cunningham, Hutchison, Slessor, & Smith, 2017). The transmission of social information, including biased information, has the potential to shape larger, cultural narratives. As societies expanded over generations, the cooperative/competitive systems arguably favoured the selection of genes that predisposed humans to increased prosocial behaviour, especially towards one’s ingroup. This selection then predisposed individuals to react to environmental challenges by creating cultural and moral systems that facilitated reproductive success – cooperating with out-group members (Boyd & Richerson, 2009).

Over generations, with increasing cognitive sophistication, evolutionary researchers theorise that humans developed biases toward specific kinds of social information involved in the categorisation, transmission, and social learning of cultural information. These biases influenced what kind of information is received and transmitted in social learning situations, serving as either filters or magnifiers of specific information. These biases can be grouped into
two broad types – content biases and context biases (Broesch, Barrett, & Henrich, 2014; Henrich & McElreath, 2003). Content biases involve the preferential acquisition and transmission of specific types of social information, particularly those that are relevant to one’s survival and reproductive success. The acquisition and development of such knowledge are based on broad categories that are perceptually observable categories (e.g., animal vs. plant). These categories are then used to make specific inferences (e.g., dangerous vs. benign animal). One such content bias forms the basis for this thesis – bias toward essentialist information.

Some social categories are formed based on an essentialist heuristic (Prentice & Miller, 2006), where members of a category are perceived as having an underlying fundamental nature (i.e., essence). This essence is not observable (Medin & Ortony, 1989), but it gives rise to core features possessed by members of that category (Dar-Nimrod & Heine, 2011). For example, if all Labrador dogs had a Labrador essence, the essence is seen as the reason why all Labradors have a short but dense coat, a long and hairy tail, brown/hazel eyes, excellent swimming skills, an unaggressive and friendly demeanour, and can make good working dogs. This essence and the associated features are also assumed to be immutable (Taylor, Rhodes, & Gelman, 2009), such that a violent Labrador is likely perceived as an anomaly to the prototypical Labrador. This heuristic extends to using genes to draw causal inferences on one’s health or social category (e.g., race), known as genetic essentialist cognition. When it comes to how one categorises people, the essentialist heuristic leads a person to evaluate who should “naturally” fall into a particular category such as gender, known as gender essentialist cognition.

In contrast to content bias, context bias makes individuals preferentially pay attention to specific attributes of individuals that they choose to observe and model behaviours from. For example, both theoretical (Kendal et al., 2018) and empirical (Cheng, Tracy, Foulsham,
Kingstone, & Henrich, 2013) evidence suggest that individuals usually choose to model
behaviours of prestigious or successful individuals. Context biases involve the attributes of
individuals that one is biased to socially learn from, based on attributes like gender, social
influence, and success (Broesch et al., 2014). For example, some social information is more
likely learnt and transmitted because of the increased attention given to ingroup social
information conveyed by the majority (Moya & Henrich, 2016) or by successful, powerful, or
prestigious individuals (Henrich & Gil-White, 2001; Richerson et al., 2010). In such a situation,
essentialist information (a content bias) may have a higher chance of being socially learnt or
transmitted when it is information that is endorsed by influential individuals (a context bias).

Past research has identified several types of essentialist cognitions that individuals
engage in, including essentialist cognitions about gender and genetics (Dar-Nimrod & Heine,
2011; Haslam, Rothschild, & Ernst, 2000; Prentice & Miller, 2007). A bias toward acquiring and
transmitting gender-based essentialist information was theorised as being a major contributor to
the evolution of modern-day gender roles (Eagly & Wood, 2013; Wood & Eagly, 2012), given
its function in basic human processes such as reproduction and division of labour (discussed
further in Chapter 4). Unlike gender, genetics likely has a more recent history as a biasing factor
in social cognition, though accounts concerning heritable “essences” were already in existence
for millennia (Dar-Nimrod & Heine, 2011).

The cultural transmission (or social learning) of gender essentialist cognition has been
explored to a much larger degree (Heyman & Giles, 2006; Hiller & Baudin, 2016; Meyer &
Gelman, 2016; Prentice & Miller, 2006; Rhodes et al., 2012) than genetic essentialist cognition.
A potential proxy for genetic essentialist cognition can be drawn from evidence on racial
essentialist cognition (Haslam, 2017; Haslam & Whelan, 2008; Moya & Henrich, 2016), but it
does not account for the diverse (and in some cases more recent) application of genetic essentialist cognition in areas such as sexual orientation, criminality, and health (see Dar-Nimrod & Heine, 2011). Thus, examining a potential bias toward acquiring and transmitting genetic information, in its modern function as a causal explanation for health conditions, may clarify the role of genetic information in cultural narratives. Similarly, gender essentialist cognition, as applied in modern-day societies, is intermingled with women’s increasing representation in high-status positions. Examining the effects of gender essentialist cognition in its applications toward power-related social hierarchies would further understanding of its role as content bias in present-day gender inequalities.

**The Present Thesis**

Based on these ideas, this thesis broadly aims to examine the cultural transmission of essentialist cognitions and their implications. To address these aims, the present research focuses on genetic essentialist cognition in the context of health, reviews the evidence concerning the historical and present-day role of gender essentialist cognition and social status in gender inequality, and assesses how gender and social status intersect in a fundamental evolutionary process – gender-influenced social learning. Beyond their purpose in demonstrating the effects of content and context biases, genetic and gender essentialist cognitions are arguably the two types of essentialist cognition that have changed most significantly in recent times. Major advancements in genetics and large societal changes to gender roles are both notably recent phenomenon in human history. Additionally, both these cognitions are potentially informative in highlighting the utility of applying the cultural evolutionary framework as well as understanding the diverse forms that the essentialist cognitions take, as specific norms of gender (Fiske, 2017; Wood & Eagly; 2012) and understanding of genetics (Chapman et al., 2018) seem to vary by
culture substantially. To address these different types of essentialist cognitions, this thesis is divided into two parts.

In the first part, I assess the cultural transmission of genetic information in, as of yet, an unexamined area – health and disorder information – using a prominent method in the cultural evolutionary literature, generational learning or a broken-telephone method of information transmission. In two studies (Chapters 2 and 3), I examine if humans have content biases in the cultural transmission of disorder causal information, particularly those with genetic etiology contrasted with environmental etiology. I also look at whether this content bias affects patient-related cognition through measures of social distance and disgust. Then, I summarise the findings and their contributions in furthering knowledge concerning the content bias toward genetic information.

In the second part, I focus on how content and context biases interact, with a primary focus on gender essentialist cognition. First, I review the relevant literature, focusing on the role of gender essentialist cognition and social status in the maintenance of gender inequality over humans’ evolutionary history (Chapter 4). I provide a brief review of the cultural evolution of gender inequality concentrating on the role of gender differences and gendered division of labour. I also discuss the emergence of social hierarchies in human societies and gender essentialist cognition facilitated justifying and accepting gender inequalities, particularly for low-status women, with recommendations for future research and interventions. Then, I empirically test one of the recommendations, namely whether the increased representation of women in high-status positions increases the possibility of learning from them (Chapter 5). I focus specifically on how social learning is influenced by gender and the social status of a model. Then, I discuss how examining genetic and gender essentialist cognitions through the cultural evolutionary
framework aids in understanding their functions as modern-day content biases for social
cognitions related to health and gender (Chapter 6). Finally, the overall implications and future
research on approaching essentialist beliefs through the cultural evolutionary framework are
discussed.
Part I: Cultural Transmission of Content Biases in Health

Chapter 2: Transmission of Disorder and Etiological Information

Study 1 Introduction

Evolutionary theories on cultural transmission can serve as a useful basis for exploring how socially-relevant information is selected for and transmitted across individuals over time to become a part of general cultural understanding. Humans have evolved and developed cognitive capacities over time which preferentially selects for useful cultural information, such as information that is relevant to social groups (Henrich & McElreath, 2003). Over generations of individuals, information that is relevant to social cognitions is often transmitted with more accuracy than information lacking in social-relevancy (Mesoudi, Whiten, & Dunbar, 2006). Consequently, this preferential selection shapes what kind of information is integrated successfully into larger group-level norms, which aids in the survival of an individual and a group of people (Henrich & McElreath, 2003). Observation also provides useful cultural information (Broesch et al., 2014). A child consistently observing adults erring on the side of caution in an uncertain situation, such as avoidance of an unknown plant, is a norm that decreases the likelihood of a person engaging in a costly, and potentially fatal, mistake (Broesch et al., 2014).

As information concerning a group’s environment accumulates over generations of individuals, its application extends to more sophisticated and more specialised forms. For instance, older women passing on information about toxic foods that younger pregnant women should avoid is incorporated into one’s culture as a taboo (Henrich & Henrich, 2010). Thus, cultural transmission of health knowledge concerns providing knowledge that is adaptive to facing challenges in one’s environment, ensuring one’s survival as well the general survival of
one’s group. However, the knowledge that is most adaptive is also usually the knowledge that individuals allocate their cognitive resources to such as immediate challenges over less urgent ones (Liberman et al., 2017). These challenges range from survival-based (e.g., fleeing a tiger) to less dangerous ones (e.g., figuring out the least demanding route home; Acerbi, 2016).

When this cultural transmission mechanism is applied to health-related knowledge, it facilitates the understanding of more micro-level and psychological processes involved in the transmission (Acerbi, 2016). Lay understanding of health conditions is context-specific, as local folk knowledge and cultural practices may override scientifically-tested knowledge on healthcare, whether in Western Africa (Towns, Mengue Eyi, & Van Andel, 2014) or Western Australia (Molster, Charles, Samanek, & O’Leary, 2009). In these situations, the salience of specific health or disorder etiologies significantly affects people’s health-related decisions (Brogan & Hevey, 2009; Dar-Nimrod & Heine, 2011; Taber et al., 2017).

Several studies have documented that a disorder framed as having a genetic cause, in particular, affect evaluations of patients and the disorder itself. Health conditions with genetic etiologies influence individuals to view the conditions as more immutable or permanent (Dar-Nimrod & Heine, 2011), but also reduce blame placed on patients because the conditions are seen as being outside their control (Haslam & Kvaale, 2015). Though patients are viewed as blameless in specific contexts, perceived biological explanations for disorders make clinicians less empathetic toward patients compared to psychosocial explanations (Lebowitz & Ahn, 2014). Empirical studies indicate that both clinicians (Kim, Ahn, Johnson, & Knobe, 2016) and individuals (Dar-Nimrod, Zuckerman, & Duberstein, 2013; Parrott, Kahl, Ndiaye, & Traeder, 2012) are susceptible to genetic or biological essentialist thinking. What these studies did not
consider was whether genetic essentialist thinking is a response toward health-related challenges in people’s environments.

Beyond clinical settings, health-related research is often misunderstood or misapplied, subsequently shaping our biases (Heine, Dar-Nimrod, Cheung, & Proulx, 2017), fears, and false beliefs about modern medicine and genetics (Cheung, Dar-Nimrod, & Gonsalkorale, 2014). Such processes hinder the appropriate use of health knowledge by the general public in making informed health decisions (Swami et al., 2009), such as in interpreting pre-existing conditions and genetic testing needs (Lowstuter et al., 2008). Much of these misunderstandings become integrated into the larger cultural sphere to affect both health and social cognitions. For example, the threats of illnesses (Murray & Schaller, 2012; Schaller & Park, 2011) and pandemics (Beall, Hofer, & Schaller, 2016) affect non-diagnosed individuals’ social decisions such as following the majority, voting behaviour, and support for social policies as well as increasing desired social distance from diagnosed individuals (Jorm & Oh, 2009; Link, Phelan, Bresnahan, Stueve, & Pescosolido, 1999). Furthermore, selective transmission of specific health information can lead to biased views on who should get medical or clinical help and judgments of who has a severe disorder (Dovidio & Fiske, 2012) as well as who should receive high-quality treatment (Penner et al., 2010). The transmission of health information may be imperfect, but central ideas and themes often persevere, which in turn, impacts how one uses the transmitted information in the face of challenges in their environment.

People acquire biased health knowledge from several sources including familial intergenerational transmission (Short & Mollborn, 2015) and traditional or digital media transmission (Acerbi, 2016). Given the “viral” nature of many online health campaigns, selective attention to specific aspects of complex health conditions may be enhanced through mediations
by non-professionals, leading to biased notions of patients’ lives. For example, Angelina Jolie’s op-ed (Jolie, 2013) concerning genetic testing for familial breast cancer has been singled out as increasing awareness on a specific type of hereditary breast cancer (Evans et al., 2014). However, awareness of stories like Jolie’s does not necessarily improve understanding of the genetic mechanism involved (Evans et al., 2014) and have resulted in increased requests for genetic testing and intervention, even when there is no familial history of that condition (Parrott et al., 2012). In Jolie’s case, the prominence of the speaker likely played a significant role in the successful transmission of this condition’s information (Acerbi, 2016). However, it is also worth examining whether certain features of a health condition such as its etiology (e.g., whether genetic or not), facilitated its successful and widespread transmission.

To test whether genetic essentialist thinking is an adaptive response in the face of a health-related challenge, it is pertinent to examine the extent of successful transmissions of specific kinds of etiologies. I contend that if the transmission of genetic information is an adaptive response, in addition to being recalled more frequently in transmissions, it will also influence people’s views concerning the health condition itself, treatment of participants, and potential interactions with patients.

The Present Study

The present study assesses the effects of transmission of disorder and etiological information through transmission chains called generations. In the study, participants were exposed to vignettes with different etiologies (genetic, environmental, and no etiology) paired with disorders (physiological, psychological, and cultural), and asked to evaluate each vignette. Each of the three disorders had unique names, age ranges (i.e., population information), and symptoms. Participants provided recollections of the vignettes, then used for participants in the
next generation position. To our knowledge, the transmission of health knowledge and its effects on health-related cognition as a parallel to real-life information transmission on digital media has yet to be experimentally examined in a controlled lab setting.

Given the research reviewed above on the transmission of useful cultural information and high salience of disorder etiologies in people’s health and social cognitions, we hypothesised that participants exposed to genetic etiology, compared to other etiologies, will (1) reproduce etiology-related information more consistently across the generations (Green & Clémence, 2008), (2) evaluate patient well-being more negatively (Dar-Nimrod et al., 2013), and (3) will desire more social distance (Jorm & Oh, 2009; Link et al., 1999). We also expected participants to devalue the least self-relevant or familiar health condition - the cultural disorder framed as affecting an outgroup (Jorm & Oh, 2009), in their recollections, patient evaluations, and social distance desired. Lastly, over generations, participants will make more positive patient well-being evaluations and desire less social distance, due to increased dilution of information (Mesoudi et al., 2006).

Study 1 Methods

Participants

Relevant generational learning experiments show effects ranging from small to large. Considering this range, to detect Cohen’s $d = .40$ (a medium effect; Cohen, 1988) for planned comparisons of at least .95 power, a minimum of 123 participants was required. Allowing for oversampling, a total of 198 first-year psychology undergraduates (131 women, 48 men, 19 unreported; $M_{age} = 19.16, SD = 3.49$) participated in return for course credit, with an additional incentive of being placed in the running for a $10$ voucher. Majority of participants identified as European/White (77), East Asian (33), Mixed ethnicity (27), South Asian (14), Southeast Asian
(12), Arab/Middle Eastern (10), and African (4). Others were either unreported or identified as “Other” (2). Most participants were native English speakers (143). Most were born in Australia (129), with the remainder indicating they were born overseas (50). Fifty-eight participants were in Generation 1, 62 participants in Generation 2, 45 participants in Generation 3, and 33 participants in Generation 4.

**Measures**

**Vignettes.** Three unique vignettes depicting one of three disorders types (i.e., physiological, psychological, or cultural) were paired with one of three etiological explanations (i.e., genetic, environmental, or no etiology). Each disorder (Kim & Ahn, 2002) had corresponding symptoms such that a physiological disorder characterised as a physiological (optic) condition, a psychological disorder represented by cognitive impairments, and a cultural disorder depicted as being exclusive to a particular population. All disorders and purported patients were fictitious. Vignettes were reviewed by five experts and ten undergraduates for open-ended feedback on the clarity of expression and minor revisions were made to the final versions (see Appendix A). Vignette sets were based on an orthogonal Latin square design (see Table 1), ensuring each participant was exposed to all disorder types and all etiologies only once.

<table>
<thead>
<tr>
<th>Etiology/Disorder</th>
<th>Genetic</th>
<th>Environmental</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological</td>
<td>Set 1</td>
<td>Set 2</td>
<td>Set 3</td>
</tr>
<tr>
<td>Psychological</td>
<td>Set 2</td>
<td>Set 3</td>
<td>Set 1</td>
</tr>
<tr>
<td>Cultural</td>
<td>Set 3</td>
<td>Set 1</td>
<td>Set 2</td>
</tr>
</tbody>
</table>
**Patient well-being evaluation.** Participants rated each patient described in the vignettes on four items, which were standardised to create a composite patient evaluation measure with higher scores indicating greater well-being ($\alpha = .68$). First, using a 7-point scale (1 = *not at all serious*, 7 = *very serious*), participants rated one item on the seriousness of the disorder to warrant $5,000,000 in research funds. Then, participants responded to two items on the likelihood of patient obtaining positive health outcomes on a 7-point scale (1 = *extremely unlikely* to 7 = *extremely likely*; e.g., “Based on what you know about this disorder, what are the chances of a person with this disorder living a healthy life?”). Lastly, using a 6-point scale (1 = *a great deal*, 5 = *none at all*, with an option for “I don’t know”), participants rated one item on the extent to which patient is in control of the condition.

**Social distance.** Participants answered the question, “How comfortable would you be with your sibling dating someone with this condition?” using a 7-point scale (1 = *not at all comfortable*, 7 = *very comfortable*).

**Procedure**

Participants arrived at a lab for a study titled “Investigation of Decisions made about Health Conditions.” They were assigned a computer by an experimenter, who then verbally introduced the study, instructed participants to read through an information sheet and provide written consent. The study began with brief instructions informing participants that they will read three vignettes, which they will recall at a later time. To incentivise recall, they were told the best recollection would receive a $10 gift card. First generation participants were randomly assigned to their vignette set by the software Qualtrics, ensuring that the experimenter remained blind to participants’ experimental condition. They read the first vignette, then completed the patient
evaluation measures. Next, they provided open-ended recollections of the vignette using their own words.

These steps were repeated twice more for the other two vignettes in the set, with randomised vignettes’ presentation order. Then, participants completed a final question to identify the correct etiology of each disorder, after which they completed demographic items (i.e., age, sex, ethnicity, native language, and their university major and minor). At the end of the 25-minute session, participants were verbally debriefed on the true purpose of the experiment, at which time the fictitious nature of the disorders was revealed. Participants in the second generation experienced the same procedures as the first. However, the vignettes presented to participants were the recollections of participants from the first generation. This transmission chain continued with the second generation’s recollections used for the third generation, and finally, the third generation’s recollections for the fourth generation. Recollections were not edited, except for minor punctuation corrections. All study procedures were approved by the University of Sydney Human Research Ethics Committee.

**Open-ended Response Coding**

The open-ended recollections coding was done in stages. First, based on research hypotheses, relevant information was identified for coding - namely etiology, afflicted population description, disorder name, and symptoms. These elements formed the basis for preliminary coding schemes. Then, three trained, independent raters, were assigned the same five sets of recollections, blind to the experimental conditions and generations. The raters coded them with an initial inter-rater reliability value of .69, assessed using Krippendorff’s alpha (Krippendorff, 2013), following which raters and one of the authors met to review and reach consensus over discrepant coding. Finally, the raters were randomly assigned recollections for
independent coding and any inconsistencies or issues were addressed on a needs-basis with the author. Inter-rater reliability for the final coding was also assessed using Krippendorff’s alpha and showed appropriate acceptance levels at .73 (Krippendorf, 2013).

Correct etiology was initially identified using a nominal scale: $0 = \text{Incorrect}$, $1 = \text{Correct}$, and $2 = \text{Not mentioned}$. To ensure consistency in coding, the recollections of any words corresponding to the relevant category were used as correct responses. For instance, for Genetic Etiology (mutations in four different genes found in DNA cellular structures), any mention of “genes” and/or “DNA” were rated as correct. Similarly, for Environmental Etiology (“the presence of ANF toxins in the near environment”), recollection of the words “toxins” and/or “environment” were considered correct responses. For the No Etiology condition, “a condition that is relatively unknown and is recommended for further research,” recollection of the keywords “unknown” and/or “research recommended” were considered correct responses. Close variants of the original keywords were considered in the coding (e.g., genetic, toxic, don’t know) based on a list provided by the author. Prior to data analysis, “Not mentioned” data were recoded as “Incorrect,” given that omission of etiology information is an inaccurate recollection, resulting in two levels of coded data, $0 = \text{Incorrect}$ and $1 = \text{Correct}$.

Analysis Plan

Statistical analyses were conducted through three separate two-level multilevel analyses for the three dependent variables: (1) whether or not correct etiology was recalled [binomial outcome], (2) evaluations of patient well-being [continuous outcome], and (3) ratings of desired social distance [continuous outcome]. Using these analyses allowed to model response variations at a within-person level simultaneously (e.g., a participant’s probability of correct recollection for one etiology type relative to their probability for the other types) as well as between-person
level (i.e., a participant’s likelihood of correct etiology recollection relative to other participants). This method also accounts for differences (i.e., heterogeneity) between and within participants by including a random effect for participants (Hoffman & Rovine, 2007) - particularly relevant given the use of the generational design in this study. In each of the three models, the dependent variable was at level 1, nested within participants. Participants were then nested at level 2 in the within-subjects fixed effects, Etiology Type (Genetic, Environmental, No Etiology) and Disorder Type (Physiological, Psychological, Cultural) as well as the between-subjects fixed effect of Generation (1, 2, 3, 4). Analyses were performed using PROC GLIMMIX and PROC MIXED in SAS 9.4 for Windows (SAS Institute Inc, 2017). Normality in residual distribution for models was assessed by scatter and Quantile-Quantile plots. No extreme outliers were found for both continuous outcomes, but the ratings of desired social distance showed skewed residuals, which are elaborated on further below.

**Study 1 Results**

For each of the models, an empty model was first estimated as a baseline to evaluate the fit of more complex models and whether a random intercept for participants was needed. In level 2, all three fixed effects were added. Pseudo-$R^2$ was reported as an estimate of effect size for the final model (Nakagawa & Schielzeth, 2013). Effect size estimations for the simple effects were conducted using odds ratio (OR) for the binomial outcome and Cohen’s $d$ for the two continuous outcomes (Lakens, 2013).

**The Effects of Etiology Type, Disorder Type, and Generation on Etiological Recollection**

For the multilevel analysis, an empty model (Model 1) without any predictors to examine variance in whether or not correct etiology recollection is accounted for by between-participant differences was estimated. Intra-class correlations (ICC) were calculated to estimate these
between-participant differences and showed a large ICC value of .65. The magnitude of the ICC suggests that approximately 65% of the total variance in etiological recollection is accounted for between-participant differences, further supporting the use of a multilevel modelling approach over a repeated measures analysis of variance (Hoffman & Rovine, 2007). Next, within-participant variation was accounted for by adding a random intercept for participants (Model 1A). The addition of this intercept significantly improved model fit [$X^2$ difference $(1) = 10.62, p < .001$]. The Bonferroni-corrected family-wise significance level for the total two possible comparisons in the model was $p \leq .025$.

The inclusion of the three-way interaction resulted in improbable odds ratio confidence intervals (> 999.99). The three-way interaction was excluded, to improve model fit, while all three two-way interactions and three main effects were included in the level 2 model (Model 2). Overall, a comparison of model deviances against Model 1A indicated that Model 2 was a significant improvement [$X^2$ difference $(23) = 68.89, p < .001$], but two of three two-way interactions, Generation X Etiology Type, and Generation X Disorder Type, were non-significant. These two interaction terms were removed to improve model parsimony (Hoffman, 2015). The revised model (Model 2A) was a significantly better fit than Model 1A [$X^2$ difference $(12) = 57.73, p < .001$] and was retained as the final model. The remaining effects in Model 2A are described below (see Table 2).
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model 1A – Intercept only</th>
<th>Model 2A – Final model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Est</td>
<td>SE</td>
</tr>
<tr>
<td>Fixed effects</td>
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<td></td>
</tr>
<tr>
<td>Intercept</td>
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<td>.17</td>
</tr>
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<td>Etiology Type</td>
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<td>Genetic</td>
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<td>.67</td>
</tr>
<tr>
<td>Environmental</td>
<td>2.16</td>
<td>.65</td>
</tr>
<tr>
<td>No Etiology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ref)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disorder Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological</td>
<td>1.54</td>
<td>.66</td>
</tr>
<tr>
<td>Psychological</td>
<td>1.86</td>
<td>.65</td>
</tr>
<tr>
<td>Cultural (ref)</td>
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</tr>
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<td>Generation</td>
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<tr>
<td>1</td>
<td>1.87</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.39</td>
<td>.43</td>
</tr>
<tr>
<td>3</td>
<td>.42</td>
<td>.46</td>
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<tr>
<td>4 (ref)</td>
<td></td>
<td></td>
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<tr>
<td>Random effects</td>
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<td></td>
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<tr>
<td>Intercept</td>
<td>.99</td>
<td>.43</td>
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<td>−2LogLikelihood</td>
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<td></td>
</tr>
<tr>
<td>Pseudo-$R^2$</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Notes: No etiology, cultural disorder, and Generation 4 were reference groups. *$p < .025$ **$p < .01$, ***$p < .005$
**Effect of etiology type and disorder type.** The main effect of Disorder Type on etiological recollection was significant, $F(2,372) = 4.39, p = .013$, while the main effect of Etiology Type was not, $F(2,372) = 1.73, p = .179$. The interaction between Etiology Type and Disorder Type was also significant, $F(4,372) = 3.20, p = .013$. Simple effects (see Table 3) indicated no significant differences in Genetic etiology recollections across all disorders. However, compared to Cultural Disorder, Environmental etiology was more likely recalled when paired with Physiological Disorder. In the No Etiology condition, participants were told that the disorder’s etiology was unknown. This lack of a known etiology showed higher recall probabilities in both Physiological and Psychological Disorders compared to Cultural Disorder. When compared across etiologies (see Table 4), the only effect present was for Cultural Disorder; participants were more likely to recall Environmental etiology compared to No Etiology when paired with Cultural Disorder. All other etiological comparisons did not vary at the Disorder Type level.
Table 3. Simple effects table at etiology type level for etiological recollection

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Disorder</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic</td>
<td>Physiology vs Psychological</td>
<td>0.49 (0.19, 1.24)</td>
</tr>
<tr>
<td></td>
<td>Physiology vs Cultural</td>
<td>1.34 (0.49, 3.68)</td>
</tr>
<tr>
<td></td>
<td>Psychological vs Cultural</td>
<td>2.76 (1.05, 7.24)</td>
</tr>
<tr>
<td>Environmental</td>
<td>Physiology vs Psychological</td>
<td>0.44 (0.16, 1.21)</td>
</tr>
<tr>
<td></td>
<td>Physiology vs Cultural</td>
<td>0.28 (0.10, 0.76)*</td>
</tr>
<tr>
<td></td>
<td>Psychological vs Cultural</td>
<td>0.64 (0.26, 1.58)</td>
</tr>
<tr>
<td>No Etiology</td>
<td>Physiology vs Psychological</td>
<td>0.75 (0.30, 1.91)</td>
</tr>
<tr>
<td></td>
<td>Physiology vs Cultural</td>
<td>4.74 (1.30, 17.20)*</td>
</tr>
<tr>
<td></td>
<td>Psychological vs Cultural</td>
<td>6.28 (1.76, 22.47)**</td>
</tr>
</tbody>
</table>

*p < .025 **p < .01, ***p < .005

Table 4. Simple effects table at disorder type level for etiological recollection

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Etiology</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological</td>
<td>Genetic vs Environmental</td>
<td>1.86 (0.65, 5.31)</td>
</tr>
<tr>
<td></td>
<td>Genetic vs No Etiology</td>
<td>0.97 (0.37, 2.57)</td>
</tr>
<tr>
<td></td>
<td>Environmental vs No Etiology</td>
<td>0.52 (0.19, 1.47)</td>
</tr>
<tr>
<td>Psychological</td>
<td>Genetic vs Environmental</td>
<td>1.67 (0.68, 4.12)</td>
</tr>
<tr>
<td></td>
<td>Genetic vs No Etiology</td>
<td>1.51 (0.62, 3.68)</td>
</tr>
<tr>
<td></td>
<td>Environmental vs No Etiology</td>
<td>0.90 (0.36, 2.25)</td>
</tr>
<tr>
<td>Cultural</td>
<td>Genetic vs Environmental</td>
<td>0.39 (0.15, 1.10)</td>
</tr>
<tr>
<td></td>
<td>Genetic vs No Etiology</td>
<td>3.43 (0.92, 12.80)</td>
</tr>
<tr>
<td></td>
<td>Environmental vs No Etiology</td>
<td>8.86 (2.48, 31.57)**</td>
</tr>
</tbody>
</table>

***p < .005

Effect of generation. Overall, the main effect of Generation was significant, $F(3,193) = 10.78, p < .001$. Participants in Generation 1 - the generation with access to the complete version
of the vignettes - were more likely to recall correct etiological information compared to Generation 4 participants (see Table 2).

As the recollection of correct etiology in later Generations is dependent on correct recollections of the earlier Generations, the effects of Generation and Correct Etiology Exposure on correct etiology recollection was explored. Thus, I conducted further analyses into whether participants exposed to correct etiology also recalled correct etiology. In fitting a model for the dependent measure – the number of correct etiological recollection – we used a Poisson regression model for count data, with Generation and Correct Etiology Exposure (yes vs. no) as predictors. The model indicated no significant interaction effect of Generation and Correct Etiology Exposure, $F(2,562) = 1.40, p = .247$ and no main effect of Generation, $F(3,562) = 0.73, p = .532$. However, there was a significant effect of Correct Etiology Exposure, $F(1,562) = 18.17, p < .001$. Participants exposed to correct etiology were 1.23 times more likely to recall correct etiology than incorrect ones in their own recollections ($SE = .61$). The lack of a generation effect also lessens the likelihood that correct recollections are due to generation-based artefacts such as simplification of information.

**Effect of overall recollection accuracy.** In addition to etiology, additional elements of the vignettes were also coded for recollection accuracy (see Appendix B). For each disorder, coding consisted of participants’ accuracy in recalling the disorder name, the afflicted population information, and a maximum of six associated symptoms. Given the role of correct etiological exposure in etiological recollection, an additional model (2B) was estimated with the inclusion of overall correct recollections as a continuous predictor (centred).

This inclusion of this predictor did not show significant interaction effects with all three fixed effects, but the model itself showed significantly better fit than Model 2A [$\chi^2$ difference (1)
= 21.58, p < .001]. When all other fixed effects constant were held constant, for every 10% increase in overall accurate recollections units, the predicted correct etiological probabilities increased by .03. Though the probability increase was small, the effect was significant, \( F(1,368) = 18.25, p < .001 \). The inclusion of this new fixed effect also reduced estimates for the Etiology Type X Disorder Type interaction to marginal significance, \( F(4,368) = 2.76, p = .028 \). Simple effects revealed that the previously shown significantly higher recollection of Environmental etiology for Physiological Disorder compared to Cultural Disorder also became marginally significant (\( p = .035 \)). Given that this model’s estimates indicate changes from significant effects to marginal ones, interpretations are made with caution (see Appendix B for Model 2B summary).

**The Effects of Etiology Type, Disorder Type, and Generation on Patient Well-being Evaluations**

An empty model (Model 3) without any predictors showed that 14% of the variance in patient well-being ratings was accounted for by between-participant differences as shown by the ICC value. Next, I accounted for within-participant variation by adding within-person variation as a random intercept (Model 3A). The addition of this intercept significantly improved model fit \( [X^2 \text{ difference (1)} = 9.90, p = .002] \). The Bonferroni-corrected family-wise significance level for the two possible comparisons in the model was \( p \leq .025 \). Then, I fitted the level-2 model consisting of all interaction and main effects (Model 4). Though the model was a better fit than model 3A \( [X^2 \text{ difference (35)} = 104.10, p < .001] \), all interaction terms were not significant and were removed to improve model parsimony. As the revised main effects only model (Model 4A) was a significantly better fit than Model 3A \( [X^2 \text{ difference (7)} = 72.00, p < .001] \), it was retained
as the final model. The remaining effects in Model 4A are shown in Table 5 and are described below.

Participants’ well-being ratings were comparable for the main effects of Generation, $F(3,193) = 0.39, p = .762$, and Etiology Type, $F(2,382) = 0.86, p = .426$, but they did significantly differ based on Disorder Type, $F(2,382) = 38.35, p < .001$. Contrasts indicated that participants evaluated patients diagnosed with the Physiological Disorder ($M = 13.24, SE = .21$) most negatively compared to Psychological ($M = 15.40, SE = .21$), $t(381) = −8.24, p < .001, d = .42, 95\% CI [.32, .53]$ and compared to the Cultural Disorder ($M = 15.00, SE = .21$), $t(382) = −6.67, p < .001, d = .34, 95\% CI [.24, .44]$. Participants’ well-being evaluations did not significantly differ between Psychological and Cultural Disorder patients, $t(382) = 1.54, p = .124, d = .08, 95\% CI [.02, .18]$. 
### Table 5. *Model summary for patient well-being evaluation*

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model 3A – Intercept only</th>
<th>Model 4A – Final model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Est</td>
<td>SE</td>
</tr>
<tr>
<td><strong>Fixed effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
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<td>.14</td>
</tr>
<tr>
<td><strong>Etiology Type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genetic</td>
<td>−.28</td>
<td>.26</td>
</tr>
<tr>
<td>Environmental</td>
<td>−.31</td>
<td>.26</td>
</tr>
<tr>
<td>No Etiology (ref)</td>
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<tr>
<td><strong>Disorder Type</strong></td>
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<td></td>
</tr>
<tr>
<td>Physiological</td>
<td>−1.76</td>
<td>.26</td>
</tr>
<tr>
<td>Psychological</td>
<td>.41</td>
<td>.26</td>
</tr>
<tr>
<td>Cultural (ref)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Generation</strong></td>
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<td>.35</td>
<td>.44</td>
</tr>
<tr>
<td>2</td>
<td>−.02</td>
<td>.43</td>
</tr>
<tr>
<td>3</td>
<td>.13</td>
<td>.46</td>
</tr>
<tr>
<td>4 (ref)</td>
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<td></td>
</tr>
<tr>
<td><strong>Random effects</strong></td>
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<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>14.55 (.14)</td>
<td>1.78 (.45)</td>
</tr>
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<td>2840.50</td>
</tr>
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<td>Pseudo-$R^2$</td>
<td>-</td>
<td>.03</td>
</tr>
</tbody>
</table>

Notes: No etiology, cultural disorder, and Generation 4 were reference groups. *$p < .025$ **$p < .01$, ***$p < .005$
The Effects of Etiology Type, Disorder Type, and Generation on Social Distance

Given that the skewed residuals of the social distance outcome, the models were tested using a log-normal distribution. An empty model (Model 5) without any predictors showed that 25% of the variance in social distance ratings was accounted for by between-participant differences as shown by the ICC value. Next, within-participant variation was accounted for by adding within-person variation as a random intercept (Model 5A). The intercept significantly improved model fit [$X^2$ difference (1) = 18.95, $p < .001$]. Bonferroni-corrected family-wise significance level for the total two possible comparisons in the model was $p \leq .025$. Then, I fitted the level-2 model consisting of all interaction and main effects (Model 6). The model was a better fit than model 5A [$X^2$ difference (35) = 215.72, $p < .001$] but all interaction terms were not significant and were removed to improve model parsimony. The revised main effects only model (Model 6A) was a significantly better fit than Model 5A [$X^2$ difference (7) = 191.51, $p < .001$] and it was maintained as the final model. The remaining effects in Model 6A are shown in Table 6 and are described below.
### Table 6. Model summary for social distance desired

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model 5A – Intercept only</th>
<th>Model 6A – Final model</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Est</td>
<td>SE</td>
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<td><strong>Fixed effects</strong></td>
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<td></td>
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<tr>
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<td>.03</td>
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<tr>
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<tr>
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<tr>
<td>Pseudo-$R^2$</td>
<td>-</td>
<td>.33</td>
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Notes: No etiology, cultural disorder, and Generation 4 were reference groups. *$p < .025$  **$p < .01$*** $p < .005$
Effect of etiology type and disorder type. The main effect of Etiology Type was not significant, \(F(2,383) = 0.43, p = .651\), but the main effect of Disorder Type was significant, \(F(2,383) = 112.60, p < .001\). Contrasts showed that participants were most comfortable with their sibling dating a patient diagnosed with the Physiological Disorder \((M = 4.89, SE = .12)\) compared to Psychological \((M = 3.35, SE = .12), t(383) = 9.45, p < .001, d = .48, 95\% CI [.38, .59]\) and compared to the Cultural Disorder \((M = 2.72, SE = .12), t(383) = 14.82, p < .001, d = .76, 95\% CI [.64, .87]\). Participants were also more comfortable with their sibling dating a patient with the Psychological Disorder over the Cultural one, \(t(383) = 5.41, p < .001, d = .28, 95\% CI [.17, .38]\).

Effect of generation. Social distance desired significantly varied by Generation, \(F(3,194) = 4.50, p = .004\). Contrasts indicated participants with the most generation gap desired significantly more social distance than those in closer or adjacent ones. Generation 1’s \((M = 3.23, SE = .16)\) participants desired more social distance from patients than Generation 4’s participants \((M = 4.19, SE = .22), t(194) = −3.64, p < .001, d = .26, 95\% CI [.12, .40]\), but not between Generation 2 \((M = 3.57, SE = .16)\) and Generation 4, \(t(194) = −2.20, p = .029, d = .16, 95\% CI [.02, .30]\) All adjacent generations did not show significant differences in social distance ratings: Generations 1 and 2, \(t(194) = −1.75, p = .081, d = −.13, 95\% CI [.01, .26]\), Generations 2 and 3, \(t(194) = −0.03, p = .741, d < −.01, 95\% CI [.01, .01]\), and Generations 3 and 4 \(t(194) = −1.78, p = .076, d = .13, 95\% CI [.01, .26]\) as did Generation 1 and 3 \((M = 3.64, SE = .19), t(194) = −1.93, p = .055, d = .13, 95\% CI [.01, .28]\).

Study 1 Discussion

This study aimed to investigate a few aspects of health-related information’s transmission. Drawing on the cultural transmission framework and previous findings concerning
disorder etiology, I predicted that: (1) genetic etiology will be more accurately transmitted over generations compared to other etiologies, (2) a disorder pertaining to people from other cultures (the least self-relevant) will be devalued as reflected in recollections and patient evaluations compared to other disorders, and (3) over generations, patients will be evaluated less negatively. Contrary to our hypothesis and prior work (e.g., Green & Clémence, 2008), participants did not show a bias toward genetic etiology in transmission chains. Etiology did not significantly impact most dependent measures, only doing so for etiology recollections when combined with the framing of disorders, the strongest effects shown for disorders not paired with genetic etiology. Although the transmission and recollection of genetic etiology were both not demonstrated, this study makes an important contribution to the existing evidence concerning biased health cognition (Green & Clémence, 2008; Kim et al., 2016; Lebowitz & Ahn, 2014). In fact, this study is among the first to show how transmissions of specific elements of disorder information impact reproduction of health information and evaluations of patients.

Furthermore and consistent with the cultural evolutionary framework, participants selectively recalled and reproduced etiological information that was more self-relevant. Indeed, participants correctly recalled the etiology (or lack of one) for both Physiological and Psychological Disorders at a similar rate and were more likely to remember the etiology of these two disorders accurately compared to the disorder affecting an outgroup, the Cultural Disorder. Though the “no etiology” served as a control group in the study, it had the strongest effect when presented with a Psychological Disorder compared to the Cultural one. In this instance, participants were possibly more concerned with remembering features of the Psychological Disorder, the more self-relevant disorder, compared to Cultural Disorder. Thus, even though no etiology was provided, participants were better able to recall placeholder information (e.g.,
“recommended for further research”) over genetic or environmental etiologies. Similarly, participants desired more social distance from the less self-relevant Cultural Disorder patients and rated their condition as being less serious compared to the other two conditions. Taken together, a disorder framed as affecting an outgroup could lead to reduced attention, which results in less reproduction of information, and more negative evaluations compared to one that is self-relevant.

Although the results of the present study did not reveal any generation-based transmission effects, contrary to most prior research (Green & Clémence, 2008; Whiten, Caldwell, & Mesoudi, 2017), the findings highlight the need for more structured and standardised replications in the area of cultural transmission. As expected for this study, first generation participants, who had access to complete information, showed more accurate etiology recollection than the last generation. Additional analysis indicated that variability in correct etiological recollection was better accounted for by exposure to correct etiology than generational position, eliminating potential confounds resulting from transmission-based artefacts. These results imply that rather than genetic information itself being adaptive, participants may also be guided by their own intuitions and evaluations concerning the different etiological information itself. Consequently, without indicators that participants should prioritise one type of information over the other, there were likely participant-level factors that better account for their recollections than generational position itself.

The generational effect also influenced participants’ social distance ratings. Earlier generation participants desired more social distance from patients (regardless of disorder and etiology) compared to later generations. In this lab-base study, it took up to three generations before health cognitions significantly changed. This finding parallels ideas of the cultural
transmission framework, where attitudes or norms do not necessarily change significantly one
generation to the next (Richerson & Boyd, 1999). Instead, norms or social cognitions relevant to
one’s environmental challenges are deeply embedded, such that it can take several generations
before they show significant and meaningful changes (Haslam, 2006). Less optimistically, these
findings imply that incorrect health information significantly decreases the rate at which correct
etiology is transmitted. In certain environments, threats posed by misinformation may not be as
explicit (Acerbi, 2016) compared to high-threat ones such as during a pandemic (Beall et al.,
2016; Oluwafemi, Gabarron, & Wynn, 2014) or our ancestors’ environments. Thus, participants
in the study may be less concerned about the transmission of misinformation in general.

The most substantial finding in this study is that disorder type or framing of disorders
significantly impacted etiological recollections and patient evaluations. Where past randomised
experiments have demonstrated the critical role of etiology for familiar health-related conditions
(Dar-Nimrod, Zuckerman, & Duberstein, 2014; Dar-Nimrod et al., 2013; Mills, Dar-Nimrod, &
Colagiuri, 2017), the current study provides a more nuanced understanding about the elements
that may affect transmission and evaluation of health information. Past research indicates that
 genetic attributions lead to less favourable prognosis (Lebowitz & Ahn, 2014; Phelan, Cruz-
rojas, & Reiff, 2002), but also lead to increased tolerance and sympathy toward patients (Phelan,
2005; Phelan et al., 2002), due to perceived attenuation of patient’s responsibility in having such
a health condition (Weiner, 1988). However, the present study showed that for patient
evaluations, information concerning the disorder itself might supersede etiological perceptions.
Further studies could examine the likelihood of etiological information selection and
transmission when a person of authority (e.g., doctor or scientist), compared to a non-
professional like Angelina Jolie, conveys health and genetic information.
Limitations and Future Directions

What the current research makes clear is the potential benefit of examining genetic essentialist thinking as an adaptive response with not just genetic information, but also its health- or disorder-related components. Unfortunately, I was not able to assess the stability of transmission of these different components, so there is no certainty that the disorder-related effects were not a function of information decay. This is an important limitation of the research, which we had attempted to account for with the additional analyses of exposure to correct etiological information, but one that needs to be highlighted, given the lack of standardised protocols for transmission-based studies (see Mesoudi & Whiten, 2008).

Another limitation is that the study included a cultural disorder to examine the role of folk knowledge in evaluations of disorder etiology; however, the particular cultural disorder used may have elicited negative responses by the mere fact of being exclusive to an outgroup population, while no targeted population was named for the other disorders. Future studies can consider whether disease population information (e.g., “exclusive to East Africa”) lead to more essentialised or negative views of those diseases and afflicted population, given prior work suggesting that genetic essentialist tendencies influence perceptions of outgroups (Williams & Eberhardt, 2008). Finally, the study used vignettes as primary stimuli, which may be considered artificial, but they were similar to stimuli used in previous research (Kim et al., 2016; Lebowitz & Ahn, 2014). Future work should explore the possibility of artificial, lab-based cultural transmission studies not tapping into essentialist responses the same way it would in transmissions in challenging environments.

I also contend that with the current design (and designs of prior studies), the effect of new information exposure is an unexamined element. Any additional information learnt in a brief
time needs to be simple enough for more natural assimilation into existing structures (Williams & Lombrozo, 2010), while being adaptive and easy to acquire. For example, given the distance between the disorder-susceptible outgroup depicted in the cultural disorder (East Africans) and the participants’ sample (East Australians), a health threat from a disorder-susceptible outgroup closer to home - one which participants may have more knowledge about - could result in more extreme social distance ratings. Further investigation into how existing individual-level knowledge structures impact evaluations of the less self-relevant, cultural disorder can help in understanding whether outgroup health information is less adaptive for one’s own needs.

Conclusions

The study provides initial evidence for the usefulness of integrating macro-level, evolutionary notions into studying micro-level, psychological processes. For most parts, laypeople evaluate disorders independent of their etiology, parallel to other works suggesting that specific causal features of the disorder are one of many aspects that a person usually considers in their health cognition (Kim & Ahn, 2002; Kim et al., 2016). From the aspects evaluated in the current study, one that seems to influence health knowledge and health cognition consistently is the framing of disorder as affecting an outgroup.

Thus, the transmission of health knowledge is dynamic and multi-layered, encompassing information on characteristics, causes, and self-relevance. The transmission and transformation of information through social networks allows many pathways to be formed as seen in the transmission of misinformation via social media during critical health epidemics (Kim, 2015; Oluwafemi et al., 2014) and as shown in the results of the present study. Biased selection, encoding, and reproduction of health information creates hurdles for fast treatment and recognition of critical patients (Dovidio & Fiske, 2012), and influence health-related cognition
concerning diagnosed patients (Green & Clémence, 2008; Jorm & Oh, 2009). Further exploration of individual factors influencing the transmission chains and subsequent reproduction of lay health knowledge is necessary for the implementation of measures that ensure ease of understanding, especially since health information is susceptible to changes in networks. This premise is explored in Chapter 3.
Chapter 3: Social Transmission of Health Information.

Introduction

Many folklores have common features, shared by various groups around the world (e.g., talking animals, dangerous predators, and listening to one’s elders; Tehrani, 2013). The essential elements of these stories may remain, but over time, differences arise due to local contextual factors, such as talking animals specific to a local species (Tehrani, 2013). These shared elements also indicate that humans are likely biased to specific kinds of content, where they pay attention to, transmit, and retain specific types of information (Broesch et al., 2014). Specific content types are likely preferred because they consume less cognitive resources – resources that are needed for more pressing decisions. Ideas that elicit strong emotions (e.g., disgust), and provide vital social information, are memorable, which also makes them more “culturally contagious” (Broesch et al., 2014; Heath, Bell, & Sternberg, 2001; Norenzayan et al., 2016). This acquisition and morphing of information through intergenerational transmission, in a broken telephone (or Chinese whispers) fashion, extends beyond folklore into areas that have immediate real-world outcomes, such as in the context of health and diseases.

In line with the cultural evolution framework, the social transmission of health information, particularly among laypeople, influence people’s own biases and beliefs related to those conditions. For example, at the height of the AIDS epidemic in the 1980s and 1990s, the disease was almost exclusively associated with gay men (Altman, 1982), which perpetuated cultural stigma for an already marginalised group. These biased narratives concerning particular disorders can impact social cognitions concerning diagnosed patients, such as gay men being more blame-worthy than heterosexual men for contracting AIDS (Anderson, 1992).
For less divisive diseases, social transmissions have both negative and positive effects, particularly in online information transmission. For example, bogus or incorrect information is more likely to spread online than information that is correct (Vosoughi, Roy, & Aral, 2018). This spread hinders public health advancements as shown in the rampant misinformation in the anti-vaccine movement (Kata, 2012). On the other hand, the transmission of information through social media has demonstrated some effectiveness in certain situations such as viral dissemination of information related to public health campaigns (Gosselin & Poitras, 2008) and support for specific health conditions (Shaw & Johnson, 2011). For instance, certain presentation styles (e.g., a blog format) or framing (e.g., a genetic cause) are more likely to affect health-related behaviours over others (Dar-Nimrod, Cheung, et al., 2014; Knobloch-Westerwick, Johnson, & Westerwick, 2013; Smith, Zhu, & Fink, 2017; Stavrositu & Kim, 2015).

In social transmission situations, a person choosing to share or transmit information may evaluate their own worldview as well as the social consequences of sharing that health information (Scholz et al., 2017). In such a situation, a well-intentioned person may tweet misinformation about vaccinations because they believe it is essential for others to know, but also because the information reinforces their own worldview. Thus, an individual who is sharing information is also attempting to share their social and cultural reality with people within their network (Kashima, Bratanova, & Peters, 2018). As with folklores, the messenger believes this information is vital for another to better face challenges in their environments (whether physical or digital). These environmental challenges may be better faced with causal information on health conditions. In such situations, the origins of health conditions provide important health and social information (Broesch et al., 2014), such as whether a group of people wishes to welcome a stranger from an unknown land to share their food.
Based on the notion that social (and health) information that is relevant for facing challenges in one’s environment is more likely retained over generations (Mesoudi et al., 2006), we examine the moderating role of perceived vulnerability to diseases. Prior work underscores the importance of individuals’ beliefs that they are vulnerable to infectious diseases as influencing factors in health cognition (Curtis, De Barra, & Aunger, 2011; Duncan, Schaller, & Park, 2009). Threats of illness have been linked to higher incidences of diseases-relevant responses, particularly through avoidance and feelings of disgust (Murray & Schaller, 2012; Schaller & Park, 2011). Such evidence raises the possibility that individuals’ beliefs about diseases could affect the extent to which these disease-relevant responses are shown.

Thus, the present study aims to further understanding of how social transmission of disorder-related information influences content-specific recollections and social assessments of individuals diagnosed with those disorders. Fictitious health conditions were chosen as the main topic of message transmission as socially-relevant issues such as gender or a well-known disease are generally more polarising, which impact how the messages are transmitted within social networks (Brady, Wills, Jost, Tucker, & Van Bavel, 2017). I also consider how beliefs held by individuals in this transmission - perceived vulnerability to diseases (PVD) – influences their desired social distance and feelings of disgust with regards to the patients.

The majority of the studies (e.g., Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015; Vosoughi et al., 2018) involved in the examination of health information transmission are large-scale research (see Lewandowsky, Ecker, & Cook, 2017, for a review). I attempt to unpack the broader dynamics involved in the social transmission of health information by focusing specifically on a specific element of content - disorder etiological information. Furthermore, past studies (see Whiten et al., 2016, for a review) have examined the transmission of socially-
relevant information such as stereotypes (Lyons & Kashima, 2006), identification of dangerous animals (Broesch et al., 2014), complex cultural information (Muthukrishna, Shulman, Vasilescu, & Henrich, 2014) or genetic causal information (Green & Clémence, 2008), but the information utilised in the studies is highly susceptible to loss, decay, and noise, as in a real-life broken telephone game (Griffiths, Lewandowsky, & Kalish, 2013; Truskanov & Prat, 2018). I aim to minimise the effects of such a loss in a social transmission experiment, by only replacing key aspects of health-related narratives. In this way, the larger “narrative” concerning a particular disorder remains the same for each participant in a transmission line, but specific parts of the disorder (e.g., etiology) may change depending on the information transmission. This method also provides a more controlled way to examine the micro-evolution of disorder-related information, complimenting existing works that have examined the macro-evolution.

Study 1 focused on identifying whether specific types of health-related information, namely genetic information, is preferentially transmitted (albeit non-significant effects). Study 2 aimed to address potential design and power issues by (1) using a between-subjects design to ensure there was no exposure to other etiologies (2) increasing the number of individuals in each generation (3) removing the need for open-ended coding. Thus, the number of generations is also reduced to 3, given that in Study 1, the effects between Generations 3 and 4 were comparable. Furthermore, contrasting a between-subjects design with a within-subjects one helps with making generalisations across design types (Lakens, 2013).

Thus, the present study tested whether participants showed preferential recollections of genetic etiology over environmental etiology in a community sample. Participants in Generation 1 were exposed to the original version of the vignettes, whereas participants in Generation 2 were exposed to modified versions, based on responses of Generation 1. Participants in
Generation 3 were exposed to the modified versions based on responses of Generation 2 participants. I focused on transmission fidelity (i.e., the amount of correct information transmitted) of the etiological accounts. To ensure the amount of information transmitted is comparable across groups, the original vignettes were modified (based on participants’ responses) by only replacing key phrases. After each vignette, participants evaluated a diagnosed patient on social distance and disgust measures.

It was hypothesised that participants would retain and transmit more information on genetic etiology compared to environmental etiology over generations, across both disorder types. A two-way interaction of Generation and Disorder Type on patient evaluations was expected to be moderated by perceived vulnerability to disease (PVD) such that individuals who rate higher on PVD will make more negative evaluations of the patient.

**Study 2 Methods**

Before data collection, an a priori power analysis for the studies was conducted, pre-registered on the Open Science Framework (https://osf.io/gjku8). An institutional ethics committee approved all procedures. Due to an unexpected change in access to the undergraduate participant pool, the undergraduate sample included in the pre-registration comprised of a smaller sample of individuals. Thus, the social transmission method is not used in this study, and the data are reported in Appendix C as Study 2a. Furthermore, the pre-registration document contained initial hypotheses on a measure of social dominance orientation. Based on the time taken by the undergraduate sample in Study 2a and in the interest of conducting a more parsimonious study, participants did not complete the social dominance orientation measure in Study 2. Furthermore, prior to analyses – to ensure a more streamlined approach in answering the main research questions (which involve recollection, disgust, and social distance) and for
adequate power to analyse the main data, the ratings for treatment outcomes, likelihood of inheritance, control of condition, access to treatment, and level of danger were considered as filler questions.

**Participants**

Participants were recruited via TurkPrime (Litman, Robinson, & Abberbock, 2017), using the Mechanical Turk platform. Participation was limited to U.S. residents, with at least 5000 HITs approved, and an approval rate of over 97%, for which they were compensated with USD$2.00. The study consisted of 299 participants (158 men, 141 women, $M_{age} = 40.96$ years, $SD = 11.70$, range = 21 – 73 years), who identified as European/White (238), African American (24), Mixed ethnicity (9), Northeast Asian (8), Hispanic/Latinx (7), Native American/Alaska Native (3), Southeast Asian (4), Middle Eastern/North African (2), South/Central Asian (1), and Other or unreported (3). Most participants were born in the U.S. (291) and had lived in the U.S. for more than five years (297). The average attrition rate across generations was 8.5%.

**Materials and Measures**

**Vignettes.** Participants were exposed to a set of three vignettes describing one of the four fictitious health conditions (adapted from Kim & Ahn, 2002): a Physiological Disorder with Genetic Etiology, a Physiological Disorder with Environmental Etiology, a Psychological Disorder with Genetic Etiology, and a Psychological Disorder with Environmental Etiology. Each disorder within the vignette set had a unique name, symptoms, and afflicted population. For example, one of the physiological disorders was characterised as a condition that causes vision loss, whereas a psychological disorder was described using symptoms such as anxiety, mild obsession, and nightmares. Both disorder types were described as either having a genetic
etiology (e.g., abnormality of spatial structure of genetic code) or an environmental etiology (e.g., infection from parasites in untreated water).

**Social distance.** As a measure of social distance desired (adapted from Bogardus, 1933), participants rated their willingness to engage with a particular diagnosed patient in various social situations using six items (e.g., *Spend an evening socializing with John* or *Share a meal with John*), on a 7-point Likert scale (1 – *definitely not*, 7 – *definitely will*). A lower score is indicative of more social distance desired (α = .97).

**Disgust.** Participants rated how much disgust or repugnance they would experience when engaging with a diagnosed patient using four items (e.g., *Sit next to John on a 10-hour flight*), on a 5-point Likert scale (0 – *No disgust or repugnance at all*, 4 – *Extreme disgust or repugnance*). A lower score is indicative of lower disgust ratings (α = .94; adapted from Bogardus, 1933).

**Perceived vulnerability of diseases (PVD; Duncan et al., 2009).** Participants completed a 15-item scale measuring their perceived susceptibility to infectious diseases with items such as “*In general, I am very susceptible to colds, flu, and other infectious diseases.*” They rated the items using a 7-point Likert scale (1 – *strongly disagree*, 7 – *strongly agree*), with higher scores indicating higher perceived vulnerability of diseases (α = .80).

**Procedure**

Participants were directed to a Qualtrics webpage. There, they were presented with details of the study and provided informed consent. Then, participants were provided with a language-check question to ascertain that they are aware that English proficiency is a requirement for the study.

The following is the procedure for the first generation of participants. Participants were randomly assigned to one of the four vignette sets, with each set consisting of two vignettes for
the first generation. After reading the vignette and moving to the next screen, participants completed the multiple-choice recognition question consisting of 21 options (see details below). Next, they completed the patient evaluation items as well as the patient social distance and feelings of disgust measures followed by the second vignette in an identical fashion to the first. The order of the vignettes was randomised. After all the vignettes were completed, participants completed the PVD scale, attention checks, and the demographic items. Finally, participants were provided an open-ended feedback box and were debriefed on the true purpose of the study.\textsuperscript{1}

\textbf{Transmission method.} The social transmission method was implemented by using the multiple-choice responses of the first-generation’s participants to replace key points in the original form of the vignette. Participants’ responses, whether correct or incorrect, were used as replacements to ensure standardised forms of transmission. For example, the etiological information for a Genetic-Physiological Disorder was characterised as “…a condition caused by mutations in four different genes.” In the multiple-choice responses, participants had three incorrect choices related to etiology (e.g., \textit{caused by mutations in a single gene}) in addition to the one correct choice. If participants made an incorrect choice, the related sentence was replaced with this incorrect information (e.g., … \textit{a condition caused by mutations in a single gene}). After modifying these key phrases in all first-generation participants’ vignettes, each participant in the second generation randomly received one of the first-generation’s participants’ responses. This random assignment ensured that each participants’ response is only seen by one other participant in the subsequent generation. This process was repeated for the third and final generation by replacing the second-generation’s vignettes with the responses of the second-generation’s

\textsuperscript{1} Generation 1 participants of Study 2 initially included three vignettes. Due to an instrumentation issue, the third vignette was omitted in the second and third generations and excluded from the overall analyses.
participants. All multiple-choice answer options remained the same for all three generations. The original vignettes and a sample of responses from one transmission line are provided in Appendix D.

**Computing Correct Etiological Recollections**

Overall, each of the two vignettes had seven correct and 14 incorrect multiple-choice options for all elements (see Appendix D for examples). Of those options, four were associated with disorder etiology – one correct choice and three incorrect choices – the main element examined in this study. Participants were given 1 point for each instance when they (1) selected of correct etiology choice and (2) had not selected incorrect etiology choices. Participants who had selected the correct choice or selected the incorrect choices were given a 0 for each error instance. Across the two vignettes, participants were able to get a maximum score of eight correct etiological recollections. Participants’ overall correct etiological recollection ratios were determined by their total number of correct responses relative to this maximum score of eight.

**Results**

**Data Management and Analytic Strategy**

**Transmission chains.** Participants were randomly assigned to a previous generations’ recollections without replacement, such that each participant’s response is only seen by one other participant in the subsequent generation. However, the 8.5% attrition rate meant that some participants had already been randomly assigned to a previous generation response but did not complete it. This attrition resulted in some previous generation responses being assigned twice. To account for this potential dependency in data, the transmission chains that participants belonged to was included as a random intercept in the model.
Analytic strategy. There were three separate models for the three dependent variables: (1) percentage correct on etiological recollection (out of eight possible correct recollections), (2) social distance desired, and (3) feelings of disgust. The first dependent variable, bounded between 0 and 1, was analysed using a generalised mixed model with a logit link function and a binomial conditional outcome distribution (see Rice, Tomblin, Hoffman, Richman, & Marquis, 2004). The second and third dependent variables were continuous outcomes modelled using generalised linear models with PVD as a moderator. Normality in residual distribution for models was assessed by scatter and Quantile-Quantile plots. No extreme outliers were found for both continuous outcomes but showed skewed residuals. Thus, the models were tested with a log-normal distribution.

For each dependent variable, the combined effects of Disorder Type (between-subjects; Genetic-Physiological, Environmental-Physiological, Genetic-Psychological, and Environmental-Psychological), and Generation (between-subjects; 1, 2, and 3) was examined. All p-values for the main analyses are reported after applying the Bonferroni-correction. All analyses were performed using PROC GLIMMIX and PROC MIXED in SAS 9.4 for Windows (SAS Institute Inc., 2017). Effect size estimations for the simple effects were conducted using odds ratio (OR) for the binomial outcome and Cohen’s d for the two continuous outcomes (Lakens, 2013).

Preliminary Analyses

Correlations. First, the correlations between perceived vulnerability to diseases (PVD) ratings, social distance, and feelings of disgust were examined. Participants who perceived themselves as being more vulnerable to diseases desired more social distance from the patient, \( r(297) = -.22, p < .001 \), and reported higher feelings of disgust, \( r(299) = .16, p = .005 \).
Participants who rated a diagnosed patient as eliciting more feelings of disgust also desired more social distance, $r(297) = -.28, p < .001$.

**Vignette versions.** As each participant was exposed to two vignettes characterising the same disorder type, I first examined whether including Vignette Version as a within-subject factor in the three models influenced the three dependent measures. Across all three dependent measures, the only significant effect was the main effect of Vignette Version on social distance ratings, $F(1,572) = 5.40, p = .021$, where participants desired more social distance from patients in the Vignette Version 2 ($M = 30.38, SE = .54$) over Version 1 ($M = 32.17, SE = .55$). As the inclusion of Vignette Version into the model did not change the reported findings for social distance ratings, this within-subject factor was omitted from all models reported.

**Etiological Recollection**

Based on the generalised mixed model, the main effect of Generation was significant, $F(2,287) = 15.81, p < .001$. Participants in Generation 1 were significantly more likely to recall accurate etiology than Generation 2, $t(287) = 4.54, p < .001$, $OR = 1.77, 95\% CI [1.38, 2.26]$ and Generation 3, $t(287) = 5.35, p < .001$, $OR = 1.95, 95\% CI [1.52, 2.45]$ (see Figure 1). However, there was no significant difference between the etiological recollections of Generations 2 and 3, $t(287) = 0.85, p = .395$, $OR = 1.10, 95\% CI [0.88, 1.38]$. 
The main effect of Disorder Type was also significant, $F(3,287) = 9.63, p < .001$. Simple effects indicated that participants exposed to the Genetic-Physiological Disorder showed lower etiological recollections probabilities than those exposed to Genetic-Psychological Disorder, $t(284) = −3.95, p < .001, OR = 0.58, 95\% CI [0.45, 0.77]$ (see Figure 2). Participants were also significantly less likely to correctly recall etiologies of Genetic-Physiological Disorder compared to both Environmental-Physiological Disorder, $t(284) = −4.60, p < .001, OR = 0.52, 95\% CI [0.39, 0.69]$, and Environmental-Psychological Disorder, $t(284) = −3.02, p = .017, OR = 0.67, 95\% CI [0.51, 0.87]$. The interaction effect between Generation and Disorder Type was not significant, $F(6,287) = 0.26, p = .956$. Means and standard errors for the two main effects are reported in Table 7.
Figure 2. Correct etiological recollection probabilities (with 95% confidence intervals) across Disorder Type.
Table 7. Mean and standard errors for main effects of Disorder Type and Generation

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<th>Variable</th>
<th>Proportion of Etiological Recollection Mean (SE&lt;sub&gt;mean&lt;/sub&gt;)</th>
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<td>.79 (.02)</td>
<td>31.82 (.98)</td>
<td>6.42 (.47)</td>
</tr>
<tr>
<td>Genetic – Psychological Disorder</td>
<td>.81 (.02)</td>
<td>29.44 (1.05)</td>
<td>3.53 (.51)</td>
</tr>
<tr>
<td>Environmental – Psychological Disorder</td>
<td>.77 (.02)</td>
<td>28.33 (.98)</td>
<td>5.21 (.48)</td>
</tr>
<tr>
<td><strong>Generation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.83 (.02)</td>
<td>30.90 (.87)</td>
<td>5.14 (.42)</td>
</tr>
<tr>
<td>2</td>
<td>.74 (.02)</td>
<td>30.40 (.97)</td>
<td>5.03 (.42)</td>
</tr>
<tr>
<td>3</td>
<td>.72 (.02)</td>
<td>32.48 (.88)</td>
<td>4.16 (.43)</td>
</tr>
</tbody>
</table>

Note: <sup>a</sup>Higher score is indicative less social distance desired. <sup>b</sup>Higher score is indicative of more feelings of disgust.

**Social Distance**

Based on the results of the generalised linear model, participants’ social distance ratings were significantly influenced by Disorder Type, $F(3,285) = 6.26$, $p < .001$ (see Table 7).

Participants desired more social distance from a Genetic-Psychological patient, $t(285) = 2.95$, $p = .021$, $d = 0.50$, 95% CI [0.16, 0.83] and an Environmental-Psychological patient, $t(286) = 4.16$, $p < .001$, $d = 0.68$, 95% CI [0.36, 1.01] compared to a Genetic-Physiological patient. All other simple effects were non-significant. Both the main effect of Generation, $F(2,285) = 1.74$, $p = .178$, and interaction of Disorder Type and Generation, $F(6,285) = 0.16$, $p = .987$, were non-
significant. Perceived vulnerability to diseases did not significantly moderate the two-way interaction of Disorder Type and Generation, \( F(6,273) = 1.68, p = .127 \).

**Feelings of Disgust**

Based on the results of the generalised linear model, the main effect of Disorder Type had a significant effect on disgust ratings, \( F(3,287) = 6.09, p < .001 \). Participants rated Environmental-Physiological Disorder as more disgusting than Genetic-Physiological Disorder, \( t(287) = -3.51, p = .003, d = 0.50, 95\% CI [0.27, 0.89] \). Furthermore, participants rated the Environmental-Physiological Disorder as more disgusting than the Genetic-Psychological one, \( t(287) = 4.18, p < .001, d = 0.68, 95\% CI [0.36, 1.01] \). All other simple effects were non-significant. Both the main effect of Generation, \( F(2,287) = 0.48, p = .617 \), and the interaction of Disorder Type and Generation, \( F(6,287) = 0.59, p = .742 \), were non-significant. Perceived vulnerability to diseases did not significantly moderate the two-way interaction of Disorder Type and Generation, \( F(6,275) = 1.34, p = .238 \).

**Study 2 Discussion**

The study examined whether participants’ recollections of disorder etiology and social evaluations of diagnosed patients is influenced by the type of disorder they were exposed to and their generational position in a social transmission chain. In a community sample, participants showed the highest number of accurate recollections for genetic etiology when it was associated with a psychological disorder, but lowest for genetic etiology paired with a physiological disorder. The recollection of both disorders with environmental etiology was comparable. Contrary to prior work and our hypothesis, participants showed greater recollection accuracy for genetic etiology only when paired with a psychological disorder (an effect only significant relative to the other genetic disorder - genetic-physiological disorder). Those exposed to the
disorders with an environmental cause were also more likely to recall the etiology accurately compared with individuals in the genetic-physiological disorder condition. Although the effect of vignette type on etiological recollections was small, the study makes an important contribution to the existing evidence concerning the social transmission of etiological information.

Furthermore, participants desired significantly more social distance from a patient diagnosed with a psychological disorder (regardless of etiology) than a genetic-physiological one. Because symptoms associated with psychological disorders are often more threatening (e.g., aggression, unpredictability) compared to physiological disorders, they may elicit more negative responses. This effect did not occur when the physiological disorder was explained by environmental causes, potentially indicating that participants want to distance themselves from a person whose environment gives rise to a disorder – as a way of managing a potential threat in one’s own environment. This possibility is further supported by previous works (Beall et al., 2016; Murray & Schaller, 2012; Schaller & Park, 2011) as well as the present study’s findings on feelings of disgust; participants rated an environmental-physiological disorder more disgusting than a genetic-psychological one.

These social evaluations of patients further varied by disorder features; participants did not show a significant desire for social distance in the comparisons between both genetic disorders with an environmental-physiological disorder, but rated it as more disgust-inducing than the two genetic disorders. The contrasting patient evaluations based on etiological and disorder information suggest that when assessing social distance, participants may have relied on multiple disorder-based features, as psychological disorders were rated the highest on social distance desired, regardless of their etiology. When assessing feelings of disgust, participants may have been concerned with infectiousness and made their evaluations based on the etiology.
Additionally, and contrary to the hypothesis regarding the moderating effect of individual characteristics, results indicated a non-significant association between perceived vulnerability to diseases and both social distance and disgust ratings. The findings suggest that environmental etiologies are more self-relevant than genetic etiologies, particularly in situations where there are no imminent threats. Genetic etiologies, if interpreted as familial, is more relevant to the patient in the vignette, unlike environmental etiologies which are infectious and relevant to the participants in this study. However, given that these effects did not vary by levels of perceived vulnerability, it is likely that participants did not view the information as being self-relevant overall or directly related to facing environmental challenges. On a positive note, the present study shows that at least one form of the disorder, genetic-psychological, may be less susceptible to the incorporation of etiological inaccuracies.

Assessing the effects of Generation, participants in Generation 1, who read the unmodified source material, recalled the most accurate etiology compared to Generation 2 and 3, but these effects did not vary across Disorder Type. The findings suggest that participants without exposure to the source material and without opportunities to verify information may transmit erroneous as well as accurate health information. The lack of a difference in correct etiological recollections between Generations 2 and 3 (despite receiving a comparable amount of information), may indicate that in social transmissions, more intuitive information is more likely to be passed on. In such a situation, the information is evaluated for its plausibility, and these highly-plausible aspects may be transmitted with more fidelity (Miton & Mercier, 2015). Therefore, after the initial errors made by Generation 1, the transmitted information does not significantly change because the information selected by Generation 1 participants is likely more intuitive (but not necessarily more accurate), requiring fewer changes over time.
Understanding this intuition-based transmission further has the potential to disentangle more complex questions in the area of health information transmission, particularly in why misinformation is transmitted alongside accurate information. For example, because vaccination or the act of injecting oneself with a foreign body to protect against disease, is a counter-intuitive task, anti-vaccine beliefs are likely to spread because it is the more intuitive counterpart (Miton & Mercier, 2015). The shared beliefs of those who are anti-vaccine (e.g., vaccines have contaminants or have side effects) centre on the effects of being injecting that foreign body, thus increasing the potential for transmission of misinformation concerning vaccines (Miton & Mercier, 2015).

To address these issues outside the lab, examining the role of experts such as clinicians and health professionals in the transmission process is a necessary next step, mainly because experts themselves have etiology-based biases in health information transmission (e.g., Lebowitz & Ahn, 2014). Content and contextual factors related to the expert can also influence how the audience receives health messages. The audience better receives messages from experts who use accessible language (Zimmermann & Jucks, 2018) or signal their expertise in online comments (Kareklas, Muehling, & Weber, 2015). Thus, the role of experts in improving transmission fidelity by strategically being placed in communication chains at specific intervals may provide potential avenues to counteract continual transmission of health-related misinformation.

The present study is limited by the use of an artificial, non-interacting transmission method. The purpose of this method in the study was twofold. First, this transmission method minimises additional loss of information, a common effect in transmission-based studies (Griffiths et al., 2013) as well as in real-life communications. Minimising information loss enabled us to focus on the types of content biases that are transmitted and how they influence
social cognition concerning afflicted individuals. Second, though the participants did not have any social interactions with the individuals on the same transmission chain, the lack of interactions between participants reduced the effects of potential contextual factors, such as physical and social attributes of the communicator, which often influence receptiveness of health information. In the real world, both these aspects are likely intermingled in social transmissions (Broesch et al., 2014), but the purpose of the study was to tease apart and examine content-specific biases. However, the artificiality of the design may have weakened the extent to which individual beliefs influenced social evaluations. Future research can extend the present study to a behavioural experiment, where individuals’ recollections and evaluations of patients are assessed, while potentially being exposed to cues alluding to the presence of infectious pathogens within the lab (see Schaller & Park, 2011).

In sum, the present study tentatively provides evidence for how unpacking the transmission of health information has the potential to add nuances to understanding their function in facing challenges in one’s environment. Since individuals may have specific content biases in the processing and transmitting of health information, measures need to be placed (Lewandowsky et al., 2017) to ensure the accurate transmission of specific kinds of information that are more susceptible to errors (e.g., information on genetic-physiological disorders). Social information, whether orally-transmitted folklore or online-transmitted scientific information, influence cultural narratives and are influenced by them (Mesoudi et al., 2006), which makes the high fidelity transmission of health information a vital avenue to continue exploring for both academics and practitioners alike.
Summary of Part I

Across two studies, in which Study 1 used open recollections and Study 2 used recognition recollections, the transmission of etiological information was primarily influenced by the disorder type rather than etiology types. The overlap in findings across the two studies also extends to social distance ratings. Undergraduates in Study 1 and community members in Study 2 both desired more social distance from patients with psychological disorders than a physiological one. The two studies diverged on other findings. In Study 1, the generational effect was shown only for correct etiological information recalled and social distance ratings such that individuals in earlier generations, who had more information about patients, had higher recollections and desired more social distance. In Study 2, when the amount of information loss was controlled for, no generational effect was shown for correct etiological recollections or social distance ratings. The role played by health information complexity in social learning and cultural transmission, particularly at the micro-level, may explain these diverging findings.

Genetics as a disorder’s etiology, in itself, is a complicated idea for laypeople and non-geneticists to understand. In the context of health cognition, the information that is easier to understand - disorder features - stands out as the more critical content bias. These findings raise some intriguing prospect for the study of genetic essentialist cognition in the context of health, which is discussed more fully in the General Discussion.

On the other hand, Study 1 and 2 contradict much of the significant findings in previous research utilising the generational learning paradigm with vignette-based social information. Quite conceivably, predispositions of social information may not extend to all types, and certain knowledge structures involving out-groups (Green & Clémence, 2008; Lee, Gelfand, & Kashima, 2014; Lyons & Kashima, 2003) is more intuitive for the cultural transmission process.
Alternatively, a cursory look at the studies reviewed in Chapter 2 and 3 suggests high variability in designs and number of individuals in transmission chains. Studies 1 and 2 were drawn from much larger samples (189 participants across four generations and 299 participants across three generations) compared to previous transmission studies (ranging from 50 participants across five generations to 169 across four generations). These differences in transmission chain compositions should, in theory, result in some small or non-significant effects. Future pre-registered replications, with standardised transmission chain compositions, should help verify the validity of the transmission effects.

In Part II of this thesis, I examine another content bias – gender essentialist cognition – to understand further its role in social cognitions contributing to gender inequality. Given the wealth of research addressing the evolutionary origins of gender inequalities, a more specific focus is necessary for the review of the literature. In Part I, I briefly raised the importance of examining the interaction between content and context biases. For example, the content of celebrity’s op-eds can potentially bias the type of information that is remembered and transmitted. The characteristics of the celebrity, such as their prestige, status, or popularity, are also equally essential in the transmission process. Both these biases, together, play significant roles in shaping the way people make use of their social worlds to face challenges (whether evolutionary or developmental) in their environments.

Thus, in Part II of this thesis, I examine the interaction between social status as a context bias and gender essentialist cognition as a content bias in their contributions to gender unequal outcomes. Given the prominent role of social status in the transmission of cultural narratives regards to gender, I extend the review to assess the role of gender system justification – a power-
based manifestation of gender essentialist cognition - a social process that is fundamental to cultural evolution - social learning.
Part II: Application of Essentialist Beliefs in Understanding Gender Inequality

Chapter 4: The Roles of Gender Essentialism and Social Status in the Maintenance of Gender Inequality

Approximately two million years ago, early humans had a rudimentary conceptualisation of social categories such as gender (Kuhn & Stiner, 2006; Kurzban, Tooby, & Cosmides, 2001). Throughout our evolutionary history, sex-based categories served essential functions in behavioural outcomes such as who will nurse an infant and who will hunt for food (Lieberman, Oum, & Kurzban, 2008). Prehistoric humans, during a time before the settlement- and agriculture-based societies emerged (i.e., pre-Neolithic Revolution), primarily consisted of hunter-gatherer bands. Scholars suggest that men were motivated most often to secure a highly-valued woman (i.e., young and fertile) as a mate by being a capable hunter and providing her and her children with sustenance and protection (Gurven & Hill, 2009; Hopcorft, 2016). Women, who spent lengthy periods in pregnancy and nursing, are suggested to have been prized by these highly-skilled hunters for their domestic and childcare skills (Bliege Bird & Codding, 2015). Women also showed more inclination to engage in foraging activities than hunting, which suited theirs and their offspring’s physical constraints (Smith, 2013; Wood & Eagly, 2012). This interaction of men as hunters and women as foragers, at a fundamental level, served as a mutually beneficial system facilitating the survival of offspring.

Just like our ancestors, in most modern-day societies, gender remains deeply entrenched (Lieberman et al., 2008; McGinn & Oh, 2017). Children as young as ten months show some ability to discern gender (Martin & Ruble, 2010), and by 18 months, children show increasing self-awareness and express basic gender identity formation (Martin & Ruble, 2010). By age two, children have some rudimentary forms of gender stereotypes (Mackie, Hamilton, Susskind, &
Rosselli, 1996; Martin, Ruble, & Szkrybalo, 2002). Moreover, gender continues to play a significant role in our social world beyond childhood into adolescence (Bjarnason & Hjalmsdottir, 2008; Ellemers, 2018), even to the extent of grouping individuals by gender when the situation does not call for it (Ito & Urland, 2003).

Given the central role of gendered division of labour in modern-day research on gender inequality, we review evidence that situates gender in the context of the historical and present-day division of labour and social hierarchies. Whereas thoughtful scholarly works touch on the roles of division of labour, gender essentialist cognition, and social hierarchies have been published (Eagly & Steffen, 1984; Wood & Eagly, 2012), they often offer a narrow focus on the high-status end of the labour-force (and rightly so as higher status for women also translates to more cultural influence). However, social hierarchies also mean these opportunities for high-status positions are often limited to women associated with powerful dynasties or with pre-existing intergenerational wealth and status (Mharte, Riggio, & Riggio, 2011). For example, previous reviews have addressed how gendered status quo, based on the belief that gender differences are biologically-determined (i.e., gender essentialist cognition), impact women as a whole (Wood & Eagly, 2012) and even counter-stereotypical men (Croft, Schmader, & Block, 2015), but not low-status women.

Historical (see Quinn, 1977, for a review) and modern-day (see McGinn & Oh, 2017, for a review) data indicate that the expansion of opportunities for women of the upper- and middle-classes is partly attributable to the employment of lower-class women, who took on a significant portion of upper- and middle-class women’s household labour. As such, this review provides particular emphasis on the effect of gender essentialist cognition on the lives of low-status women. In this regard, how gender essentialist cognition (Brescoll & LaFrance, 2004; Dar-
Nimrod & Heine, 2006) and social hierarchies have impacted the maintenance of gender inequality was considered, with a particular focus on low-status women. Thus, this review aims to extend the arguments about the effects of one form of gender-based cognition (i.e., gender essentialist cognition) in the maintenance of gender inequality to address women from many walks of life. This approach will provide the novel predictions for investigating gender inequality through an intersectional focus that considers the various manifestations of gender essentialist cognition for women of various social status, cultures, and background.

To present this synthesis, I first briefly discuss the evolution of division of labour and the social categories emerging from the expansion of small hunter-gatherer groups into large-scale societies impacted division of labour. Then, I review relevant literature on gender essentialist cognition and its adverse effects on gender-related outcomes. I examine how gender essentialist cognition facilitates justifying and accepting gender inequalities through three separate outcomes - restriction of upward mobility, selective attention to achievements related to men, and benevolent sexism – all three outcomes having especially adverse effects for low-status women. Finally, I discuss potential future directions for this rich area of work, specifically in relevant areas that target the adverse effects resulting from the interaction of gender essentialist cognition and social hierarchies in the maintenance of gender inequality.

**Cultural Evolution of Gender Inequality**

Several useful evolutionary explanations for why gender inequality persisted over human history have been offered, primarily focusing on the rise of gender differences and gender roles (Hansen et al., 2015; Wood & Eagly, 2012) and gendered division of labour (Bliege Bird & Codding, 2015; Marlowe, 2007; Panter-Brick, 2002). Other arguments, though beyond the scope of this paper, have highlighted the effects of technological or tool-based advancements (see
Creanza, Kolodny, & Feldman, 2017) and the increasing spread of monogamous marriages and male power within those marriages (see Henrich, Boyd, & Richerson, 2012) as further considerations. The two main predictions concerning the maintenance of gender inequality – biological and psychological differences between women and men (Archer, 2009; Jackson, 1998; Mukhopadhyay & Higgins, 1988) and gendered division of labour (Gurven & Hill, 2009; Hyde, 2014; Leacock, 1983) – are arguably the two that have the longest historical relevance. Both these factors served critical functions in how early humans developed cognitions about gender and thus, are particularly relevant in discussing gender inequality.

The first – gender differences - has been addressed in many volumes of academic work over the years. Some literature reviews (Eagly & Wood, 2013; Halpern et al., 2007; Hyde, 2014; Pellegrini, Dupuis, & Smith, 2007; Schmitt et al., 2017; Wood & Eagly, 2012), meta-analyses (Cross, Copping, & Campbell, 2011; Hyde, 2005; Voyer & Voyer, 2014), and meta-syntheses (Zell, Krizan, & Teeter, 2015) identify small gender differences in specific domains (e.g., math performance, perceptions of well-being, emotional expressions) but more considerable differences in others (e.g., sensation seeking, motor performance, language performance, childhood aggression, reporting masculine vs. feminine traits, sexual mating strategies). Studies have identified some moderators influencing the expression of these differences such as age (Hyde, 2005; Zell et al., 2015) and cultural factors (Schmitt et al., 2017; Weber, Skirbekk, Freund, & Herlitz, 2014; Zell et al., 2015). Some studies also suggest that gender-based variations, particularly in cognitive abilities, is reduced when country-level gender inequality is controlled for (Coutrot et al., 2017; Hyde & Mertz, 2009). These findings (and numerous others) suggest the scale does not tip significantly to favour either a wide array of meaningful gender
differences or complete gender similarities and will be a question that will continue to invigorate research in the years to come.

Gendered division of labour, on the other hand, is a factor particularly relevant to evolutionary explanations of gender inequality. Gendered division of labour in pre-historic humans is acknowledged as one of the main reasons why humans culturally evolved to have distinct gender roles (Hansen et al., 2015). This differential labour system has been documented in research on pre-historic humans (Alesina, Giuliano, & Nunn, 2013; Hansen et al., 2015; Macintosh, Pinhasi, & Stock, 2017) as well as modern-day small- (Bliege Bird & Codding, 2015; Gurven & Hill, 2009; Jarvenpa & Brumbach, 2006) and large-scale societies (Hyde, 2014; Jayachandran, 2015; O’Leary, 1974). Research suggests that the norm was for prehistoric men to focus on hunting and for women to focus on domesticity or foraging, though there are some notable exceptions, especially in modern small-societies (e.g., Adovasio, Soffer, & Page, 2009; Dyble et al., 2015; Gurven & Hill, 2009; Jarvenpa & Brumbach, 2006; Lew-Levy, Lavi, Reckin, Cristóbal-Azkare, & Ellis-Davies, 2017). As humans continued to become more cognitively and psychologically sophisticated over human history, this gendered division of labour, fuelling increasingly distinct gender roles, provided the scaffolding for more formal (and unequal) gender-based systems (see Alesina, Giuliano, & Nunn, 2013; Hansen et al., 2015; Lew-Levy, Lavi, Reckin, Cristóbal-Azkare, & Ellis-Davies, 2017).

The persistence of gender inequality over human history suggests that a significant piece of the puzzle may lie in human’s expansion into large-scale societies and cognitive representations concerning gender. Cultural evolutionary explanations theorise that many cognitive representations result from continual interactions between genes and culture over generations, a dynamic known as the gene-culture coevolution (Gintis, 2011). Genes usually take
a significant amount of time to encode information from and adapt to one’s environment, even as the environments change rapidly (Mesoudi, 2017). To enable humans to adapt to these rapid environmental changes, our cognitive capacities evolved to be considerably flexible so that we can learn and adapt (Gintis, 2011; Richerson, Boyd, & Henrich, 2010). For example, flexible learning facilitated many historical explorers to observe and copy behaviours of indigenous people in hopes of surviving new or harsh environments such as the Arctic Circle (though some explorers did suffer or die; see Boyd et al., 2011). In the case of social categories like gender, a person first observes what people (e.g., women and men) do on a daily basis. Over time, a person derives the relevance of that category in social situations, which informs the cognitive representations of a group’s social norms (Martin, Cunningham, Hutchison, Slessor, & Smith, 2017; Wood & Eagly, 2012). Gendered division of labour is notably a general tendency across human history, which varied in level and intensity depending on its relevance in specific locales in pre-historic and modern-day societies (Bliege Bird & Codding, 2015; Gurven & Hill, 2009; Jarvenpa & Brumbach, 2006; Newson & Richerson, 2009).

When prehistoric humans grew from hunter-gatherer bands to large-scale cooperative groups, subsistence activities expanded from hunting, gathering, and foraging to agricultural work and settlement-based initiatives, and economic dependence shifted to activities such as farming (Hansen et al., 2015). In particular, women’s reproductive activities and men’s physical strength and size played fundamental roles in continuing gendered divisions of labour over human history (Wood & Eagly, 2012). Agricultural activities were physically-intensive and overwhelmingly favoured men at the expense of women’s economic viability (Hansen et al., 2015). Some studies suggest that women did participate in various activities involved in farming (Macintosh et al., 2017) and horticultural economies (Qian, 2008). Though, Macintosh et al.
(2017) highlight that there are still many gaps in the understanding of women’s roles in historical farming and manual labour, it is generally suggested that the agricultural shift further intensified gendered division of labour (Alesina et al., 2013; Hansen et al., 2015; Panter-Brick, 2002; Waller, 2010), even within some matrilineal cultures (Holden & Mace, 2003). So despite the apparent progress, the participation of women in economic activities was usually limited (Charles & Bradley, 2009) or determined by men (Hopcroft, 2016), further facilitating the maintenance of gender inequality.

The expansion to large-scale cooperative groups also increased social stratification within and between groups (Boyd & Richerson, 2009) giving rise to more complex social hierarchies in the transition. This paper argues that this transition led to increasing rigidity of gendered division of labour parallel to increasing rigidity of the hierarchies, such that “… patriarchal authority was deeply embedded, thoroughly protected, and almost unquestioned” (Jackson, 1998, p. 36).

**The Foundations of Gender Inequality in Large-Scale Societies**

The period when humans began to form settlements and large-scale societies is also theorised as the period when humans began to use their social categorisation abilities to form intergroup structures (Boyd & Richerson, 2009). In such hierarchical societies, social inequalities were formed by those of high-status with narrow goals in mind, rooted in “individual selfishness, kinship, and often, the tribal solidarity of the elite…” (Richerson & Boyd, 1999, p. 269). I next review the literature on the effects of social status-based hierarchies on the maintenance of gender inequality. I use a broad definition of power, encompassing individuals with higher social status (e.g., upper-class or leaders) as well as individuals who have more social power in a specific context (e.g., intellectual elites). I use a similarly broad definition of what constitutes
low-status, to account for both historical (e.g., enslaved women) and present-day (e.g., poor women) unequal statuses.

**Social Status and Maintenance of Gender Inequality**

As large-scale historical societies grew more complex, the labours involved became multifaceted, resulting in goals of individuals of these societies extending beyond longevity of their kin to exploration of pathways to acquiring and producing resources (Richerson & Boyd, 1999). The Neolithic Revolution brought about more multilevel societies, introducing intellectuals and leaders as upper classes or “non-food-producing class” (Hansen et al., 2015, p. 377). Through this class’s involvement in literary and technological advancements, these individuals may have played a significant role in gendered labour becoming deterministic of how labour should be divided, setting into motion the formalisation of patriarchal norms, particularly notable in early philosophical and religious texts (Hansen et al., 2015). This involvement in societal governance and culture also provided these intellectuals and leaders with opportunities to codify and protect (or limit) access to their class (Jefferson, Bloor, & Maynard, 2015).

Unlike their hunter-gatherer ancestors, the upper classes held power in the transmission of culture and norms without actually engaging in physical labours that signals their production skills (Hansen et al., 2015). In addition to economic systems, the upper classes were also better able to control symbolic systems such as who was buried with high value items, who should be immortalised in art, and who should be allowed to access the higher levels of social hierarchies (Norenzayan et al., 2016; Richerson & Boyd, 1999). Thus, the fundamental division of labour, which initially facilitated reproductive success for our hunter-gatherer ancestors, slowly morphed to include labours that did not directly contribute to the economy of sustenance - labours in
which innate gender differences, such as physical strength, may have had little to do with the ability to carry them out efficiently.

In the context of gender, high-status individuals play an essential role in influencing beliefs about gender and what gender means within a particular group. Such power, especially within a stratified society, has the potential to spread selective cultural narratives about women and men codified into group norms (Alesina et al., 2013; Newson & Richerson, 2009) – even when they are inaccurate narratives. As the gate to social status shifted from physical strength towards realms in which there are no clear, pronounced gender differences (e.g., leadership skills, reasoning), privilege-guarding may have stoked the fire of gender inequality utilising purported rather than actual gender differences. For example, the historical segregation of women from high-status jobs may be rooted in the perception that sex-based biological differences, such as reduced ability to control emotions, disadvantage women, but not men (Hyde, 2014).

Many historical equivalents of the upper and middle classes have been identified as practicing more rigid gender norms, where women did not work for wages, compared to the lower classes (Gordon & Nair, 2000; Hansen et al., 2015; Khalil, Moustafa, Moftah, & Karim, 2017). Paradoxically, the reality of lower-class’s living meant that lower-class women (and children) showed high representation in historical labour forces, as reliance on single-income male labour was usually insufficient to ensure economic security (Gordon & Nair, 2000; Qian, 2008; Teso, 2018). An examination of how class-based segregated gender norms were applied has the potential to deepen our understanding of the broader effects of gender essentialist cognition. In that context, gender essentialist cognition is an important contributor to the maintenance of gender inequality in the workforce.
Gender Essentialist Cognition and Gender Unequal Outcomes

Some social categories are formed based on an essentialist heuristic (Prentice & Miller, 2006), where members of a category are perceived as having an underlying common, fundamental nature (i.e., essence). Viewing organisms through this essentialist lens is potentially evolutionarily adaptive as it allows one to make instant (and most often correct) inferences when encountering a new member of an established category, and guide appropriate behaviour (e.g., adopt a Labrador pup to groom it for future work; run away from an unfamiliar 300-pound lioness but not the unfamiliar, yet much larger 1000-pound cow). The perceived essence of entities is not limited to how prototypical it is of a species, but can also apply in the social categorisation of people. Though humans have a general tendency to perceive essences when grouping their social environment (Rhodes, 2013), the role of gender in guiding appropriate behaviours associated with division of labour and reproductive success arguably made a gender-based view of essences particularly salient and prevalent. Gender represents a socially-constructed grouping, but people seem to perceive an underlying essence that organises their distinction of gender categories in the same way as they do with a species (Rothbart & Taylor, 1992). Thus, gender essentialist cognition is rooted in the idea that women and men have certain inherent, stable, underlying qualities that differentiate them from one another (Dar-Nimrod & Heine, 2011; Smiler & Gelman, 2008).

Gender essentialist cognition includes descriptive beliefs of how a social group is (e.g., men are strong) or prescriptive beliefs on what a social group should be (e.g., men should be stoic; Meyer & Gelman, 2016). Although gender essentialist cognition encompasses characteristics that are accurate of some men or women, essentialist biases increase the possibility of generalising them to all men or all women (e.g., all men should be stoic). When
applying gender essentialist cognition, gendered traits and qualities are viewed as unchanging and more likely determined by biological than environmental factors (Heine et al., 2017; Smiler & Gelman, 2008).

**Gender essentialist cognition and gender stereotypes.** What makes gender essentialist cognition distinct from gender stereotypes - an area that contributed to the significant amount of work focusing on gender inequality (Ellemers, 2018; Lenton, Bruder, & Sedikides, 2009; Spencer, Logel, & Davies, 2016) - is that gender essentialist cognitions are identified as the basis for stereotype endorsement (Bastian & Haslam, 2006) and may exacerbate their deleterious outcomes (Dar-Nimrod & Heine, 2006). Gender stereotypes encompass both accurate and inaccurate beliefs about individuals from a particular group (Ellemers, 2018; Jussim, 2017), but unlikely based on representative observations of that particular population (Martin et al., 2017). Gender essentialist cognition, on the other hand, provides the scaffolding for these beliefs (Bastian & Haslam, 2006; Bian & Cimpian, 2017). If one holds the accurate belief that more men are on average physically stronger than women, the primary justification for holding such beliefs are likely rooted in broader biological differences. These explanations may also consider environmental, social, and cultural differences that lead to more specific variations in physical strength among the two genders. Experimental works also suggest essentialist explanations or beliefs increase endorsement of gender stereotypes (Brescoll & LaFrance, 2004; Nürnberger, Nerb, Schmitz, Keller, & Sütterlin, 2016).

In the context of gender, in particular, these explanations provide the basis for behaviours or policies. For example, women's emotional stability is commonly seen as being tied to their menstruation cycle (Forbes, Adams-Curtis, White, & Holmgren, 2003), and they are perceived as being less in control of their emotions and mental state, despite evidence to the contrary (Leeners
et al., 2017). Thus, if one is exposed to the stereotype that women are ill-suited for high-status jobs, then explanations are more consistently rooted in perceived inherent, deep qualities of women (Bian & Cimpian, 2017). Given that gender stereotypes consist of accurate and inaccurate beliefs about a group, gender essentialist cognition may play a crucial role in whether these gender stereotypes are seen as defining, immutable, and unchanging qualities of women and men. One can hold the belief that more men are physically stronger than women, but also believe that in certain aspects some women have the potential to be physically stronger than some men. As such, gender essentialist cognition may limit the amount of nuance people consider in their beliefs about other people.

**Research on Gender Essentialist Cognition**

Generally, studies indicate a strong inclination to engage in gender essentialist cognition throughout the lifespan including children (Diesendruck & Weiss, 2015; Meyer & Gelman, 2016; Rhodes et al., 2012; Taylor et al., 2010), adolescents (Sikora & Pokropek, 2012), and adults (Dar-Nimrod & Heine, 2006; Eidson & Coley, 2014; Mahalingam & Rodriguez, 2003; Nürnberger, Nerb, Schmitz, Keller, & Sütterlin, 2016; Prentice & Miller, 2006; Smiler & Gelman, 2008). Children aged five and six show basic gender essentialist cognition (Taylor et al., 2009), and are more likely to hold essentialist beliefs about gender than they are about race (Rhodes, 2013). This trend continues into adulthood as adults demonstrate a higher tendency to essentialise gender than any other social category (Haslam et al., 2000).

Such beliefs can translate into meaningful, real-world word outcomes. Research consistently shows negative consequences resulting from gender essentialist cognition being applied in social hierarchies, particularly in justifying or accepting inequality (Bikmen, Torrence, & Krumholtz, 2018; Brescoll, Uhlmann, & Newman, 2013; Gaunt, 2006; Iatridis & Stergiou,
2016; Kray, Howland, Russell, & Jackman, 2017; Morton, Postmes, Haslam, & Hornsey, 2009; Ryazanov & Christenfeld, 2018; Verniers & Vala, 2018). For example, women who believed in the immutability of gender stereotypes were more likely to view themselves as being typical of their gender rather than as unique individuals (Coleman & Hong, 2008). Morton et al. (2009) found that men exposed to essentialist information showed more support for workplace-related discriminatory practices and reported higher self-esteem compared to men in an essentialist-opposed condition. Conversely, individuals primed with situationally-based (compared to those primed with essentialist-based) gender differences were less likely to attribute gender disparities to workplace discrimination (Cundiff & Vescio, 2016). Relatedly, though beyond the scope of this paper, gender essentialist cognition also introduces adverse effects for men by reinforcing the avoidance of help-seeking (Addis & Mahalik, 2003).

Socially-meaningful identities such as being a “mother” are viewed in more essentialist terms compared to “fathers” (Park, Banchefsky, & Reynolds, 2015), where one might infer that all mothers share similar inherent qualities (e.g., unable to cope with having kids and holding a job) to a more considerable degree than fathers. Even historically, in the post-World War II era, employers in high-status jobs like medicine had informally barred employment of married or pregnant women (Jefferson et al., 2015). Notably, between 2010 and 2015, 31,000 pregnancy discrimination cases were filed in the United States (National Partnership for Women and Families, 2016), suggesting that the negative connotations associated with women’s biological processes continue to impact their labour opportunities in modern-day workplaces.

For low-status women, the effects of essentialist cognition can go beyond gender to include race-based (or caste-based) essentialist evaluations (Mahalingam, 2003; Moya & Henrich, 2016). The multidimensional evaluations of these less powerful groups often manifest
through power structures motivated by essentialist biases. If social norms, such as gender roles, are rigid, then there are fewer options of upward mobility for low-status members (Hays & Bendersky, 2015) and attempts at upward mobility could result in hostile reactions (Kasumovic & Kuznekoff, 2015). The biases can be more flexible for women who are in the ethnic majority (e.g., White women; McMahon & Kahn, 2016) or of a higher-status (e.g., high-caste Indian women; Mahalingam, 2003), but more inflexible for lower-status women. For example, Mahalingam (2003) found that higher-caste men and women in India were more likely to engage in essentialist thinking than lower-caste men and women, suggesting multi-dimensional essentialising based on multiple social identities (e.g., caste and gender, or ethnicity and gender).

The intersection between these two cognitive biases in the context of large-scale groups is necessary for further understanding how gender inequality impacted women of various statuses.

To summarise, gender essentialist cognition facilitates deep divides between genders and strengthens a rigid approach to gender roles (Dar-Nimrod & Heine, 2011; Haslam et al., 2000). This cognition may also lend itself to illusory correlations between lasting, physiological gender differences such as physical strength with more ephemeral, normative gender differences such as math aptitude and care-related skills (Halpern et al., 2007). Consequently, gender essentialist cognition could potentially make the changes in the latter less likely as these ephemeral differences are now bundled up and essentialised with more lasting gender differences (Brescoll & LaFrance, 2004). The different facets of innate endorsement of essentialist cognition (Atran et al., 2001; Gelman, 2003) may have interacted with the historic gendered division of labour to create systemic structures that favoured men over women in the context of work (and the economic power correlates of it). Haslam et al. (2000) identified that social categories perceived as being natural, such as gender, are less likely to vary across historical periods and cultural
groups. Because rigid social categories are less susceptible to being shaped by sociocultural factors, the social transmission of these cultural norms over generations further intensified gender essentialist cognition and maintained gendered division of labour. This notion is supported by some research suggesting a lack of change in perceptions of fundamental gender differences such as female- and male-typed jobs from the 1980s (Haines, Deaux, & Lofaro, 2016), though other studies indicate more gender equal transitions for gender role-typing (Donnelly & Twenge, 2017; Miller, Nolla, Eagly, & Uttal, 2018).

Overall, the lack of visible female representation in certain labours and perceived inadequacies of the female “essence” both reinforce views of women’s shortcomings (Cheryan, Master, & Meltzoff, 2015). Such beliefs, in turn, further reduced opportunities for female representation and deter women’s participation in these domains – as shown by the large body of literature on the underrepresentation in high-status positions of women’s in general (Cheryan, Plaut, Handron, & Hudson, 2013; Cheryan, Siy, Vichayapai, Drury, & Kim, 2011; Dennehy & Dasgupta, 2017; Paustian-Underdahl, Walker, & Woehr, 2014; Rydell & Boucher, 2017) and low-status women in particular (O’Brien et al., 2015; J. E. Phelan & Rudman, 2010). Without restrictions or incentive to change, the combination of the pre-existing gendered division of labour, gender essentialism, and gender-based status quo may have resulted in rigid social and economic systems fuelled by a spiralling circle in which these elements get more entrenched through their solidifying effects on each other.

**Gender Essentialist Cognition and Maintenance of Gender Inequality**

As society progresses, systems and institutions that reinforce gender inequality seem justifiable, as gender essentialist beliefs became more normative and accepted (Brescoll et al., 2013). Women’s perceived deficiencies and men’s perceived advantages in physical strength,
through extensions to cognitive abilities and emotional stability, reinforced the maintenance of a gendered system, particular in divisions of labour (Hyde, 2014). As such, the use of gender essentialist cognition by those who are powerful is often motivated by their need to maintain their status (Jost et al., 2004), conveyed through ideas of legitimacy, fairness, desirability, or inevitability, spread among both advantaged and disadvantaged members of society (Jost, Banaji, & Nosek, 2004).

Over time, intersecting gender essentialist cognition with systemic power provided a specific part of the population with an overwhelming amount of control and power over others. For example, men asserted more power by controlling many aspects of women’s lives, even by determining who their sisters or daughters marry (Henrich et al., 2012). These essentialist beliefs, when shared by a large part of a society, establishes narrow perspectives about traits concerning a particular group, even when variations are expected (Jost et al., 2004; Strimling, de Barra, & Eriksson, 2018) and when the original justifications fade. To illustrate, a 2017 Pew Research Center survey showed that Americans still view men and women as being fundamentally different, even if they do not attribute that difference to biological or social differences (Parker, Horowitz, & Stepler, 2017). These culturally-entrenched perspectives can shape whether or not a status quo is maintained and accepted by the powerful and less powerful alike.

**Gender Essentialist Cognition and Social Status in Maintenance of Gender Inequality**

As large-scale societies further modernised, many individuals of the intellectual-class played an instrumental role in the maintenance of gender essentialist norms (Hansen et al., 2015). These gendered systems enable those with the power to differentiate specific jobs as masculine and feminine, definitions which themselves changed to maintain a gendered status quo
as labours evolved. There are some instances throughout history where the upper- and intellectual-classes use gender essentialist cognitions as foundational elements for who should be in the labour force. In the 18th century, British women actively worked as midwives, but were not given access to surgical instruments as they were only made available to surgeons accredited by men-only medical authorities and women were not yet allowed to gain formal qualifications to become an accredited medical practitioner (Jefferson et al., 2015). The introduction of obstetric forceps led a significant number of male doctors to become obstetricians resulting in the decline of female midwives; unsurprisingly, the status of the profession was then elevated among the elite (Jefferson et al., 2015). In this situation, women had the skills (and perhaps even more so than some male doctors), but institutions barred them from accessing the tools needed for participating formally in that labour.

The transition of obstetrics from a primarily “feminine” occupation to a high-status “masculine” one, illustrates how gender essentialist cognition influences decisions of powerful individuals and institutions in a way that benefits a high-status group. Consequently, men thrived in various domains because gender essentialist cognition framed masculinity as naturally advantageous, while women (particularly low-status women) stagnated in those domains because femininity was framed as naturally disadvantageous.

**Low-status Women, Gender Essentialist Cognition, and Gender Inequality**

Some argue that gender essentialist cognition, when used by individuals in high-status positions, usually generalises its features to all women with less consideration for nuances (Haslam et al., 2000). However, less is known about the application of gender essentialist cognition to low-status women. This focus on a particular definition of what constitutes a woman may, at best, overlook the presence of lower-status women in society or, at worst, dehumanise
them to the point of being excluded from the female “essence” altogether. Though women were formally barred from high-status institutions in many cultures, they still represented a sizeable number of the working class historically (Fedigan, 1986; Pedraza, 1991). Women characterised as low-status during specific points in history have consistently (and some forcibly) participated in hard labour, often referred to as “men’s work” (Hawkes & Bird, 2002). For example, African descent women under slavery worked in British-Caribbean plantations during the 1700s (Bush-Slimani, 1993), poor English women worked as coal miners in the 1800s (Murphy, 2013), and Jewish women worked as forced labourers in concentration camps during World War II in 1900s (Saidel, 2006). These instances with working-class and lower-status women participating in the labour force indicate that the perseverance and maintenance of gender inequality are facilitated by the selective emphasis of essentialist differences between the genders, which further limits upward mobility among low-status women.

When multiple social identities are considered, the identity-based barriers experienced and overcome by low-status women is better understood. Though high-status women were segregated based on their gender, they were still considered the ingroup of powerful men on dimensions such as ethnicity, nationality, and class. Therefore, being in the ingroup can afford high-status women more consideration as human beings (or the perceived essence of what it means to be human) compared to their lower-status counterparts (Haslam & Loughnan, 2014). This type of dehumanisation, known as infrahumanisation, involves perceiving individuals from one’s outgroups (compared to one’s ingroup) as lacking characteristics that are unique to humans such as cognitive skills, civility, and complex emotionality (Haslam & Loughnan, 2014). Historically, many powerful groups across cultures have often characterised less powerful groups in sub-human terms. For example, some colonising forces often described locals as primitive,
lacking in intellect and refinement (Haslam & Loughnan, 2014), or using animalistic terms (Haslam, 2006). These downward applications of infrahuman qualities can extend to powerful groups in general such as high-caste to low-caste members (Mahalingam, 2003) and higher socioeconomic individuals toward lower socioeconomic ones, even when they identify as being in the same ethnic ingroup (Loughnan, Haslam, Sutton, & Spencer, 2014).

The critical role played by power in these evaluations is that when sub-human characteristics (e.g., low intellect or animalistic qualities) are applied to low-status women, it potentially diminishes the extent to which the “female essence” is representative of low-status women, which may then explain the greater acceptance of these women in fulfilling traditionally-viewed men’s hard labours. If lower-status women are viewed as being outside of the “female essence,” then their participation in “men’s work” does not violate powerful individuals’ (and by extension, dominant cultural perspectives) essentialist views of women. For example, Ghavami and Peplau (2013) found that people’s general stereotypes about women had more considerable overlap with stereotypes about White-American women compared to stereotypes about Middle-Eastern-, Latina-, or Asian-American women. Stereotypes about African-American women were the least similar to general stereotypes about women (Ghavami & Peplau, 2013). Consequently, even though gender essentialist cognition may have been directed less toward low-status women, they still experienced adverse outcomes resulting from having their essence perceived as less than human (Haslam, 2006) and likely experienced increased oppression by the differentiation between their own essence and the essence of high-status women, who are considered the paragons of the “female essence”.

In the presence of lower-status women who were infrahumanised instead of gender essentialised, one possible outcome is that the visibility of working lower-status women may
have paved the way for high-status women to participate in paid work as well. As societies adopted more liberal, humanistic ideas, which acknowledge the humanness of all members of the species, the participation of lower-status women in the workforce may have helped set into motion the loosening of rigid, gender essentialist hierarchies for the formally-barred high-status women, as the perceived schism between these diverse groups of women has been reduced.

**Maintenance of Gender Inequality for Low-status Women**

In hierarchical systems, low-status men or men without leadership positions are more likely to have a higher social influence than their female counterparts (Hays & Bendersky, 2015). However, these men, despite their lower status, can also be complicit in the maintenance of an unequal system for low-status women (Kasumovic & Kuznekoff, 2015). Though an unequal system disadvantages low-status men as well (Al Dabbagh, Bowles, & Thomason, 2016; Chetty, Hendren, Jones, & Porter, 2018), gender essentialist cognition inclines lower status men to justify and maintain gender inequality because it still benefits them, but also because of cultural mores that originate from the upper echelons (Brescoll et al., 2013).

Even high-status women, who faced obstacles to success, can be complicit in the maintenance of gender gaps disproportionately affecting lower-status women; they are often termed “queen bees.” Queen bees are women who emphasise their difference from other women, especially when they are in male-dominated spaces that disfavour feminine characteristics (Derks, van Laar, Ellemers, & de Groot, 2011). This emphasis results in queen bees attempting to separate themselves from women they perceive as being stereotypically female (Ellemers, Heuvel, Gilder, Maass, & Bonvini, 2004). These women are more likely to make harsher evaluations of female subordinates than they do of equally-qualified male subordinates (Ellemers et al., 2004). Research drawn from modern-day organisations indicates that the extent to which
women in male-dominated arenas identify with their gender is an essential factor in whether women show queen bee characteristics or not. Specifically, low female-identifying women, compared to high-identifying ones, are less concerned about the mobility of subordinate women (Derks, Ellemers, van Laar, & de Groot, 2011; Derks, van Laar, Ellemers, & de Groot, 2011; Derks, van Laar, Ellemers, & Raghoe, 2015; Ellemers et al., 2004). This finding holds certain parallels to benevolent sexism. Whereas queen bees may believe one needs to be less feminine to be successful, normative women who endorse benevolent views of women may believe one needs to be more feminine to be successful, but both are possibly rooted in the internalisation of essentialist beliefs about women. Future research can examine this contradiction, such as whether both these subgroups of women indirectly justify a gender-unequal status quo through similar cognitive biases.

When considering the effects of gender inequalities for low-status women, the majority of empirical research converges on three general areas - restriction of upward mobility, selective attention to achievements related to men, and benevolent sexism. The three themes are proposed to have subtle, yet far-reaching consequences, consequences that may be moderated by the woman’s status.

**Effects of Gender Essentialist Endorsements**

**Restricting upward mobility.** Endorsing gender essentialist cognition maintains gender inequality by withholding upward mobility opportunities for women. Historically, as the gender gap in access to influential institutions and opportunities developed, it may have allowed powerful groups to withhold or cut-off low-power groups from fruits of progress (Jackson, 1998). Less powerful individuals faced restricted upward progressions as it reduced potential threats to the position of the high power individuals (Jost et al., 2004). In large-scale societies,
gendered division in labour becomes gender inequality because it affects the opportunities available for each gender to acquire and develop relevant skills (Gurven & Hill, 2009). These opportunities extend to both formal and informal opportunities (Jackson, 1998), but if powerful people or systems are the ones determining who receives these opportunities, the division of labour is more likely to remain unequal. For example, one study, based on population data, showed that countries with higher educational prestige inequality (i.e., older, prestigious universities favouring students from the upper classes compared to newer, less prestigious ones) might lead to lower opportunities for social mobility, with women being disproportionately affected (Abrantes & Abrantes, 2014). Thus, gender essentialist cognition can be used to limit the upward mobility of women by highlighting the deficiencies of the female essence.

Here, the lack of female representation in certain domains is seen as being attributable to deficiencies in women rather than an outcome of opportunities available, to whom opportunities are given, and (to a certain degree) interest in those domains (see Abrantes & Abrantes, 2014). Consequently, what little achievements women have in these domains are overlooked and afforded less prestige or accolades, especially if it is the social norm to do so in that specific arena (Eagly & Miller, 2016). The reduced recognition of women’s potential to significantly contribute in these domains can impact whether or not women get and continue getting opportunities for social mobility, perpetuating the essentialist cognition that contributed to the gender differences in opportunities in the first place.

**Selective attention to outcomes related to men.** The rigidity of gender essentialist cognition arguably creates a form of tunnel vision for elements that fit one’s limited definition of gender. Even when women show the capacity for high-level achievements, gender essentialist cognition facilitates the tendency among those in power to have significant blind spots in
accepting these achievements (Scholl, Sassenberg, Ellemers, Scheepers, & de Wit, 2018). These blind spots further fuel cultural prioritising of men’s achievements (Eagly & Miller, 2016) and contributions (Holman, Stuart-Fox, & Hauser, 2018) over women’s. For example, men are more likely used as success stories and role models in industries such as entrepreneurship (Gupta, Turban, Wasti, & Sikdar, 2009) and computer science (Cheryan et al., 2015) than women.

Furthermore, the stereotypes associated with these successful individuals, such as inborn brilliance, technical skills, singular obsession, are often traits and qualities that are more valued in men than women, especially in Western cultures (Cheryan et al., 2015). These stereotypes become gatekeepers to women and their contributions when they venture into various domains (Cheryan et al., 2015). Certain public intellectuals, presently and historically, have also attributed essentialist “male” qualities to identities such as atheists (Boorstein, 2014) and geniuses (Saini, 2017) as a way to justify the real or perceived lack of female representation, despite lack of scientific evidence for making those attributions.

Additionally, historians have noted several instances where female collaborators (some of whom were also spouses) of male scientists were excluded from prestigious accolades (e.g., the Nobel Prize) despite having made significant contributions (Rossiter, 1993). If women are perceived as being naturally inferior, male collaborators may have a blind spot for the extent of women’s contributions, even if it was substantial. Such achievements in various domains can also be justified as the exception, an anomaly, or a result of being hand-held by men (Proudfoot, Kay, & Koval, 2015). If one sees the female essence as being naturally inferior, accepting their achievement is likely a violation of one’s gender essentialist cognition, which can result in motivated, reduced attention to women’s work. There is much potential to explore the perceptual biases that have affected and resulted from gender essentialist cognition, given that this blind
spot is likely either intentional or unintentional or could also be related to infrahumanisation of lower-status women.

**Benevolent sexism.** Without a certain level of acceptance from the disadvantaged, inequality is unlikely to last as long as gender inequality has (Jost & Banaji, 1994). The acceptance of an unequal status quo can be facilitated by framing the inequality as a desirable group difference (Jost et al., 2004), which in the case of gender was expressed through seemingly benevolent beliefs about women (i.e., benevolent sexism). Benevolent sexism is defined by the male reverence of women, where men are motivated to provide physical and economic security to women (Glick & Fiske, 1996). However, a woman is expected to cede most of her competence-based authority to her spouse and is expected to aid him in furthering his goals, without reciprocal aid from her spouse in her role as a homemaker (Hammond, Sibley, & Overall, 2014). While benevolent sexism may benefit women by putting their womanhood on a pedestal, it also further perpetuates structural gender inequality based on gender essentialist cognition, especially in reinforcing the rigidity and immutability of perceived gender roles. This reverent view of women is noted historically, for example, in how 19th and 20th-century scholars portray women, where “they are overly gallant and sentimental about them [women]…” (Wider, 1986, p.23). More recent data shows that describing women as being natural “mothers” or caregivers serves as justification for workplace discrimination, even in countries that rank high on gender equality policies (Verniers & Vala, 2018).

Status-based social identities also determine the extent to which high-status women and low-status women are subjected to benevolent sexism. The protective function of benevolent sexism means that women who are in high-status men’s ingroup (i.e., women who represent the “female essence”) need protection, often from men of ethnic outgroups such as Black men or
non-White immigrant men (McMahon & Kahn, 2018). This paradox of promising protection for women (because women are fragile), while limiting their freedom, is not necessarily extended to lower-status women, and empirical works exploring this premise are still at its early stages (McMahon & Kahn, 2016, 2018). Furthermore, benevolent sexist women may endorse equality that benefits themselves (Sibley & Perry, 2010), but that endorsement does not necessarily extend to opportunities that benefit women they do not consider as “female” or a part of their ingroup (Cassese & Barnes, 2018; Katz, Merrilees, Hoxmeier, & Motisi, 2017). Consequently, where benevolent sexism hinders high-status women’s progress, low-status women may have to reckon with a more hostile version of sexism (McMahon & Kahn, 2016, 2018) and infrahumanisation from men and other women in their own progress. Thus, future studies can examine whether this protective function is extended to lower-status women as well as higher-status women.

The effects of endorsing these benevolent gender norms also lead to the negative portrayal of men who take on roles perceived as falling outside of competence or protective roles, such as men who are homemakers, nannies, or nurses (Croft et al., 2015; Gaunt, 2013). Generally, men holding benevolent beliefs may not be explicitly doing so with oppression in mind. It is highly possible that viewing men as natural breadwinners and women as natural homemakers likely provide certain individuals, including women, with a simplistic justification for discounting gender inequality with minimal (or no) deleterious effects on one’s perceived self-worth (Kteily, Sheehy-Skeffington, & Ho, 2017).

**Effects on men.** The endorsement of gender essentialist cognition by those in power can also shape gender-based attitudes of young boys and men. Young boys perceived as being atypical of their gender are more likely to be bullied or ostracised (Young & Sweeting, 2004),
and men who are modest are viewed as being of lower status and more likely to experience backlash than men portrayed as confident or ambitious (Moss-Racusin, Phelan, & Rudman, 2010). Williams (1992) noted that men who venture into female-dominated careers are more likely to experience prejudice outside of the workplace rather than within the workplace, unlike women who experience prejudice both outside of and within male-dominated workplaces. Research also suggests that gendered division of labour, when combined with essentialist cognition about gender differences, can inhibit men from developing interests in gender-atypical vocations (Croft et al., 2015).

The features of gender essentialist cognition, especially immutability and naturalness, can subsequently influence men’s perceptions of high-status women. Given that historically, it was the case that men were more likely to have high-status positions than women (Ellemers, 2018), the removal of legal restrictions does not necessarily negate the effects of gender essentialist cognition. Because many male-dominated spaces are often seen as being naturally-suited for men, gender essentialist cognition can perpetuate a sense of entitlement over these spaces (Grubbs, Exline, & Twenge, 2014), especially in areas that are visible, competitive, or high-status. As women (minority women in particular) slowly take on more gender atypical, high-status positions (Hyde, 2014), gender essentialist cognition can influence men to view such women as taking what is rightfully positions of men.

Thus far, the review focused on examining gender essentialist cognition within the historical trajectories of gender inequality by examining the emergence of social hierarchies, gendered division of labour, and gender essentialist cognition in its maintenance. Then, the review explored the role of gender essentialist cognition in the maintenance of gender inequality for low-status women and identified three separate effects - restriction of upward mobility,
selective attention to outcomes related to men, and benevolent sexism. In particular, this review highlighted the differential application of benevolent sexism between high-status and low-status women, where higher status women are hindered by the coddling of benevolent sexism and lower-status women are hindered by infrahumanisation and more hostile forms of sexism. Understanding these potentially diverging essentialist views of women, especially when multiple identities are considered, can inform how they are empirically tested within diverse groups of women. As such, applying broad psychological concepts such as gender essentialist cognition and their variants associated with the maintenance of gender inequality to sub-populations of women, as this review has done, can aid in providing a multidimensional view of gender inequality and help identify novel directions and potential interventions for research.

**Future Research Directions**

**Exploring Women’s Experiences in Diverse Workforces**

Much of the research in women’s workforce representations has focused on science, technology, engineering, and math (STEM) jobs in specific populations and there is potential for future research to examine other job areas where women are disadvantaged, particularly in highly gender-unequal societies. This line of work may also facilitate the mapping of both historical and evolutionary trajectories of women’s representations in other fields. For example, high-status positions in arts-related sectors (e.g., fine arts, classical music) are also difficult for women to access because the gatekeepers are more likely to be men or prioritise artistic products of men (Adams, Krrussl, Navone, & Verwijmeren, 2017). Given that the application of gender essentialist cognition is closely tied to these social hierarchies, its role in non-STEM, high-status jobs warrants a more detailed examination.
To that end, jobs that are dominated by lower-status women should also be given prominence in discussions of gender inequality maintenance. For example, the public discourse on the working-class often centres on jobs that are dominated by men (e.g., coal miners or construction workers), at the expense of jobs dominated by working-class women (e.g., service or retail workers). Beyond census and survey data from Western countries (Eagly, Diekman, Johannesen-Schmidt, & Koenig, 2004), there are limited empirical and experimental works that address how psychological dimensions like gender essentialist cognition and gender system justification function in these populations. Given that the working-class also comprises of demographically diverse women, future research into their psychological experiences is necessary to address their experiences with gender inequality fully. In this context, this review suggests that incorporating established psychological aspects, such as infrahumanisation and benevolent sexism, can enrich our understanding of both social-level processes and particular individual experiences of gender inequality and its implications.

**The Function of Role Models**

**Intersectionality concerns of women as role models.** One of the few avenues that women can use for social mobility in rigid gendered systems is through prestige-based leadership or social status that focuses on characteristics associated with skills, respect, and admiration (Cheng et al., 2013; Maner & Case, 2016). Whereas evolutionary research focusing on how prestige functions in the context of women and social hierarchies are still in early stages (Maner, 2017), exploring whether centring attention on aspects of a woman one can admire and respect affects how men and women evaluate leaders has the potential for exciting findings. Such research can consider the inclusion of diverse women, particularly as it relates to reducing gender essentialist cognition. For example, when choosing a historical role model to empower
women and lower-status women, in particular, it may be necessary to showcase the contrasting experiences of influential women. As our review highlights, gender essentialist cognition is not limited to expressions of sexism, but also infrahumanisation of low-status women. The divergent trajectories of women such as Harriet Tubman and Susan B. Anthony as political activists can be examined within the context of their social status in the 19th century for a richer view on the lives of influential women. Encouraging students to consider these different trajectories can help in illustrating how privileges, such as intergenerational wealth, increase some women’s opportunities for social mobility, but not others. In this context, it also important to include experiences across diverse groups of women, such as experiences of women who are historically and presently also marginalised by caste and socioeconomic status in other societies, to humanise them. To that end, educating students on women’s liberations movements in other nations as part of high school syllabi provides a starting point for encouraging the adoption of intersectional outlooks on gender inequality issues.

When considering how to counteract essentialist perceptions associated with low-status women, examining various forms of power and prestige for women, including how some women may have benefited from intergenerational power, is an important avenue forward. Historically and presently, many leadership positions for men and women were attained via formal or informal nepotism such as in political dynasties or royal families (Graham, 2016; Mharte et al., 2011). Outside of governments that have formally elected women into positions with minimal familial ties, many former and current government officials, such as Benazir Bhutto, Cristina Kirchner, Indira Gandhi, and Aung San Suu Kyi, had either a parent or a spouse who served as former leaders. Nepotism provides access to leadership opportunities that are usually unavailable to others, such as low-status women and is closely tied with intergenerational transmission of
power. This notion implies that a particular lineage has an “essence” that makes them exceptional enough to maintain that power. Such a belief overlaps with other essentialist biases (Dar-Nimrod & Heine, 2011). This intersection of essentialist cognitions about gender, inheritance, and social rank has much potential for future studies, particularly in increasing low-status women’s opportunity for social mobility. For example, future research may consider whether historical women who became influential without systemic privileges are evaluated differently on essentialist biases dimensions than those who were privileged, as well as whether such counter-examples can be used to reduce essentialist cognitions.

**Women as role models for all genders.** A more inclusive focus of women as leaders and idols for all genders, instead of just girls or women, helps in better understanding how to encourage children and adolescents to see women as role models. In everyday life, women are often sidelined from being role models to boys. For example, BBC’s casting of a female actor as Dr. Who received negative reactions from a male actor who had previously played the role, who suggested that boys have lost a role model (Grierson, 2017). However, qualitative research suggests that boys do see their female teachers as someone they wish to emulate (Hutchings et al., 2008), but more rigorous empirical testing is needed to address this line of work. Furthermore, previous research on female role models has largely focused on women as gender-specific role models for girls or women (Cheryan et al., 2013; Dennehy & Dasgupta, 2017). Such a focus limits our knowledge of women’s social influence as role models for all genders. For example, labelling potential role models as “female Dr. Who” or “female scientist” may have the effect of “other-ing” them for young boys and men, and whether such framing is deterring boys from adopting women as role models remain open for investigation. Future studies may also
consider the effects of an inclusive gender-framing in minimising gender-based intergroup problems and in encouraging all children to adopt women as role models.

**Men as role models.** Because gender and gender roles are central to gender essentialist cognition, deterministic views of masculinity are equally stifling for low-status men. As such, influential men who are viewed as role models by boys and other men play an important role in imparting gender egalitarian beliefs about gender roles (Halpern & Perry-Jenkins, 2016). De-emphasising the stereotypical traits associated with their gender and focusing on male role models who endorse healthy and varied expressions of masculinity are important steps forward. Traditionally male-dominated, influential organisations, such as national sporting bodies and athletes themselves, have the potential to be useful role models of gender equality (Flood, 2011). The proposed interventions may also help reduce the influence of gender essentialist cognition for low-status boys and men, but research is needed to test this premise empirically. This integrated approach of endorsing gender egalitarian beliefs through individual and organisational role models has the potential to uplift both low-status girls and boys, particularly in counteracting the development of gender essentialist views (Croft et al., 2015).

**Religious leaders.** Religious institutions are one of the few areas (especially historically) where women, such as Joan of Arc or Mother Theresa, could have obtained high-status even in male-dominated societies since religious leaders also need to possess qualities beyond material wealth and resources (Soler, 2016). Understanding of gender dynamics can be limited by leaning heavily on evidence from male-dominated traditions and narratives, especially since masculine portrayal of gods is more likely to be associated with conservative gender ideology than more gender-neutral or feminine ones (Whitehead, 2012). Many religions have diverse female figures with characterisations encompassing virginal and divine (e.g., the Virgin Mary), aggressive (e.g.,
Kali in Hinduism and Athena in Greek mythology), and being gender fluid (e.g., Mami Wata of West African Voodoo). However, formal religious institutions also endorse gender essentialist views about women, often rooted in benevolent sexism. For instance, many major religions such as Hinduism, Catholicism, Islam, and Buddhism have only within the last decade, discussed the inclusion of women as priests, monks, or imams, who have yet to be represented in leadership roles. To date, studies looking at how gender essentialist cognition moderates beliefs concerning women’s status across different religions has been limited (Mahalingam & Rodriguez, 2003), but it is an important line of research to explore, as religion is viewed as one of the last major barriers to gender equality (Grim & Lyon, 2015).

**Understanding Female-towards-Female Aggression**

In considering how different forms of power and social status have influenced gender inequality, promising newer research has examined intrasexual competition among women (Blake, Bastian, Denson, Grosjean, & Brooks, 2018; Rosvall, 2011; Stockley & Campbell, 2013). Among adults, this work on female aggression and women’s direct and indirect use of power (Arnocky & Vaillancourt, 2017; Cross et al., 2011; McAndrew, 2014) has furthered inquiry into female status attainment. Such findings in female intrasexual interactions can help clarify the role of women in the perpetuation of gender essentialist cognition. They also indicate that female status, exerted through power (notably, indirect power), prestige, social mobility, and motherhood status, serves as a necessary area to investigate in both high- and low-status women. This body of work also has the potential to explore whether childhood experiences of female-female competition and girl-to-girl aggression in schools (Duffy, Penn, Nesdale, & Zimmer-Gembeck, 2017) predict internalisation of essentialist gender beliefs by adult “queen bees” or benevolent sexists. Understanding whether “mean girls” end up as “queen bees” may identify
useful points of intervention during childhood and adolescence to minimise negative beliefs concerning the female “essence.”

**Public Discourse on Gender Research**

Extending the function of influential individuals further, public intellectuals, researchers, and public relations officials should be encouraged to exercise more caution in their interpretation of gender-related research. A more balanced discourse concerning gender differences, to minimise endorsement of gender essentialist cognition, may also need to emphasise research on sex differences just as equally. In preparing future researchers for such situations, it is important for gender-related undergraduate courses to provide some form of training for engaging in dialogues that balance both the biological and social aspects of gender. Such training may help ensure that well-supported research findings concerning sex differences are not overlooked or downplayed when attempting to avoid gender essentialist cognition.

**Conclusions**

Both the evolutionary and historical context of gender inequality provide novel predictions in the psychological adaptations involved in such a pervasive phenomenon as gender inequality. Empirical evidence from modern-day, small- and large-scale societies indicate strong tendencies for humans of various ages toward gendered thinking as well as a strong relationship between gender essentialist cognition and status quo maintenance. The challenge in searching for the origins of gender inequality is that a definitive answer is hard to pin down, but examination of specific cognitive biases recognised by psychological research, such as the gender essentialist cognition, as well as further investigation with non-traditional samples (see Mesoudi, Chang, Murray, & Lu, 2014), may identify specific psychological adaptations that play a more significant role over others.
A short-term examination of gender inequality, at least in the last 50 years, would suggest there has been the significant closing of gender gaps and removal of many formal barriers in education, political, and economic representation in various countries (Dorius & Firebaugh, 2010; Jackson, 1998). A long-term examination, over many millennia, provides a broader scope of factors to consider, especially when facets such as power and prestige systems have shaped and been shaped by long-term societal and cultural shifts (see Reyes-García et al., 2016). Such an examination can produce potentially counterintuitive predictions to explore (such as whether low-status women paved the way for higher status women’s achievements in pushing the glass ceiling further up) and should not be discounted. Cultural evolution research has provided essential and novel findings concerning various distal and proximal factors influencing social inequalities (Boyd & Richerson, 2009; Richerson & Boyd, 1999). Assimilating those works with lab-based psychological findings provides avenues to explore nuances in both evolutionary and historical explanations of gender inequality. As highlighted throughout this article, the maintenance of gender inequality has stimulated scholarship in diverse areas of research. In addressing the robust tendencies for humans to engage in gender essentialist cognition, there is much potential to address how such thinking has impacted culture, thoughts, and behaviours of individuals and institutions alike, through both experimental and big data methods. Taken together, these findings can inform research into strategies to counteract the pitfalls of engaging in gender essentialist cognition.

Although women and men have likely adapted to be better in specific activities (e.g., childcare versus hunting; Archer, 2009), the division of labour does not entirely explain why activities that are afforded prestige and status, regardless of their economic returns, are those that are preferred or led by men, while those activities engaged in by women are not afforded an
equal status (see Eagly & Wood, 2009). Even if biological differences provided the conditions under which gendered socio-economic activities were historically formed and preferentially selected for (Campbell, 2013), gender essentialist cognition coupled with power-based systems provided the conditions under which the various facets of gender inequality persisted and thrived.

In the next chapter, I explore the identified interaction between gender essentialist cognition and power-based context – gender system justification - in the social influence that women have in decisions made by individuals from diverse backgrounds. I extend the one aspect of the ideas reviewed in this chapter through experimental studies on how justification of gender inequalities moderates the extent to which female and male experts influence the social decisions of women and men. I focus on a process that is fundamental to the cultural evolution of humans – social learning – to understand whether beliefs about gender, which relate to its immutability, have the potential to influence the contextual factors involved the transmission of cultural narratives.
Chapter 5: How Gender and Beliefs about Gender influence Social Learning

Introduction

For humans in large-scale societies, social learning is an essential tool for inexperienced group members, especially in ensuring the continuing safety and survival of one’s kin (Boyd & Richerson, 1995). An efficient and adaptive way to respond to a new or uncertain situation is by modelling, copying, or observing a more skilled person (Boyd & Richerson, 1995). Given this almost instinctual drive to protect oneself or thrive in new situations, novices are more likely to look for social cues from individuals who display survival- and competence-based qualities that they can imitate and learn from (Henrich & Gil-White, 2001). When deciding on which model to socially learn from, the influencing factors range from whether or not the expert is one’s kin to copying the most successful expert (Kendal et al., 2018). These observations also provide a novice with a view of group dynamics critical to one’s longevity and success so as not to offend powerful individuals or violate norms.

Research indicates that group norms such as the appropriate social roles for women and men influence the type of social learning biases that develop in children (Lew-Levy et al., 2017; Marlowe, 2007; Over & Carpenter, 2015). For example, a young boy is more likely to develop attentional and social learning biases that favour observing and emulating male role models, particularly if group norms dictate highly gendered social roles (Over & Carpenter, 2015). Social learning among children has received particular attention among human evolution and developmental researchers (Harris, Bartz, & Rowe, 2017; Legare, 2017; Poulin-Dubois & Brosseau-Liard, 2016; Whiten, 2017) and many small- and large-scale societies show gendered social learning both historically and presently (Alesina et al., 2013; Newson & Richerson, 2009). Though theoretical works have raised the possibility of the gender of an expert influencing social
learning within large-scale groups (Henrich & Gil-White, 2001; Kendal et al., 2018), this influence, to our knowledge, has yet to be experimentally tested.

The continuing interest in gender inequality, particularly for women in expert-based roles (Dennehy & Dasgupta, 2017; Hyde, 2014), has essential considerations in whether there are gender biases involved in the extent to which individuals choose to learn from a male versus female expert. This selection of expertise is also relevant to another form of social learning strategy – expert-based learning or learning from an individual who displays competence, shares their expertise, and has their followers’ respect (Cheng et al., 2013; Reyes-Garcia et al., 2008).

Specific prestigious qualities are arguably informed by cultural or group consensus on what traits are valuable or essential (Dar-Nimrod, Ganesan, & MacCann, 2018; Jost et al., 2004) – including the relevance of the gender of an expert. For example, intellectuals such as Confucius in historical China (Hansen et al., 2015) and Mahatma Gandhi in colonial India were skilled philosophers and orators. These skills, in turn, increased their social status, subsequently affording these individuals opportunities to shape and shift larger cultural systems (Henrich, Chudek, & Boyd, 2015; Maner & Case, 2016). Such opportunities were historically rare for skilled women (with women who are considered experts courtesy of familial ties being the exception), making them less likely also to be considered role models (Cheryan, Ziegler, Montoya, & Jiang, 2017). For women, in particular, being seen as an expert provides more opportunities to gain social status, unlike the qualities associated with more authoritarian forms of leadership (e.g., coercion and manipulation), which often lead to women experiencing backlash (O’Leary, 1974; Rudman, Moss-Racusin, Phelan, & Nauts, 2012). As prestigious qualities are also conducive for becoming a good role model to novices (Atkisson, O’Brien, & Mesoudi, 2012), the influence that prestigious women (and men) have on the broader cultural
sphere provides essential dimensions to our current understanding of social status and gender inequality.

Beyond the expert’s gender, one’s specific beliefs about gender differences can translate into viewpoints about who should be afforded prestige, leadership, and accolades, as well as which gender has attributes that are prestigious (Skewes, Fine, & Haslam, 2018). Several empirical works also suggest that individuals who rationalise a particular status quo show an increased tendency to endorse beliefs that gender differences are immutable and/or natural (Brescoll et al., 2013; Brown, Diekman, & Schneider, 2011; Iatridis & Stergiou, 2016; Kray et al., 2017; Mahalingam, 2003; Morton et al., 2009; Rudman et al., 2012). If particular societal mores afford men’s prototypical qualities and skills more prestige, the effects and interactions between expertise-based cues and role models’ gender have the potential to affect who is considered an expert and in effect, whom we choose in crucial social learning situations.

Though the presence of prestigious women fosters more positive outcomes for other women in under-represented areas such as politics (Wolbrecht & Campbell, 2017) and engineering (Dennehy & Dasgupta, 2017), these studies on women as mentors and leaders for other women tentatively suggest that prestigious women are gender-specific role models rather than role models for all individuals. The role of gender in expert-biased learning has received less attention, but available research suggests that the gender of leaders impacts how social learning occurs – primarily, by leading learners to elect to learn from a person who exhibits power, success, or competence (Henrich et al., 2015; Henrich & Henrich, 2010; Kendal et al., 2018; Over & Carpenter, 2015). In high-stakes social learning situations, gender bias may lead individuals to believe that men are more likely to be experts than women. On the other hand, expert-bias may lead some to choose an expert based on their prestigious qualities. Thus, our
goal is to investigate whether expert biases can potentially override gender biases in social learning situations and whether these biases function differently when the learners are men or women. Given the body of literature on the positive effects of female representation in high-status positions (Dennehy & Dasgupta, 2017), this study aims to examine whether representation translates to meaningful outcomes, namely whether the presence of Female Expert (versus Male Expert) results in her selection as a social learning model and how the selection impacts the extent to which social learning occurs. This study extends the social learning literature to individuals of diverse backgrounds, particularly adults outside of academic environments.

**The Present Study**

Two studies, based on community samples, test predictions relating to the effects of gender- and expert-biased learning on social learning. In the present studies, expertise cues are characterised as extensive experience in a particular domain, supplemented by academic qualifications. Study 3 examines whether women are more likely to choose a Female Expert as a role model over a Male Expert and whether gender similarities between models and learners overrides expertise-related information in both genders. Participants will select one of four individuals (varied in gender and expertise-levels) to help them in an unfamiliar task and the extent to which they incorporate the responses of the model is the estimate of social learning. Using similar dependent variables, Study 4 eliminates the model-choice element in Study 3 and randomly assigns one of four models to examine expertise-level and gender effects on social learning. In both studies, participants complete various self-report measures, with a special focus on a measure of the extent to which an individual legitimises gender inequalities through a measure of gender system justification.
Previous works suggest that individuals choose experts (or high-prestige individuals) models based on similarities (Chudek, Heller, Birch, & Henrich, 2012; Henrich & Gil-White, 2001) and recent works show that women and men rate supervisors of their own gender more positively (Doering & Thébaud, 2017; Vial, Brescoll, Napier, Dovidio, & Tyler, 2018). Other research suggests that women, in particular, show comparable outcomes when exposed to either male or female experts (Dennehy & Dasgupta, 2017; Eagly, Makhijani, & Klonsky, 1992).

Based on these findings, for Study 3, it is hypothesised that women are expected to show a comparable likelihood of choosing the Male Expert and Female Expert model. Men are more likely to choose the Male Expert than the Female Expert to learn from. Furthermore, participant gender and model choice are both predicted to impact social learning (measured by the extent to which they emulate the model) such that women who choose either the Male or Female Expert will socially learn at comparable levels. Men who choose the Male Expert will socially learn more compared to men who choose the Female Expert. The two-way interaction of participant gender and model choice is expected to be moderated by gender system justification. Higher GSJ for both men and women will increase social learning rates (to varying degrees) from the Male Expert over the Female Expert. I also include a measure of risk aversion to examine whether participants’ decisions in the novel task were not accounted for by their risk-taking levels.

For Study 4, men and women exposed to the Male Expert are expected to socially learn more (to varying degrees) compared to those exposed to the Female Expert. When exposed to either the Male Non-Expert or Female Non-Expert, participants are expected to learn more from the model of the same gender as them. The three-way interaction of participant gender, model sex, and expertise level was expected to be moderated by gender system justification (GSJ) such
that higher GSJ for both men and women will increase social learning rates (to varying degrees) from the Male Expert over the Female Expert.

**Method**

Prior to data collection, separate power analyses were conducted for the two studies, pre-registered on the Open Science Framework (https://osf.io/c2qye). All data reported can be accessed via this pre-registration link. As the hypotheses were pre-registered before examining the demographic characteristics of the sample, the predictions did not consider the predominantly African-American participants in Study 3. A sample of undergraduates were recruited for a supplementary study (Study 3a), which is reported in Appendix E.

**Study 3 Method**

**Participants**

Participants were community members from a large, urban city in the United States (U.S.), recruited by a local university, with procedures approved by an institutional review board. Research assistants recruited participants in-person as well as through online mailing lists and website-based or social media postings. The contact information of participants was only accessible to recruitment personnel at the local university. The authors were not directly involved in the recruitment process or the initiation of contact with potential participants.

A total of 257 individuals participated in the study. Twenty-four participants were excluded for failing multiple attention checks, and further six participants were excluded for not reporting their gender. Among the remaining 227 participants \(
M_{age} = 38.75 \text{ years, } SD = 14.57, \text{ range } = 18 – 88 \text{ years},
\) the majority identified as African Americans (122) or White or European (56). The remainder consisted of those identifying as Mixed ethnicity (16), Hispanic/Latinx/Central American (9), South/Central Asian (8), Northeast Asian (6), African (2),
Southeast Asian (2), Arabic/Middle Eastern/North African (1), and Native American (1). One participant chose “Other,” and three participants did not report their ethnicity. The sample consisted of 125 men and 102 women. Most participants were born in the U.S. (205) and/or had lived in the U.S. for more than five years (223).

Measures

**Arctic survival task.** The Arctic survival task consisted of asking participants to rank-order a set of nine items (e.g., arctic sleeping bag, granola bar, GPS tracker) based on their suitability for a long-term research trip in the Arctic. Participants had to choose three items each for three levels of importance – highest, average, and lowest importance. The task was adapted from a widely-used team-building exercise (Hall & Watson, 1970) and a similar ranking-based task has been used in previous research on expertise (Cheng et al., 2013).

**Role model profiles.** The models varied by gender (female and male) and expertise (expert or non-expert on the Arctic). Expert was characterised as seniority in rank and longer duration spent in the Arctic, reflective of competence. The Female Expert was described as “Dr. Sandra A., Arctic Climate Scientist, 74 months spent in the Arctic for research project”, while the Female Non-Expert was described as “Claire M., research assistant, 12 months spent in the Arctic for research project.” The corresponding male profiles were described as “Dr. James S., Arctic Research Scientist, 74 months spent in the Arctic for research project” for the Male Expert profile, and “Cole P., Research Assistant, 12 months spent in the Arctic for research project” for Male Non-Expert one.

**Gender system justification** (Jost & Kay, 2005). Participants completed an 8-item scale measuring their views on systemic gender-based inequalities with items such as “In general, relations between men and women are fair.” They completed the measure using a 9-point Likert
scale (1 – strongly agree, 9 – strongly disagree). A lower score is indicative of a reduced tendency to justify gender inequality ($\alpha = .70$).

**Risk aversion** (Ball & Zuckerman, 1990) Participants completed the 15-item scale indicating their agreement with self-related risk-taking behaviours. They responded to items such as “If I invested in stocks I would probably lose money” using a 7-point scale (1 – strongly agree, 7 – strongly disagree). A lower score on this scale is indicative of less risk aversive tendencies ($\alpha = .79$).

**Additional measures.** Participants completed additional questionnaires used in exploratory analyses – Social Dominance Orientation (Pratto, Sidanius, Stallworth, & Malle, 1994; SDO) and Right-Wing Authoritarianism (Zakrisson, 2005; RWA). For SDO, participants rated the extent of positive/negative feelings induced by 16 statements such as “Group equality is not a worthwhile ideal” on a 7-point scale (1 – very negative, 7 – very positive). A higher score is indicative of increased endorsement for group-based hierarchy ($\alpha = .86$). For the RWA, participants rated 15 items describing right-wing, conservative views (e.g., “The old-fashioned ways” and “old-fashioned values” still show the best way to live”) on a 9-point scale (1 – very negative, 9 – very positive), with higher scores indicating more favourable views for authoritarian beliefs ($\alpha = .81$). The GSJ, Risk Aversion, and additional measures were administered after the dependent variable to minimise the possible effects of additional gender-based cues (e.g., from gender system justification) in revealing the actual purpose of the study.

**Procedure**

Participants arrived at a lab for a study titled “Investigation of Decisions Made in New Situations.” They completed the study on a computer through the Qualtrics platform. Next, they were instructed to read through an information sheet and provide informed consent. The study
began with a brief statement describing weather conditions in the Arctic and the lack of access to resources. Then, participants were instructed to rank-order a list of nine items needed for surviving in the Arctic. Once completed, all participants were shown the same bogus survival score (55% survival rate) and then provided with the four social learning profiles as individuals who may help improve their survival score. Participants were told to select one individual to see their recommended ranking for the survival items. They selected only one model that they believed would improve their survival rates based on the profile information. All participants received the same rank-order of items as the model’s rank, regardless of which profile they chose. A standardised image of a group of Arctic researchers accompanied the profile to increase the authenticity of the profile information.

Once having read the profile, participants had the option to modify their initial rankings based on the information provided by the chosen individual. Next, participants completed a study check, which asked them to recollect information about the person they chose. Then, participants completed the GSJ, Risk Aversion, RWA, and SDO questionnaires, all presented in a randomised order. Following this, they completed demographic items such as age, gender, ethnicity, country of birth, language/s spoken, and length of U.S. residence, as well as a one-item measure of political views measured on seven points: 1 (very liberal) to 7 (very conservative). Finally, participants were debriefed on the real purpose of the study and compensated. The study lasted for about 15 minutes.

**Analysing Social Learning Rates**

Social learning was estimated based on an adjusted Spearman’s rho formula, which measures the correlations between rankings based on the distance between two sets rankings (Cohen, 2008). The following equation was used:
\[ y_i = \frac{\sum_{j=1}^{9} (x_{ij \ post} - x_{j \ model})^2}{\sum_{j=1}^{9} (x_{ij \ pre} - x_{j \ model})^2} \]

Where \( y_i \) represents the probability of not socially learning for participant \( i \), \( x_{ij} \) represents participant \( i \)'s ranking on item \( j \), and \( x_j \) represents the model’s ranking of item \( j \). The probability is derived from the differences in item rankings between the participants and model post-social information exposure relative to pre-social information exposure, for each of the nine items (resulting in an outcome with a binomial distribution). Both expressions in parentheses are squared to make all ranking differences positive integers. Participants who show a higher probability of not incorporating social information are those who have larger differences between theirs and the model’s rankings. This is indicative of a low level of learning from the model. This method accounts for individuals who had ranked specific items in isolation and maintained those items after receiving the social information. It also provides the estimation of opportunities to socially learn that participants utilised relative to the opportunities they had, given their original ranking. The findings are visualised based on the probability of not socially learning, but for the sake of clarity, the results are explained as the probability of socially learning.

**Study 3 Results**

To test the effect of Participant Gender on whether participants chose the Male Expert or Female Expert (dichotomous outcome), I compared the frequencies through a chi-square test for proportions, with the Phi coefficient \( (\phi) \) as an estimate of effect size. I fitted a generalised linear model, assuming a binomial distribution with a logit link function and examined all possible interactions between Participant Gender (male vs. female) and Model Type (Male Expert vs. Female Expert), with GSJ and risk aversion as moderators (all continuous predictors were
centred) on social learning probabilities (bounded between 0.00 and 1.00), with odds ratios as estimate of effect size. All models were tested for over-dispersion and estimated using PROC FREQ and PROC GLIMMIX in SAS 9.4 for Windows (SAS Institute Inc, 2017).

Only 10 participants selected the Non-Expert models. Thus, these 10 data points were excluded from the analyses due to insufficient representation (a criteria documented in the pre-registration); the subsequent analyses only included participants who chose the two Expert models. Unexpectedly, the estimation of social learning revealed that 16 participants had proportions above 1.00, indicating that their distance from the model rankings increased after receiving the expert’s opinion compared to before. Here, participants changed their rankings in a manner that further distanced themselves from their chosen model after viewing the model’s rankings. These 16 data points were not exclusive to a particular model type. Though an attention check was not included within the arctic survival task, these unexpected responses potentially indicate participants’ lack of attention given that they did change their ranking, in a potentially nonsensical manner. Such an occurrence has been suggested in theoretical works on social learning (Boyd et al., 2011; Griffiths et al., 2013), where individuals may receive social information, but that information results in anti-learning (due to misunderstandings) or no learning at all. Given that there are not enough individuals in this sub-group to explore this “lack of learning” further, these 16 observations were excluded from the main analyses.

To account for multiple comparisons, a sequential Holm-Bonferroni correction (HBC) was performed, which involved correcting the lowest p-values first as a more conservative correction for multiple comparisons (Abdi, 2010). HBC p-values are reported along with the uncorrected p-values as previous research indicate reporting both p-values is informative in interpreting the results (Murray, Fessler, Kerry, White, & Marin, 2017). Given that the
moderators were administered after the dependent measure, I ran additional analyses to examine the effect of the manipulated independent variable on the moderators. The manipulated independent variable – Model Choice – did not significantly affect any of the moderator variables (p’s > .050)

Effects of Participant Gender on Model Selection

I compared the frequencies in model selection within each gender (i.e., the ratio for women/men selecting Female Expert or Male Expert) through a chi-square test for proportions. Overall, more women chose the Female Expert (79%) model than the Male Expert (21%) one, $X^2(1, N=90) = 57.78, p < .001$ (HBC $p < .001$), $\varphi = .80$, showing a large effect size (see Cohen, 1988). Men were also overall more likely to choose the Female Expert model (63%), $X^2(1, N=111) = 7.58, p = .006$ (HBC $p = .012$), $\varphi = .26$, albeit a small effect.

Effects of Participant Gender, Model Choice, and Gender System Justification on Social Learning

I examined the effects of Participant Gender and Model Choice (i.e., whether participants chose the male or female expert) on social learning probabilities. The main effect of Participant Gender [$F(1,197) = 24.50, p < .001$ (HBC $p < .001$)] was significant, but the main effect of Model Choice was not [$F(1,197) = 0.16, p = .690$]. The interaction between Participant Gender and Model Choice on learning probabilities was significant, $F(1,197) = 42.50, p < .001$, (HBC $p < .001$), $\eta^2 = .18, 95\% CI [.09, .27]$ (see Figure 3 and Table 8). Comparing the gender-matched combinations, men who chose the Male Expert showed higher probabilities of learning compared to women who chose the Female Expert model, $t(197) = -3.72, p < .001$, (HBC $p = .001$), $OR = 0.89, 95\% CI [0.83, 0.95]$. Among those who made cross-gender model selections, women who
chose the Male Expert showed lower probabilities of learning compared to men who chose the Female Expert model, $t(197) = -3.38, p < .001$, (HBC $p = .005$), $OR = 0.87$, 95% CI [0.80, 0.94].

<table>
<thead>
<tr>
<th>Participant Gender</th>
<th>Model Choice</th>
<th>Means for Probability of Not Socially Learning (SE$_{mean}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>Female Expert</td>
<td>.349 (.004)</td>
</tr>
<tr>
<td></td>
<td>Male Expert</td>
<td>.391 (.009)</td>
</tr>
<tr>
<td>Men</td>
<td>Female Expert</td>
<td>.358 (.005)</td>
</tr>
<tr>
<td></td>
<td>Male Expert</td>
<td>.322 (.006)</td>
</tr>
</tbody>
</table>

Among men, those who chose the Female Expert had lower probabilities of learning than those who chose the Male Expert, $t(197) = 4.94, p < .001$, (HBC $p < .001$), $OR = 1.18$, 95% CI [1.10, 1.25]. Women had higher probabilities of learning when they chose the Female Expert compared to the Male Expert, $t(197) = -4.40, p < .001$, (HBC $p < .001$), $OR = 0.83$, 95% CI [0.77, 0.90].

Among those who chose the Male Expert, women were less likely to learn compared to men, $t(197) = -6.72, p < .001$, (HBC $p < .001$), $OR = 0.74$, 95% CI [0.68, 0.81]. Both women and men who chose the Female Expert model did not show significantly different probabilities of learning, $t(197) = 1.50, p = .135$, $OR = 1.04$, 95% CI [0.99, 1.10].
Figure 3. The interaction effect of Participant Gender and Model Choice on social learning. Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.

Gender system justification. The inclusion of GSJ significantly moderated the interaction effect of Participant Gender and Model Choice on learning (see Figure 4), \( F(1,193) = 14.02, p < .001 \) (HBC \( p < .001 \)), \( \eta^2 = .07, 95\%CI [.01, .14] \). The simple slopes for GSJ predicting social learning for each of the four conditions were evaluated. The associations between GSJ and social learning was significant for both those who chose the Female Expert \( b = .04, SE = .01, t(201) = 10.72, p < .001 \) and the Male Expert \( b = .02, SE = .01, t(201) = 3.09, p \).
Higher GSJ decreased social learning for most participants, but the opposite pattern was shown for women who chose to learn from the Female Expert, where higher GSJ increased social learning.

**Figure 4.** The effects of participant gender, model choice, and gender system justification (GSJ) scores (centred) on social learning index (with 95% confidence intervals). A lower score on GSJ represents a reduced tendency to justify gender inequality. Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.
**Risk aversion.** Risk aversion was not a significant moderator for the interaction of Participant Gender and Model Choice on social learning, $F(1,193) = 2.83, p = .094, \eta^2 = .02, 95\% CI [.01, .06].

**Exploratory analyses.** Both SDO [$F(1,193) = 22.90, p < .001, \eta^2 = .11, 95\% CI [.04, .19]$ and RWA [$F(1,193) = 53.62, p < .001, \eta^2 = .22, 95\% CI [.12, .31]$ significantly moderated the interaction of Participant Gender and Model Choice on social learning probabilities.

For SDO (see Figure 5), simple slopes indicated that among those who chose the Male Expert, women who endorsed fewer group-based hierarchies showed lower probabilities of socially learning than women who did endorse them ($p < .001$). Men who chose the Male Expert showed comparable probabilities of socially learning across the SDO spectrum. Among those who the Female Expert, the simple slope was not significant ($p = .787$). Thus, higher SDO increased learning overall, with the exception of men who chose the Male Expert, who showed the opposite pattern.
Figure 5. The interaction of participant gender and model choice, moderated by social dominance orientation (SDO) scores on social learning probabilities (with 95% confidence intervals). A lower score on SDO represents lower tendency to endorse group hierarchy-based beliefs. Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.

For RWA (see Figure 6), simple slopes indicated that among participants who chose the Male Expert, women who endorsed more right-wing authoritarian values showed lower probabilities of socially learning than women who made less authoritarian endorsements ($p < .001$). Men who chose the Male Expert showed comparable social learning probabilities across
levels of RWA. Among those who chose the Female Expert, both women and men scoring higher on RWA showed lower probabilities of socially learning compared to their same gender counterparts who scored lower on RWA ($p$’s < .001).

*Figure 6.* The interaction of participant gender and model choice, moderated by right-wing authoritarianism (RWA) scores on social learning probabilities (with 95% confidence intervals). A lower score on RWA represents lower tendency to endorse right-wing authoritarian beliefs. Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.
To summarise, Study 3 showed that when given a choice, both women and men chose the Female Expert more often than the Male Expert. With regards to social learning, women and men learnt at the same rate when they chose the Female Expert. Men showed higher learning probabilities if they had chosen the Male Expert, whereas women showed lower learning probabilities if they made the same choice.

Overall, higher justification of gender inequalities reduced social learning for most participants, with the exception of women who chose to learn from the Female Expert, who showed increased social learning. In particular, women who chose the Male Expert were less likely to socially learn than men who chose the Female Expert, especially if they showed increased justification of gender inequality. These men who chose the Female Expert and more strongly justified gender inequality were less likely to learn. Among men and women who chose the Male Expert, those with stronger tendencies to justify gender inequality were less likely to learn.

These findings further our understanding of how, when making a choice on whom one wishes to emulate, compared with members of the other gender, individuals were more likely to choose someone of their own gender (Chudek et al., 2012). If they chose someone of a different gender, their individual beliefs about gender inequality (and general group hierarchy through social dominance orientation) influenced the extent to which they learn from them (Henrich & Gil-White, 2001). The next study examines whether taking away that choice by randomly assigning one of four models - differentiated by gender and expertise level - influences social learning.
**Study 4 Method**

In Study 4, the choice component in Study 3 was eliminated to create a between-subjects, randomised design, where participants were only exposed to one of the four models. This design allows an assessment of social learning that is not coloured by the preference of the model’s sex, similar to many real-life situations. I also included a measure of model evaluation to examine whether participants’ evaluation of the assigned model was related to model characteristics.

**Participants**

Participants were recruited via the microworkers site, TurkPrime (Litman et al., 2017). They were limited to: (1) U.S. residents, (2) workers with Master Workers qualification (given by Mechanical Turk based on pre-determined criteria such as data quality, approval rating, and completion rate), (3) workers with 97% and above approval rating, and (4) more than 100 completed Human Intelligence Tasks (HITs). Participants received US$1.25 for their participation. Overall, the study had a low dropout (or self-selection) rate; only 6% of all workers who viewed the study opted out.

A total of 301 participants ($M_{age} = 41.05$ years, $SD = 11.72$, range = 22 – 88 years) completed the study, all of whom passed all attention checks. The sample consisted of 146 men and 155 women, who mostly identified as White or European (233). The remainder identified as African American (22), Mixed ethnicity (15), Northeast Asian (11), Hispanic/Latinx/Central American (8), Southeast Asian (4), Native American or Alaskan Native (1), Native Hawaiian/Pacific Islander (1), and Arabic/Middle Eastern/North African (1). Three participants chose “Other” and two participants did not report their ethnicity. Most participants were born in the U.S. (290) and/or had lived there for more than five years (300).
Procedure and Measures

The procedure for Study 4 was mostly similar to that of Study 3 with exceptions noted below. Potential participants who qualified for the study were able to access the study information and hyperlink via their Amazon Mechanical Turk account. Once there, they were directed to the study taken on the Qualtrics platform. They read through an information sheet and provided informed consent. Similarly to Study 3, Study 4 began with a brief statement describing the conditions in the Arctic, following which participants’ rank-ordered nine survival items. Once completed, they viewed a bogus survival score (55% survival rate). Then, participants were randomly assigned to view one of the four potential models (i.e., Female Expert, Male Expert, Female Non-Expert, Male Non-Expert) who also ranked the same items and thus may help the participant improve their survival scores. All participants received the same rank-order of items as the model’s rank, regardless of which profile they were assigned. To increase the authenticity of the profile information, a standardised image of a group of Arctic researchers accompanied the profile.

After viewing the recommendation of their assigned model, participants had the option to modify their initial ranking of items. Next, participants completed a study check, recollecting information about their assigned model, whom they then evaluated the Affective Response to Social Exchange questionnaire (Molm, Collett, & Schaefer, 2007). The 5-item measure (α = .88) assesses perceived qualities of the model (e.g., How unskilled/skilled did the arctic researcher seem to be?) rated on an 11-point bipolar semantic differential scale (e.g., Unskilled – Skilled). Following this, participants completed the GSJ (α = .90), RWA (α = .94), and SDO (α = .95) measures, all presented in a randomised order and centred prior to analyses. Finally, they
completed a series of demographic items, after which they were debriefed on the true purpose of the study and compensated appropriately.

Results

To examine the combined effects of Participant Gender (man vs. woman), Model Sex (male vs. female), and Expertise Level (expert vs. non-expert) on social learning probabilities, I estimated a generalised linear model, assuming a binomial distribution model using PROC GLIMMIX in SAS 9.4, with GSJ as a moderator. I also explored the role of SDO and RWA as moderators using interaction terms. These interaction effects on model evaluation (continuous outcome) were estimated as a generalised linear model using PROC MIXED.

As in Study 3, 15 participants who had social learning scores above 1.0, indicative of a lack of attention during the survival task, were excluded. The sequential Holm-Bonferroni correction (HBC) was applied again to account for multiple comparisons and report both uncorrected and corrected p-values. As the moderators were administered after the dependent measure, I ran additional analyses to examine the effects of the manipulated independent variables on the moderators. Both the manipulated independent variables – Model Sex and Expertise Level – did not significantly affect any of the moderator variables (p’s > .050).

Effects of Participant Gender, Model Sex, Expertise Level, and Gender System

Justification on Social Learning

Both the main effects of Participant Gender, $F(1,276) = 375.25, p < .001$ (HBC $p = .001$), $\eta^2 = .58, 95\% CI [.50, .63]$ and Model Sex, $F(1,276) = 24.82, p < .001$ (HBC $p = .001$), $\eta^2 = .08, 95\% CI [.03, .15]$ had significant effects on social learning. The main effect of Expertise Level was non-significant, $F(1,276) = 1.85, p = .174, \eta^2 = .01, 95\% CI [.01, .04]$. The two-way interaction between Model Sex and Expertise Level on social learning was significant, $F(1,276)$
= 397.91, \( p < .001 \) (HBC \( p = .001 \)), \( \eta^2 = .59 \), \( 95\%CI [.52, .65] \). The two remaining two-way interactions were non-significant (\( p \)’s > .050).

The three-way interaction of Participant Gender, Model Sex, and Expertise Level (see Table 9) had a significant effect on social learning, \( F(1,276) = 27.78, \ p < .001 \) (HBC \( p < .001 \)), \( \eta^2 = .09 \), \( 95\%CI [.04, .16] \). When this interaction is examined across genders (see Figure 7 and Table 9), both women and men indicated a similar pattern of social learning after receiving social information from the model, with men consistently showing lower probabilities of socially learning from all four models than women (all \( p \)’s and corrected \( p \)’s < .001). When examined across the four model types, the contrasts indicate that both women and men showed similar probabilities of socially learning from the Male Expert and the Female Non-Expert (see Table 10). However, both women and men had lower probabilities of socially learning from the Male Non-Expert and the Female Expert. Both women and men also had comparable social learning probabilities from the Male Non-Expert compared to the Female Expert.
Table 9. Descriptives of Study 4 variables.

<table>
<thead>
<tr>
<th>Participant Gender</th>
<th>Model Gender</th>
<th>Expertise Level</th>
<th>Means for Probability of Not Socially Learning (SE&lt;sub&gt;mean&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>Female</td>
<td>Non-Expert</td>
<td>.300 (.007)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Expert</td>
<td>.418 (.006)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Non-Expert</td>
<td>.384 (.006)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Expert</td>
<td>.278 (.006)</td>
</tr>
<tr>
<td>Men</td>
<td>Female</td>
<td>Non-Expert</td>
<td>.403 (.008)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Expert</td>
<td>.484 (.008)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Non-Expert</td>
<td>.456 (.007)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Expert</td>
<td>.394 (.007)</td>
</tr>
</tbody>
</table>
Figure 7. Three-way interaction effect of participant gender, model sex, and expertise level on social learning probabilities (with $SE_{\text{mean}}$). Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.
Table 10. Contrasts for three-way interaction of Participant Gender, Model Sex, and Expertise Level on social learning

<table>
<thead>
<tr>
<th>Participant Gender</th>
<th>Model x Expertise Level</th>
<th>t-value</th>
<th>p (HBC p)</th>
<th>OR [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>Male-Low vs Male-High</td>
<td>6.68</td>
<td>&lt; .001 (&lt;.001)</td>
<td>1.29 [1.20, 1.39]</td>
</tr>
<tr>
<td></td>
<td>Male-Low vs Female-Low</td>
<td>5.64</td>
<td>&lt; .001 (&lt;.001)</td>
<td>1.24 [1.15, 1.34]</td>
</tr>
<tr>
<td></td>
<td>Male-Low vs Female-High</td>
<td>−2.74</td>
<td>.007 (.039)</td>
<td>0.90 [0.83, 0.94]</td>
</tr>
<tr>
<td></td>
<td>Male-High vs Female-Low</td>
<td>−0.99</td>
<td>.323</td>
<td>0.96 [0.89, 1.04]</td>
</tr>
<tr>
<td></td>
<td>Male-High vs Female-High</td>
<td>−8.91</td>
<td>&lt; .001 (&lt;.001)</td>
<td>0.69 [0.64, 0.75]</td>
</tr>
<tr>
<td></td>
<td>Female-Low vs Female-High</td>
<td>−7.94</td>
<td>&lt; .001 (&lt;.001)</td>
<td>0.72 [0.67, 0.78]</td>
</tr>
<tr>
<td>Women</td>
<td>Male-Low vs Male-High</td>
<td>12.24</td>
<td>&lt; .001 (&lt;.001)</td>
<td>1.62 [1.50, 1.75]</td>
</tr>
<tr>
<td></td>
<td>Male-Low vs Female-Low</td>
<td>9.20</td>
<td>&lt; .001 (&lt;.001)</td>
<td>1.46 [1.35, 1.58]</td>
</tr>
<tr>
<td></td>
<td>Male-Low vs Female-High</td>
<td>−3.84</td>
<td>&lt; .001 (.001)</td>
<td>0.87 [0.81, 0.93]</td>
</tr>
<tr>
<td></td>
<td>Male-High vs Female-Low</td>
<td>−2.48</td>
<td>.014 (.083)</td>
<td>0.90 [0.83, 0.98]</td>
</tr>
<tr>
<td></td>
<td>Male-High vs Female-High</td>
<td>−16.32</td>
<td>&lt; .001 (&lt;.001)</td>
<td>0.54 [0.50, 0.58]</td>
</tr>
<tr>
<td></td>
<td>Female-Low vs Female-High</td>
<td>−13.01</td>
<td>&lt; .001 (&lt;.001)</td>
<td>0.60 [0.55, 0.65]</td>
</tr>
</tbody>
</table>

Gender system justification. The inclusion of GSJ significantly moderated the three-way interaction of Participant Gender, Model Sex, and Expertise Level on social learning (see Figure 8), $F(1,268) = 105.68, p < .001$ (HBC $p < .001$), $\eta^2 = .28$, $95\%CI [.19, .36]$. For most men, simple slopes indicated that stronger justification of gender inequalities significantly increased the probability of socially learning, especially when they were exposed the Female Non-Expert [$b = -.02, SE < .01, t(284) = -11.90, p < .001$ (HBC $p < .001$)]. The same directional effect was shown for the Male Non-Expert [$b < -.01, SE < .01, t(284) = -5.34, p < .001$ (HBC $p < .001$)], and the Female Expert [$b < -.01, SE < .01, t(284) = -.66, p = .508$], but weak or non-significant effects. Conversely, stronger tendencies to justify gender inequality significantly
decreased the probability of social learning among men exposed to the Male Expert \( [b < .01, SE < .01, t(284) = 3.62, p < .001 \text{ (HBC } p = .001) ] \).

Among women, simple slopes indicated that women exposed to the Male Expert and justified gender inequalities significantly decreased the probability of socially learning, the strongest effect shown \( [b = -.06, SE < .01, t(284) = -20.30, p < .001 \text{ (HBC } p < .001) ] \). All other women who were exposed to either, the Male Non-Expert \( [b = .01, SE < .01, t(284) = 3.50, p < .001 \text{ (HBC } p = .002) ] \), Female Expert \( [b = .01, SE < .01, t(284) = 3.87, p < .001 \text{ (HBC } p < .001) ] \), Female Non-Expert \( [b < .01, SE < .01, t(284) = .65, p = .515] \), and had stronger tendencies to justify gender inequality, decreased the probability of socially learning with weaker or non-significant effects.
Figure 8. The interaction of participant gender, model sex, and expertise level, moderated by gender system justification (GSJ) scores (centred) on social learning probabilities (with 95% confidence intervals). A lower score on GSJ represents lower tendency to justify gender inequality. Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.

**Exploratory analyses.** Potential moderating effects of SDO and RWA on the three-way interaction effect of Participant Gender, Model Sex, and Expertise Level on social learning, were evaluated. Both SDO \[ F(1,268) = 30.96, p < .001, \eta^2 = .10, 95\% CI [.05, .18] \] and RWA \[ F(1,268) = 52.10, p < .001, \eta^2 = .16, 95\% CI [.09, .24] \] significantly moderated the three-way...
interaction effect. For men, simple slopes indicated that higher rates of SDO decreased probabilities of social learning from all four models ($p$’s $\leq .005$). For women, higher SDO also decreased the probability of social learning, but only from the Female Expert and the Male Expert ($p$’s $< .001$). Women showing higher SDO had higher probabilities of social learning for the Female Non-Expert ($p < .001$), but no significant effect was found for the Male Non-Expert ($p = .159$; see Figure 9).
Figure 9. The interaction of participant gender, model gender, and expertise level, moderated by social dominance orientation (SDO) scores on social learning probabilities (with 95% confidence intervals). A lower score on SDO represents lower tendency to endorse group hierarchy-based beliefs. Higher probabilities of not socially learning indicate more differences between participants’ and model rankings.

Simple slopes for RWA (see Figure 10) indicated that among men, higher RWA endorsement decreased probability of socially learning for Female Expert ($p < .001$) and the Male Non-Expert ($p < .001$), but had no significant effect on men’s social learning from the Male Expert ($p = .998$) and Non-Expert Female ($p = .129$). Among women, lower RWA endorsement
decreased the probability of social learning from only the two female models – Female Expert and Female Non-Expert (p’s < .001). No significant effects were found for the two male models – Male Expert (p = .100) and the Male Non-Expert (p = .213).

Figure 10. The interaction of participant gender, model gender, and expertise level, moderated by right-wing authoritarianism (RWA) scores on social learning probabilities (with 95% confidence intervals). A lower score on RWA represents lower tendency to endorse right-wing authoritarian beliefs. Higher probabilities of not incorporating social informative indicate more differences between participants’ and model rankings (thus, less social learning).
Effects of Participant Gender, Model Sex, Expertise Level, and Gender System

Justification on Model Evaluation

The residuals of the model evaluation outcome were skewed (no extreme outliers) and the model was initially tested using a log-normal distribution, which did not change the effects shown considerably. Thus, the original model was maintained as the final model. The main effect of Gender significantly influenced participants' evaluations of their assigned model, $F(1,277) = 7.17, p = .008$, (HBC $p = .056$), $\eta^2 = .03$, 95%CI [.01, .07]. Overall, women ($M = 36.99, SE = .91$) made more positive evaluations of their assigned model than men ($M = 33.50, SE = .93$). All other main and interaction effects were non-significant ($p$’s > .050).

To summarise, Study 4 found that when there is no knowledge of other available experts, women and men learnt less from the Female Expert than the Female Non-Expert, but more from the Expert Male than the Non-Expert Male. Overall, men learnt less than women. Among women, as expected, those who justified gender inequalities learnt more from Expert Male, the strongest effect shown, but learnt less from the Female Expert and the Non-Expert Male. For men, those who justified gender inequalities learnt more from the Non-Expert Male and the Non-Expert Female, but less from the Expert Male. Gender system justification did not influence social learning from the Female Expert for both women and men. For men, the exploratory analyses also indicated that other beliefs of group-based norms such as RWA influenced social learning.

These effects provide support for how cues of gender and expertise interact to affect the social influence of expert women and men. In particular, Study 4 shows that women and men possibly look for different cues as markers of expertise in these situations. I discuss this possibility further in the General Discussion. Next, given the commonalities in design between
the two primary studies and the one supplementary study, I conducted a series of internal meta-
analyses to examine the overall effects of the three studies.

**Internal Meta-Analysis**

Internal meta-analyses of relevant effects of Studies 3, 3a (reported in Appendix E), and 4 were conducted. These analyses aim to compare effects using robust methods, weighted by their respective sample sizes (Goh, Hall, & Rosenthal, 2016). The studies meet the assumptions of conducting internal meta-analyses – (1) All studies are free of p-hacking, as evidenced by the pre-registered analyses and (2) All valid studies are included, as evidenced by the inclusion of the Study 3a. All p-values reported are two-tailed.

Separate internal meta-analyses examined the robustness of the interaction effect of Participant Gender and Expert Sex (Male Expert e and Female Expert) and the moderating effect of GSJ on social learning probabilities across all three studies (N = 548).

The first meta-analysis examined the effect of participant gender on social learning probabilities from each of the experts, with odds ratio (OR) estimates as effect sizes. The overall effect of participant gender on social learning was significant for the Male Expert model, $\text{OR}_{\text{Mean}} = 1.17$ [95% CI (1.10, 1.23)], $Z = 5.42, p < .001$, as well as the Female Expert, $\text{OR}_{\text{Mean}} = 1.09$ [95% CI (1.05, 1.14)], $Z = 5.42, p < .001$. Random effects analyses were significant for both the Male Expert, $t(2) = 35.41, p < .001$ and Female Expert models, $t(2) = 46.12, p < .001$.

In examining the effect of participant gender and the moderating effect of GSJ on social learning from the two expert models, the simple slopes estimates were converted into Cohen’s $d$. For the Female Expert model, the effects of participant gender and GSJ levels on the probability of social learning were significant with an overall large effect size, $d_{\text{Mean}} = 1.30$ [95% CI (1.01, 1.58)], $Z = -8.94, p < .001$. A fully random effects model of the overall effect was significant,
For the Male Expert, the effects of participant gender and GSJ levels on the probability of social learning were significant with an overall large effect size, $d_{\text{Mean}} = 1.18$ [95% CI (.74, 1.63)], $Z = -5.23, p < .001$. The fully random effects model was significant, $t(2) = -5.23, p = .035$.

**Study 3 and 4 Discussion**

Across studies of diverse samples, I found evidence that in social learning situations, expertise- and gender-based social information on expertise have differential effects on who women and men choose as a role model and the extent to which they socially learn from these models, with consideration for the learners’ beliefs about gender inequalities. In a multicultural, predominantly African-American community sample, both women and men chose the Female Expert more frequently than the Male Expert. Men who chose the Male Expert showed higher social learning than men who chose the Female Expert, the largest ratio shown, whereas Women showed the opposite trend, albeit with a smaller effect. Only women who chose to learn from the Female Expert showed higher social learning if they believed gender inequalities were justified, while for all other participants showed lower social learning if they held the same beliefs.

Although the effect for women learning from the Female Expert is counter to the hypothesis, it is still an explainable outcome, as women who believe in gendered power systems will likely be influenced by individuals of authority than women who do not believe in the same systems. For all other participants, this effect diverges from previous experimental work using the same measure, gender system justification (Jost & Kay, 2005), or similar measures of system justification (Brescoll et al., 2013; Kray et al., 2017). The commonly expected effect is that higher justification of gender inequalities by individuals in disadvantaged groups will lead to higher agreement with the status quo. Men and women who chose the Male Expert and with
stronger tendencies to justify gender inequalities were less influenced by the expert, possibly indicative of women and men showing similar processing of gendered power cues, particularly in a task that is not highly-gendered. Future work should explore this possibility.

In Study 4, with a predominantly White-American sample, expertise and gender cues played a more significant role in social learning for women compared to men, notably when the model was Male. In line with prior work and my prediction, women with stronger tendencies to justify gender inequalities (compared to women with weaker tendencies) learnt more from the Male Expert, the largest effect shown, but learnt less from the Female Expert and Non-Expert Male. Surprisingly, men exposed to either the Male or Female Non-Experts and showed higher justification of gender inequalities learnt more compared to men exposed to the Expert Male and also showed higher justification of gender inequalities. Taken together, these findings show how gender, expertise, and individual beliefs about gender inequality influence the extent to which people learn from experts and non-experts. In fact, these findings are also the first to demonstrate how these effects can vary when individuals are given a choice of whom they want as a role model.

The exploratory analyses with SDO and RWA show that other beliefs about groups and systems contribute to the social influence of expert women and men, in line with previous research (Whitley Jr & Ægisdottir, 2000). In Study 3, women who chose the Male Expert and rated high on social dominance orientation showed higher social learning, whereas in Study 4, women who were assigned the Male Expert and rated high on social dominance orientation showed lower social learning. Both women and men in Study 3 with higher right-wing authoritarian endorsement who chose the Female Expert showed lower social learning as did such men who were assigned the Female Expert in Study 4. These findings underscore the
importance of hierarchy-based beliefs beyond gender-based ones, which affect the social influence of women and men in power.

Additionally, Studies 3 and 4 add to the understanding of how beliefs related to gender and gender-based status can potentially diverge from what is commonly known about system-justifying beliefs. Members of a dominant group may be more motivated to maintain the status quo, even if it is gender-unequal (Jost et al., 2004). Individuals in subordinate groups who have less power to change the status quo may hold views on the gender status quo that is distinct from their views of prestigious women (Iatridis & Stergiou, 2016). That justification of a gender-based status quo is attributable to the perception that the division of labour is “complementary but equal” (Iatridis & Stergiou, p. 39). Thus, individuals in the present studies who legitimise gender inequality may view a gender-based status quo as fair, while still being receptive to learning from expert women (or as shown in Study 4, even non-expert women). As such, in the present research, gender system justification may concern more normative beliefs about gender rather than beliefs about expertise itself.

Taken together, these studies provide a more nuanced view of how expertise-biased learning leads to gender-biased social influence. Though expert women were chosen more often (when given a choice), it did not necessarily translate to more influence, where it did for expert men, particularly when the learners were men. Thus, the gender of a prestigious person continues to have implications even after being afforded social status. Even if a woman has an influential position of leadership, followers’ beliefs about gender and social hierarchy may continue to affect the extent to which that woman shapes and contributes to the broader group culture. Over generations, these beliefs have the potential to shape larger cultural narratives associated with gender roles (Eisenhart & Holland, 1983; Hiller & Baudin, 2016).
However, the limitations of the present research should be considered in its evaluation. The Arctic survival task utilised in these studies, though a novel task to all participants, is also a situation that is low in stakes. In certain social learning situations, when the information is pertinent to a learner’s safety, they might be more attentive to displays of situation-specific competence rather than age or similarity (Chudek et al., 2012). Though the Arctic survival task may parallel other types of social learning situations such as mentorship and teaching, expert-biased learning could benefit from knowing how situationally-differentiated social learning occurs. Furthermore, as the present studies characterised the two non-experts - Male Non-Expert and Female Non-Expert models - with having some expertise (rather than no expertise), future studies may consider expertise in a non-binary nature (e.g., expert, non-expert, and no expertise). Further examination of what constitutes non-expert characteristics may provide a clearer picture of why both women and men in the present research showed different social learning tendencies from Male Non-Expert and Female Non-Expert models.

When considering the effects of the experts’ sex, the findings parallel previous works suggesting that experimenter gender effects account for specific behavioural and attitudinal effects, in psychological studies (Chapman, Benedict, & Schiöth, 2018). This line of work is particularly relevant to the present study when considering that in experimental research focusing on gender, an experimenter is seen as an individual of competence or authority. The present study accounts for a potential experimenter effect by making both studies virtual, with minimal to no interactions with an experimenter, but examining these dynamics further in future research could provide valuable considerations in designing lab-based gender experiments. Finally, the moderator measures were administered after the dependent variable to minimise potential effects that the measures, particularly gender system justification, may have in revealing the true
purpose of the study. Though additional analyses showed model choice in Study 3 and model type in Study 4 did not significantly affect the moderator variables, future studies should measure these moderators at a completely different time ideally.

The extension of this research into areas where women have historically-held positions of prestige or expertise, such as religious or spiritual leaders, may provide novel predictions for factors involved in evaluations of competence and prestige. This line of research is particularly relevant, given evidence suggesting that achievements of women are less likely to be afforded prestige, respect, and accolades compared to men (Atir & Ferguson, 2018; Eagly & Miller, 2016). Thus, future studies have much potential to extend the understanding of how social cognitions concerning gender differences influence expert-biased learning, particularly in identifying whether normative knowledge about gender (e.g., gender norms) impacts various forms of social learning.

The studies’ use of both choice-based and forced selections of the role models underscores an often overlooked element in examining the subordinate-supervisor relationship, in both social psychological and cultural evolutionary works - namely not everyone gets to choose their supervisor or “role model.” Individuals in some situations (e.g., choosing an academic supervisor) may have more options than others (e.g., being hired by a human resource manager). The differences in men’s social learning from the Female further and prior work (e.g., Creanza et al., 2017) support this notion, where men in Study 3 who chose a Female Expert learnt more than men in Study 4 assigned a Female Expert – the former being given the opportunity to confer deference rather than being forced to do so (see Gil-White & Henrich, 2001). These choices also vary as a product of environment, accessibility, organisational structures, and demographic factors like social class (see Remedios & Synder, 2018). For
example, in some patriarchal cultures, not only do women face challenges in the workplace, but male-female work interactions are taboo, which leads to a limited pool of experts (who are often men) for women to learn from. Future research on social influence should explore such possibilities.

**Conclusions**

The findings of the present studies provide tentative evidence for the role of gender, gender-related beliefs, and expertise in social learning. The use of community samples, in particular, indicated that expert-biased learning manifests in different forms in women and men. These findings contribute to a broader notion of the role of social status in large-scale societies, by providing preliminary evidence for how structural beliefs about gender roles can influence who is selected as a role model. Importantly, the findings, in support of theoretical works (e.g., Henrich & Gil-White, 2001; Kendal et al., 2018), show that gender-related factors impact a process fundamental to human’s cultural evolution – social learning. On a conceptual level, our findings indicate that if people learn to different extents from male and female role models, and both models’ characteristics and people’s beliefs about gender affect that learning, then such a bias may impact gender-based characteristics that are afforded importance in broader cultural narratives. Understanding whether long-standing beliefs about gender differences shape vital social processes like social learning could facilitate interventions at critical developmental stages to minimise the effects of such beliefs.
Chapter 6: General Discussion

When attempting to understand how humans have culturally and socially progressed as much as we have, looking at our evolutionary history provides a meaningful context. Cultural evolution, in particular, enables us to understand the origins of everyday social cognition better. In this thesis, I situated two such cognitions – genetic essentialist cognition and gender essentialist cognition – within the cultural evolutionary framework.

Summary of Part I

In the first part of this thesis, I examined content biases relating to genetic and environmental etiology through cultural transmission studies. Intriguingly, the lack of strong generational effects across both studies contrasts significant generational effects shown in past cultural transmissions experiments, specifically those focusing on transmission of social narratives (Lee et al., 2014; Lyons & Kashima, 2001; 2006). The reason for the lack of transmission effects in the present studies may be attributable to (1) complexities involved in the transmission of health-based narratives, which do not necessarily involve social information that is habitually processed, unlike narratives concerning social groups, and/or (2) a potential file drawer issue with regards to cultural transmission experiments with null findings. For the first, further research on the transmission of health-based narratives about genetic essentialist cognition may address this gap. For the second, the current sweeping changes in research practices in psychology may help ascertain whether certain lab-based conditions elicit significant transmission effects.

Recall that the broader purpose of this line of work was to examine whether genetic essentialist cognition was an adaptive response in the face of health-related challenges. The successful transmissions of genetic etiology would be indicative of such a possibility. The data
from Part I proved inconsistent with this premise. That said, the findings highlight the benefit of considering the disorder type when exploring this question in future studies. However, they also highlight that lab-based studies of potential adaptive responses may need to ensure that a “challenge” is indeed present. The results imply that in understanding the content biases shaping genetic essentialist cognition, behavioural experiments, which necessitate interactions within individuals or patients that previous works show elicit genetic essentialist tendencies (e.g., obese individuals), are crucial next steps.

**Implications for Genetic Essentialist Cognition**

Genes are often perceived as the embodiment of people’s unchanging essence, which can evoke thoughts of immutability and permanence (Dar-Nimrod & Heine, 2011) and selective attention for specific health-related outcomes were examined in Studies 1 and 2. The studies showed that the combination of relying on heuristics and misinformed lay knowledge have adverse effects, including how individuals process information about healthcare. Thus, lay theories on genetics and health are passed from one individual to another, with a higher likelihood for simplistic, inaccurate knowledge persevering within individual networks. Here, the distinct effects of memorisation and exploration of alternatives are aspects of this area of work that is still in its early stages, especially in the development of content biases for health information. In Studies 1 and 2, memory plays an essential role in the transmission of information, especially in tasks involving the accumulation of knowledge over multiple trials. The recollections provide a wealth of information on what content biases are prominent.

Taking the role of memory a step further, it is necessary to understand whether participants have maximised exploration potential and arrived that the explanation or the explanation was merely a script or heuristic (Norenzayan et al., 2006). Future work should
explore this possibility, with a particular focus on whether people are biased toward genetic content in the transmission of specific health information (or misinformation). In simple terms, the transmission and evolution of content biases in health could be due to, “it’s what we’ve always been told (i.e., heuristics)”, “it’s what’s easiest to remember and recall (i.e., memorisation)” or “it’s the best response based on inferences (i.e., exploration)”. It is highly possible that the choice of which one of these processes is used is based on the desired information to be transmitted, but currently, there is yet a study to explore whether these three processes work independently or together in influencing the cultural transmission process.

Here, lab-based cultural transmission experiments can provide useful directions for more large-scale studies. As shown through Studies 1 and 2, the transmission of health information appears to be a combination of what is easiest recalled in conjunction with reconstructions based on heuristics, which were not necessarily biased toward genetic information. The intriguing question remains as to whether genetic essentialist cognition is a product of exploration of possible solutions, where individuals weigh various causal information alongside the genetic one in health decision making. Exploring the type of information that gets selectively transmitted for health conditions that already highly-stigmatised such as obesity or mental illnesses, can help in forming interventions for minimising social stigma as well as encouraging more responsible media representation of the condition.

Understanding how lay knowledge integrates and distorts scientific knowledge has significant implications for health service providers and the public. For example, overgeneralisations made based on social categories like race, gender, and socioeconomic status of patients can decrease the perceived importance of accurate diagnosis and increase the use of heuristics when making health decisions (Major, Mendes, & Dovidio, 2013). Given research
suggesting that other social categories, which are susceptible to being viewed through a genetic essentialist lens, have important implications in the area of health (Hall et al., 2015), the differential effects of genetic essentialist cognition when social categories intersect with health conditions is an important extension of this current line of work. In simple terms (and as discussed further below), the use of various content biases in everyday social cognition may provide a clearer view of the collective effects of individual content biases.

**Summary of Part II**

In the second part of this thesis, I first reviewed the literature concerning the role of gender essentialist cognition in the maintenance of gender inequality, with a particular focus on low-status women. I also provided several recommendations for future research. Then, I tested one of those recommendations. Broadly, Studies 3 and 4 focused on whether gender and beliefs about gender affect who one chooses as a role and how much one learns from that role model. I showed how expert- and gender-based information affect whom one chooses as a social learning model. Women and men (relative to each other) chose an expert female as someone they want to socially learn from. This choice did not translate into higher social learning from that model. In fact, gender-related factors – participant gender, learning model sex, and gender system justification beliefs – impacted individuals’ actual social learning, in favour of the expert man. The studies support the importance of going beyond a narrow focus on increasing representation of women in high-status positions, to examining how their presence impacts the people around them. Understanding these effects, within a specific society and across various societies, has the potential to inform the best ways to prepare societies and particularly men, for the further upsurge in female representation in high-status and leadership positions.
Implications for Gender Essentialist Cognition

Long-term power structures play a significant role in how people understand the world around them. The existence of these structures creates challenges for some while advantages others. Placing a particular social phenomenon in its historical context is a valuable counterpoint to deterministic explanations of gender inequality and the use of essentialist beliefs to bolster these explanations. Hierarchies exist to enable the best form of organisation and functioning of large-scale societies, but how these hierarchies are decided can often be disadvantages to some. For example, as examined in the literature review (Chapter 4), it is useful to disentangle gender differences, gender-based choices, and gender essentialist cognition. All these contributed to form the basis for gender inequality in both the historical and modern-day workforce. Here, a complimentary and promising direction forward is in big data, which serves an important function in highlighting systematic gender inequalities and moderators that result in some unexpected findings (Blake et al., 2018; Dorius & Firebaugh, 2010; Hechtman et al., 2018; Nittrouer et al., 2018; Olivetti & Petrongolo, 2016; Stoet & Geary, 2018; Weber et al., 2014). They also illuminate the real-world implications of gender inequalities in specific jobs such as how the gender gap in clinical practice (favouring men) has negative implications for female patients (Greenwood, Carnahan, & Huang, 2018).

Essentialist generalisations become a part of an unchanging view of the female or male essences and lead to overstated perceived differences (Demoulin, Leyens, & Yzerbyt, 2006). For example, the popular self-help book “Men are from Mars, Women are from Venus” (Gray, 1992) describes men and women as being fundamentally different to such a degree that they seem to come from different planets and our gender essentialist cognition facilitates the popularity (and implied acceptance) of this book’s distorted premise. The unchanging female and male essence
become particularly relevant when gender differences are seen as necessary in everyday social
cognition such as who should be doing a particular job (Heyman & Giles, 2006; Prentice &
Miller, 2007). Modern female-dominated jobs such as nursing, teaching, and administrative
positions were also historically, inconsistently available to women because of formal barriers to
equal opportunities and equal outcomes as their male counterparts (Pedraza, 1991). Despite these
barriers, they were also jobs that were most readily available to historical women. Thus, rather
than division of labour or gender roles, there is a strong possibility that women currently
dominate these jobs because they were the only ones historical women could join. This line of
work, that is, examining the historical trajectory of female representation in specific jobs, has
potential to provide key empirical support for decreasing essentialist framing of women’s
workforce underrepresentation (see Jefferson, Bloor, & Maynard, 2015).

In considering the long reach of gender essentialist cognition, exploring the core beliefs
associated with essentialist thinking (see Bastian & Haslam, 2006) – immutability, discreteness,
informativeness, and naturalness – can be informative in the context of historical trajectory of
gendered occupations. These expressions of gender essentialist cognition also contribute to the
current public discourse on gender and power in areas such as gendered crimes, women in
atypical jobs, and recognition of minority women’s achievements. Research suggests that women
who violate traditional gender roles are more likely to victim-blamed (Grubb & Turner, 2012),
penalised for their success (Heilman & Okimoto, 2007; Heilman, Wallen, Fuchs, & Tamkins,
2004), and generally less liked (Williams & Tiedens, 2016). The visibility and representation of
women in areas considered to be male-dominated extend beyond STEM to science fiction and
fantasy, video games, and comics, which often result in women facing backlash and online
harassment (Dockterman, 2014). This backlash highlights a recent change in beliefs about
gender, particularly among sub-groups who were socially marginalised. For example, men, historically labelled as “nerds” or “geeks,” have seen their previously marginalised domains gain increasing status. Part of this shift is attributed to the high value that modern societies place on “nerdy skills” in computers and technology (Almog & Kaplan, 2017). However, much less is known about how identities of these sub-groups intersect with race and gender, particularly in empirical research. Examining the sub-groups of women and men is necessary for our continuing exploration of the evolution of gender essentialist cognition.

**Understanding Essentialist Beliefs**

The findings of this thesis highlight the need to assess if essentialist cognitions have diverse meanings and representations based on cultural or contextual differences. For example, Israeli children were less likely to essentialise race as they became older, unlike American children who tended to essentialise race as they aged (Diesendruck, Goldfein-Elbaz, Rhodes, Gelman, & Neumark, 2013). Such a finding is crucial in determining intervention points, as well as in charting the trajectory of these essentialist beliefs over time. The application of essentialist beliefs for specific social designations (e.g., being rich or being powerful), even though they may not be the primary categories that children essentialise like gender and race, could be a consideration in future developmental studies. Furthermore, in Chapter 4, I addressed the intersection between different types of essentialist beliefs and their potential contribution to maintaining gender inequality. Such an approach is often useful for other forms of inequalities as well, such as economic, educational, and class inequalities.

The combined effects of essentialist beliefs about gender, inheritance, and genes may explain the historical presence of prominent women originating from privileged dynasties. What remains unclear is whether the presence of these women as potential role models has detrimental
effects on efforts to bridge social inequalities. I reviewed relevant evidence on the intersection between race and gender essentialist beliefs, which indicated a more adverse outcome for ethnic minority women. However, the interaction between genetic and gender essentialist belief may elicit different outcomes, particularly given that it in the context of nepotism, the “gene” is highly associated with both biological (e.g., height of a basketball player’s child) and ephemeral outcomes (e.g., business, political, or acting skills). Thus, future research has much potential to disentangle this interaction of essentialist beliefs, extending research on how they impact low-status individuals.

**Implications for Cultural Evolution Research**

In this thesis, Studies 1 and 2 showed parallel findings, despite being conducted in different populations and cultures (predominantly White and Asian Australian undergraduates vs. predominantly White American community samples). Studies 3 (predominantly African American and ethnically-diverse community sample) and 4 (predominantly White American community sample) showed overlap in specific findings but differed on others. These findings suggest that the next step in cultural evolutionary research, particularly in experimental work, diversity is a crucial consideration. The importance of sampling participants outside of the Western, Educated, Industrialised, Rich, and Democratic (WEIRD) populations has been raised since the seminal Henrich et al.’s (2010) paper, but our understanding of diversity outside of these populations still awaits a more thorough investigation (e.g., Fiske, 2017; Nielsen, Haun, Kärtner, & Legare, 2017).

Diversity is an essential aspect of cultural evolution. As such, cultural transmission has some conceptual parallels to the Dynamic Social Impact Theory (DSIT: Harton & Bullock, 2007; Latane, 1996). DSIT posits that over time, groups who communicate with each other evolve and
this evolution is examinable through four markers: clustering, correlation, consolidation, and continuing diversity (Harton & Bullock, 2007). Clustering is shown by regional or geographical differences in attitudes, beliefs, and behaviours, where clusters form depending on the proximity of spaces occupied by individuals. Then, previously unrelated attitudes, beliefs, and behaviours will now become more correlated. Subsequently, diversity in these attitudes, beliefs, and behaviours decrease. However, diversity does not entirely disappear and may persist, potentially through factions and sub-factions within the population. Consequently, dynamic and repeated social interactions can influence social information processing and social learning as well as creating and maintaining diversity in certain situations (Muthukrishna & Schaller, 2014). As cultural information is sometimes expected to spread through an entire population (Kashima, 2007), DSIT provides a compelling explanation for why cultural diversity persists, even when social learning may follow predictable patterns.

The role of diversity in the cultural transmission process has been examined in computational models. When diversity is below a certain threshold, one subgroup begins to dominate the population, but when the diversity is above this threshold, many homogenous culture groups can emerge within that population (Pfau, Kirley, & Kashima, 2013). This model provides an exciting basis for exploring the effects of increasing diversity on various types of essentialist beliefs held by people from different cultures. Thus, an intriguing next step would be to examine how diversity in groups influences cultural transmission and social-cognitive outcomes in laboratory and field experiments as well as through longitudinal studies, taking into consideration the multi-level interactions of the groups.
Final Conclusions

This thesis applies the cultural evolutionary framework in areas of established social cognition research such as essentialist beliefs. In applying this framework to the two essentialist beliefs—genetic and gender, several avenues for future studies were highlighted, particularly focusing on examining essentialist cognitions within sub-groups or low-status groups. As the more recent form of content bias, genetic essentialist cognition, is one that is ripe for further exploration. Gender essentialist cognition, the more long-standing and one with direct relevance to human evolution, will likely remain an essential part of psychological research. Thus, the present thesis broadly highlights the varied applications of essentialist cognitions, providing the basis for continued research that examines their roles at both micro- and macro-culture levels.
References


perspective. *Journal of Cognition and Culture, 1*, 3–42.

https://doi.org/10.1163/156853701300063561


https://doi.org/10.1016/j.jesp.2005.03.003


https://doi.org/10.1017/S0140525X15002307


https://doi.org/10.1073/pnas.1717959115


science. *Science Advances, 4.* https://doi.org/10.1126/sciadv.1701427


Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields

https://doi.org/10.1037/bul0000052


https://doi.org/10.3386/w24441


https://doi.org/10.1016/j.evolhumbehav.2011.05.005


https://doi.org/10.1080/15298860600980185


https://doi.org/10.1016/j.appet.2014.06.109


https://doi.org/10.1080/15248372.2013.763810

https://doi.org/10.17730/humo.42.4.1qr0185774m5w418

https://doi.org/10.1146/annurev-psych-122216-011719


https://doi.org/10.1186/s13058-014-0442-6


and benevolent sexism in women’s and men’s perceptions of the menstruating woman.

*Psychology of Women Quarterly, 27, 58–63. https://doi.org/10.1111/1471-6402.t01-2-00007*


https://doi.org/10.1080/136668803.2013.779231


https://doi.org/10.1177/0361684312464203


https://doi.org/10.1098/rstb.2010.0310


https://doi.org/10.1037/0022-3514.70.3.491


Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbache, M. A.


https://doi.org/10.1177/1948550613506124


https://doi.org/10.1007/s10887-015-9119-y


https://doi.org/10.1073/pnas.1620745114


https://doi.org/10.1007/978-3-319-57306-9_1


https://doi.org/10.1177/0963721415588082


selection and niche-construction case studies, *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*, 3577-3589.

https://dx.doi.org/10.1098%2Frsbt.2008.0132


https://doi.org/10.1073/pnas.1620743114


https://doi.org/10.1111/j.1471-6402.2009.01488.x


https://doi.org/10.1521/soco.19.3.372.21470


that of athletes through the first 5500 years of farming in Central Europe. *Science Advances, 3*, eaao3893. https://doi.org/10.1126/sciadv.aao3893

foundations of stereotype formation. In C. N. Macrae, C. Stangor, & M. Hewstone (Eds.),
*Stereotypes and stereotyping* (pp. 41–78). New York, NY: Guilford Press.


https://doi.org/10.1163/156853703322148525

https://doi.org/10.1037/a0030358


(Eds.), *Similarity and analogical reasoning* (pp. 179–195). New York: Cambridge University Press.


https://doi.org/10.1111/j.1728-4457.2009.00263.x


https://doi.org/10.1073/pnas.1708414115

https://doi.org/10.1207/s15516709cog0000_68


https://doi.org/10.1080/00220973.2015.1027807


Paustian-Underdahl, S. C., Walker, L. S., & Woehr, D. J. (2014). Gender and perceptions of


https://doi.org/10.1177/0963721415613962


https://doi.org/10.1177/0956797615598739


https://doi.org/10.1162/qjec.2008.123.3.1251


Reyes-García, V., Balbo, A. L., Gómez-Baggethun, E., Gueze, M., Mesoudi, A., Richerson, P. J.,


Whitley Jr, B. E., & Ægisdottir, S. (2000). The gender belief system, authoritarianism, social dominance orientation, and heterosexuals’ attitude toward lesbians and gay men. *Sex Roles,


Appendix A: Study 1 Vignettes

Based on the specific Etiology Type and Disorder Type pairings, a total of nine different vignettes were created. The italicised phrases below represent aetiologies, which were varied depending on the randomised conditions. The bolded phrases represent the afflicted population.

**Physiological Disorder – Genetic Etiology**

Leber’s optic disorder is related to *mutations in four different genes found in DNA cellular structures*. The disorder usually appears in **18 to 30 year-olds**. The first symptoms of Leber’s optic disorder are the blurring and clouding of vision. Over time, vision in both eyes worsens with a severe loss of visual acuity (sharpness) and colour vision. The condition mainly affects central vision, which is needed in detailed tasks such as reading, driving, and recognising faces.

**Psychological Disorder – Environmental Etiology**

Johnston-Marcus disorder is a condition related to *the presence of ANF toxins in the near environment*. This disorder is characterised by uncontrolled movements, emotional problems and loss of thinking ability. The disorder usually appears in **30 to 40 year-olds**. Early symptoms of Johnston-Marcus disorder can include irritability, depression, poor coordination and trouble learning new information. They also experience changes in personality and a decline in thinking and reasoning abilities.

**Cultural Disorder – No Etiology**

Methinismus is a condition that *is relatively unknown*, is exclusive to a small tribe in East Africa, and *is recommended for further research*. This disorder is characterised by mild obsession with death or a deceased person. This disorder occurs in individuals of **18 – 85 years old**. Other symptoms of Methinismus include weakness, fatigue, and diminished appetite. People with this disorder may experience nightmares, anxiety, and a sense of being in danger.
Appendix B: Study 1 Model 2B Summary

Table A1

*Model 2B summary for etiological recollection.*

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model 1A – Intercept only</th>
<th>Model 2B – Additional model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Est</td>
<td>SE</td>
</tr>
<tr>
<td>Fixed effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>−1.56</td>
<td>.17</td>
</tr>
<tr>
<td>Etiology Type</td>
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<td></td>
</tr>
<tr>
<td>Genetic</td>
<td>1.19</td>
<td>.68</td>
</tr>
<tr>
<td>Environmental</td>
<td>2.12</td>
<td>.66</td>
</tr>
<tr>
<td>No Etiology (ref)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disorder Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological</td>
<td>1.55</td>
<td>.66</td>
</tr>
<tr>
<td>Psychological</td>
<td>1.61</td>
<td>.66</td>
</tr>
<tr>
<td>Cultural (ref)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.25</td>
<td>.45</td>
</tr>
<tr>
<td>2</td>
<td>.16</td>
<td>.44</td>
</tr>
<tr>
<td>3</td>
<td>.39</td>
<td>.46</td>
</tr>
<tr>
<td>4 (ref)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Recall</td>
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<td>.07</td>
</tr>
<tr>
<td>Random effects</td>
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<td></td>
</tr>
<tr>
<td>Intercept</td>
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<tr>
<td>−2LogLikelihood</td>
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</tr>
<tr>
<td>Pseudo-R²</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Notes: No etiology, cultural disorder, and Generation 4 were reference groups. *p < .025 **p < .01, ***p < .005. Odds ratio estimate for Overall Recall represents unit change from mean.
Appendix C: Study 2a

Study 2a examined whether participants show preferential recollection of genetic etiology over environmental etiology in an undergraduate sample, without a social transmission design. Participants were randomly assigned to one of four sets of vignettes characterizing fictitious disorders. After each vignette, participants were asked to select the options that correctly describe the disorder they had read. Then, they evaluated a diagnosed patient on social distance and disgust measures. Participants also completed self-report measures on perceived vulnerability to diseases (PVD) and social dominance orientation (SDO). As the a-priori targeted sample-size was not reached because of changes in the availability of participants in the subject pool, the present, underpowered study is reported in this appendix rather than the main text.

Social dominance orientation (Pratto et al., 1994). Participants rated their feelings towards 16 statements such as “Group equality is not a worthwhile ideal” on a 7-point scale (1 – very negative, 7 – very positive). A higher score is indicative of increased endorsement for group hierarchy ($\alpha = .89$).

Participants

A total of 57 first-year psychology undergraduates (20 men, 37 women, $M_{age} = 20.28$ years, $SD = 2.51$, range = 18 – 32 years) were recruited from a large, urban Australian university. Majority of participants identified as Northeast Asian (20) and European/White (19), with others identifying as Southeast Asian (7), Mixed ethnicity (6), South/Central Asian (2), or Maori/Pacific Islander (1). Two participants refrained from reporting their ethnicity. Most participants were born in Australia (32) or China (16), and had lived in Australia for more than five years (38). All participants were compensated with course credit.

Procedure
Upon arrival, participants read through an information sheet about the study, provided informed consent, and were assigned a computer. The study began with brief instructions on the study procedures, following which they were assigned to one of four vignette conditions by the software Qualtrics, ensuring that the experimenter remained blind to participants’ experimental conditions. Participants began by reading the first vignette. Upon completion, the vignette disappeared, and participants responded to 21-option multiple-choice questions in which they had to identify all the correct statements or refrain from selecting incorrect statements based on what they had read in the vignette (described in detail below). Then, participants rated their desired social distance from and feelings of disgust for a patient with the disorder. These steps were repeated for the second and third vignettes, presented in a randomized order. Then, participants completed demographic items (e.g., age, gender, ethnicity). At the end of the 20-minute session, participants were debriefed on the true purpose of the experiment, at which time the fictitious nature of the disorders was revealed.

Results

Data Management

Statistical analyses were conducted through three separate models for the three dependent variables: (1) probabilities of correct etiological recollection, (2) social distance desired (α = .93), and (3) feelings of disgust (α = .86). For the first dependent variable, it was assessed the number of correct etiological recollection out of maximum recollection score of eight, using a logit link function and a binomial conditional outcome distribution. For the second and third dependent variables (ratings averaged across the two vignettes), I estimated generalized linear models and included PVD (α = .80) and SDO (α = .89) as moderators (with continuous measures centered). All p-values reported for the main analyses are reported after applying Bonferroni
corrections. Analyses were performed using PROC GLIMMIX and PROC MIXED in SAS 9.4 for Windows.

**Preliminary Analyses**

**Correlations.** First the correlations between perceived vulnerability to diseases ratings, social dominance orientation, social distance, and feelings of disgust were examined. Participants who perceived themselves as being more vulnerable to diseases did not significantly desire more social distance from the patient, \( r(57) = -0.17, p = .212 \), and did not report significantly higher feelings of disgust, \( r(57) = 0.26, p = .051 \). Participants who endorsed more group-hierarchy based beliefs desired more social distance from the patient, \( r(57) = -0.42, p = .001 \), but did not report significantly higher feelings of disgust \( r(57) = 0.18, p = .178 \). Participants who rated a diagnosed patient as eliciting more feelings of disgust also desired more social distance, \( r(57) = -0.53, p < .001 \).

**Vignette versions.** I examined whether including Vignette Version as a within-subjects factor influenced the results of the three outcome measures. Vignette Version did not significantly impact etiological recollections. Across all three dependent measures, the only significant effect shown was the main effect of Vignette Version, \( F(1,106) = 5.76, p = .036 \), where participants (regardless of Disorder Type) desired more social distance from patients in the Vignette Version 2 (\( M = 27.67, SE = .96 \)) over Version 1 (\( M = 30.19, SE = .96 \)). Given that the inclusion of Vignette Version into the model for social distance did not change the reported findings, all models are reported without this within-subjects factor.

**Etiological Recollection**

The first analysis examined the effect of Disorder Type on content recognition. Contrary to our hypothesis, Disorder Type did not significantly affect the probabilities of correct
etiological recollection, $F(3,53) = 1.13, p = .344$. Table A2 indicates the means and standard errors for each of the four vignettes.

Table A2

*Descriptives for Disorder Type*

<table>
<thead>
<tr>
<th>Disorder Type</th>
<th>Proportion of Content recognition</th>
<th>Social distance $^a$ Mean (SE$_{\text{mean}}$)</th>
<th>Disgust $^b$ Mean (SE$_{\text{mean}}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic – Physiological Disorder</td>
<td>.90 (.03)</td>
<td>32.80 (1.60)</td>
<td>4.30 (.79)</td>
</tr>
<tr>
<td>Environmental – Physiological Disorder</td>
<td>.81 (.05)</td>
<td>29.43 (1.66)</td>
<td>6.18 (.81)</td>
</tr>
<tr>
<td>Genetic – Psychological Disorder</td>
<td>.81 (.05)</td>
<td>29.27 (1.72)</td>
<td>4.04 (.84)</td>
</tr>
<tr>
<td>Environmental – Psychological Disorder</td>
<td>.84 (.05)</td>
<td>25.67 (1.60)</td>
<td>6.63 (.79)</td>
</tr>
</tbody>
</table>

Note: $^a$ Higher score is indicative less social distance desired. $^b$ Higher score is indicative of more feelings of disgust.

**Social Distance**

The effect of Disorder Type significantly influenced participants’ desired social distance, $F(3,53) = 3.31, p = .027$. Simple effects indicated that participants desired significantly more social distance from patients diagnosed with an Environmental-Psychological Disorder than a Genetic-Physiological Disorder patient, $t(53) = 3.15, p = .016, d = 1.15, 95\% CI [0.39, 1.89]$. All other comparisons were not significant ($ps > .050$). PVD did not significantly moderate the relationship between Disorder Type and social distance ratings, $F(3,49) = 1.49, p = .229$, as did SDO, $F(3,49) = 1.85, p = .150$.
Feelings of Disgust

The effect of Disorder Type did not significantly affect disgust ratings, $F(3,53) = 2.63, p = .060$. Both PVD, $F(3,49) = 0.48, p = .695$, and SDO, $F(3,49) = 1.63, p = .195$, did not significantly moderate the relationship between Disorder Type and disgust ratings.
Appendix D: Study 2 Vignettes and Sample Responses

Original Versions of Vignettes

Genetic-Physiological Disorder – Vignette 1
Leber’s disorder is a condition caused by mutations in four different genes. The disorder was discovered in the 1980s. The first symptom of this condition is the blurring and clouding of vision. The disorder can appear in all ages. Other symptoms for this condition include loss of visual sharpness and loss of colour vision. These problems may begin suddenly, without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.

Genetic-Physiological Disorder – Vignette 2
Methinismus is a condition caused by abnormality of the spatial structure of a person’s genetic code. The condition was first known in the 2000s. The first symptom of this condition is abdominal pain, weak bladder control, and swollen feet. The disorder usually appears in 18 – 85 years olds. Other symptoms of this condition include weakness, severe weight loss, and high fever. Some problems related to this condition can appear years apart. A recent study showed more people living in the U.S. have this disorder than those in Canada. Scientists have proposed more research to decide on treatment options.

Environmental-Physiological Disorder – Vignette 1
Leber’s disorder is a condition caused by infection from parasites in untreated water. The disorder was discovered in the 1980s. The first symptom of this condition is the blurring and clouding of vision. The disorder can appear in all ages. Other symptoms for this condition include loss of visual sharpness and loss of colour vision. These problems may begin suddenly,
without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.

**Environmental-Physiological Disorder – Vignette 2**

Methinismus is a condition that is caused by a viral infection in the gut. The condition was first known in the 2000s. The first symptom of this condition is abdominal pain, weak bladder control, and swollen feet. The disorder usually appears in 18 – 85 years olds. Other symptoms of this condition include weakness, severe weight loss, and high fever. Some problems related to this condition can appear years apart. A recent study showed more people living in U.S. have this disorder than those in Canada. Scientists have proposed more research to decide on treatment options.

**Genetic-Psychological Disorder – Vignette 1**

Leber’s disorder is a condition caused by mutations in four different genes. The disorder was discovered in the 1980s. The first symptom of this condition is intense fear of gaining weight. The disorder can appear in all ages. Other symptoms of this condition include perfectionism that interferes with task completion and fake suicide attempts. These problems may begin suddenly, without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.

**Genetic-Psychological Disorder – Vignette 2**

Methinismus is a condition caused by abnormality of the spatial structure of a person’s genetic code. The condition was first known in the 2000s. The first symptom of this condition is mild obsession with death or a deceased person. The disorder usually appears in 18 – 85 years olds.
Patients of this condition may experience anxiety, nightmares, and a sense of being in danger. Some problems related to this condition can appear years apart. A recent study showed more people living in the U.S. have this disorder than those in Canada. Scientists have proposed more research to decide on treatment options.

**Environmental-Psychological Disorder – Vignette 1**

Leber’s disorder is a condition caused by infection from parasites in untreated water. The disorder was discovered in the 1980s. The first symptom of this condition is intense fear of gaining weight. The disorder can appear in all ages. Other symptoms of this condition include perfectionism that interferes with task completion and fake suicide attempts. These problems may begin suddenly, without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.

**Environmental-Psychological Disorder – Vignette 2**

Methinismus is a condition that is caused by a viral infection in the gut. The condition was first known in the 2000s. The first symptom of this condition is mild obsession with death or a deceased person. This disorder usually appears in 18 – 85 years olds. Patients of this condition may experience anxiety, nightmares, and a sense of being in danger. Some problems related to this condition can appear years apart. A recent study showed more people living in the U.S. have this disorder than those in Canada. Scientists have proposed more research to decide on treatment options.
Sample responses for one transmission chain, across three generations, for Genetic-Physiological

Original version of vignette and answer options, read by Generation 1 participant

Leber’s disorder is a condition caused by mutations in four different genes. The disorder was discovered in the 1980s. The first symptom of this condition is the blurring and clouding of vision. The disorder can appear in all ages. Other symptoms for this condition include loss of visual sharpness and loss of color vision. These problems may begin suddenly, without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.

Which of the following statements correctly describe Leber’s disorder? Choose ALL the correct statements based on what you’ve read about the disorder (an example of a Generation 1 participant’s answer selections, both correct and incorrect, are underlined).

- Not always genetically-related
- Caused by mutations in a single gene
- Not always genetically-related
- Caused by mutations in the DNA
- Only occurs in young children
- Discovered in the 1890s
- Discovered in the 1980s
- Affects everyone around the world
- Affects only Australians
- Affects only Americans
- Blurs and clouds vision
- Caused by mutations in four genes
- Clouds your cognition
- Lessens colour sharpness
- Increases eye lesions
- Increases vision-related headaches
- Can be easily treated
- There is no known treatment
• Symptoms are noticeable at early stages
• Symptoms can show up suddenly
• Occurs in people of all ages

Version of vignette viewed by Generation 2 participant (answer options remain the same as Generation 1). Changes to vignette based on Generation 1 responses are bolded.

Leber’s disorder is a condition caused by mutations in a single gene. The disorder was discovered in the 1980s. The first symptom of this condition is the blurring and clouding of vision. The disorder can appear in all ages. Other symptoms for this condition include loss of visual sharpness and loss of color vision. These problems may begin suddenly, without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.

Version of vignette viewed by Generation 3 participant (answer options remain the same as Generation 1 and 2). Participant in Generation 2 recalled all elements of the vignette, thus the vignette remained the same for Generation 3.

Leber’s disorder is a condition caused by mutations in a single gene. The disorder was discovered in the 1980s. The first symptom of this condition is the blurring and clouding of vision. The disorder can appear in all ages. Other symptoms for this condition include loss of visual sharpness and loss of color vision. These problems may begin suddenly, without any prior signs. Studies show that this disorder can be found in most countries around the world. The condition has been recommended for further research to understand how patients can manage it better.
Appendix E: Study 3a

Study 3 was replicated in an undergraduate sample, using identical lab-based procedures, approved by an institutional ethics committee. We had initially intended to run a replication of Study 3 in an undergraduate sample (as in our pre-registration). However, due to resources’ availability (an unexpected change in access to the undergraduate participant pool), this replication study comprised of a smaller sample of individuals. As the analyses of Study 3a will be underpowered, we do not report them in the main manuscript. We have included the Study 3a analyses here for those interested.

Participants

A total of 52 first-year psychology undergraduates (38 women, 14 men; $M_{\text{age}} = 20.40$ years, $SD = 2.68$, range = 18 – 32 years) in a large, urban Australian city, participated in exchange for course credit. Majority of participants identified as White or European (17) and Northeast Asian (17), while the remainder identified as Mixed ethnicity (8), Southeast Asian (8), South/Central Asian (1), and two unidentified participants. Most participants were born in Australia (28) or China (15) and/or had lived in Australia for more than five years (34).

Measures and Procedure

In addition to all the measures presented in Study 3 [GSJ ($\alpha = .74$), Risk aversion ($\alpha = .64$), SDO ($\alpha = .86$), and RWA ($\alpha = .81$)], participants also completed the Gender Theory Questionnaire (Coleman & Hong, 2008), which examines their views on whether gender is innate or socially-constructed (e.g., The innate properties of a persons’ gender determine what the person is like). The measure consists of 11 items, rated on a 7-point scale (1 – strongly disagree, 7 – strongly agree) and used in an exploratory analysis. A higher score is indicative of
stronger beliefs that gender is innate (α = .80). The procedure of Study 3a is identical to that of Study 3.

**Results**

Results were analysed mostly using the same procedures as in Study 3. As in Study 3, six participants – three who chose the non-expert models and three who had negative social learning rates – were excluded from the final analyses.

**Effect of Participant Gender on Model Selection**

I compared the frequencies in model selection within each gender (i.e., the ratio for women/men selecting Female Expert or Male Expert) through a chi-square test for proportions. Overall, women chose the Female Expert (58%) model at a comparable to the Male Expert (42%) one, $X^2 (1, N=33) = 0.76, p = .384, \varphi = .15$. Men were also overall more likely to choose the Female Expert model (62%), $X^2 (1, N=13) = 0.69, p = .006, \varphi = .23$.

**Effects of Participant Gender, Model Choice, and Gender System Justification on Social Learning**

The main effect of Model Choice was on social learning rates was significant, $F(1,39) = 25.07, p < .001$ (HBC $p < .001$), but the main effect of Participant Gender was not, $F(1,39) = 0.25, p = .620$. The interaction of Model Choice and Participant Gender was significant, $F(1,39) = 4.84, p = .034$ (HBC $p = .068$). Contrasts indicated that men who chose the Female Expert showed higher probabilities not socially learning than men who chose the Male Expert, $t(39) = 4.30, p < .001, OR = 1.47$ (HBC $p = .001$). Among those who made cross-gender selections, women who chose the Male Expert showed lower probabilities of not socially learning than men who chose the Female Expert, $t(39) = -4.21, p < .001, OR = 0.75$ (HBC $p = .001$). In contrast, women who chose the Female Expert showed higher probabilities of not socially learning
compared to men who chose the Male Expert, \( t(39) = 2.98, p = .005, OR = 1.27 \) (HBC \( p = .030 \)). All other contrasts were not significant \((p > .050)\). Descriptives are reported in Table A3.

Table A3

*Descriptives of Study 3a variables.*

<table>
<thead>
<tr>
<th>Participant Gender</th>
<th>Model Choice</th>
<th>Means for Probability of Not Socially Learning (SE&lt;sub&gt;mean&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>Female Expert</td>
<td>.518 (.010)</td>
</tr>
<tr>
<td></td>
<td>Male Expert</td>
<td>.481 (.011)</td>
</tr>
<tr>
<td>Men</td>
<td>Female Expert</td>
<td>.554 (.014)</td>
</tr>
<tr>
<td></td>
<td>Male Expert</td>
<td>.458 (.018)</td>
</tr>
</tbody>
</table>

**GSJ.** The inclusion of GSJ significant moderated the interaction of Participant Gender and Model Choice, \( F(1,35) = 135.07, p < .001 \) (HBC \( p < .001 \)). When compared between women and men who chose the Female Expert model, the association between GSJ and social learning was significant, \( b = .06, SE = .01, t(43) = 7.89, p < .001 \). Women who chose the Female Expert and showed a higher tendency to justify gender inequality showed lower probabilities of not socially learning compared to their counterparts with lower tendencies to justify gender inequality. Conversely, men who justified gender inequality and chose the Female Expert showed higher probabilities of not socially learning than men who were less likely to justify gender inequality. This pattern was reversed among participants who chose the Male Expert, \( b = -.10, SE = .01, t(43) = -8.68, p < .001 \). Women who justified gender inequality showed higher probabilities of not socially learning from the Male Expert compared to women who were less
likely to justify gender inequality. Men who chose the Male Expert and justified gender inequality showed lower probabilities of not socially learning than their counterparts who did not justify gender inequality.

**Exploratory analyses.** Both SDO \([F(1,35) = 171.81, p < .001]\) and RWA \([F(1,35) = 139.13, p < .001]\) significantly moderated the interaction of Participant Gender and Model Choice on social learning probabilities. For SDO, simple slopes indicated that among those who chose the Male Expert \((b = .17, p < .001)\), women who endorsed fewer group-based hierarchies showed higher probabilities of not socially learning than women who did endorse them. Men who chose the Male Expert and rated higher on SDO showed higher probabilities of not socially learning. The simple slope was not significant among those who chose the Female Expert model \((b < .01, p = .321)\), with both women and men who scored lower on SDO showing higher probabilities of not socially learning.

For RWA, simple slopes indicated among participants who chose Male Expert \((b = .06, p < .001)\), women who endorsed more right-wing authoritarian values showed lower probabilities of not socially learning than women who made fewer RWA endorsements. Men who chose the Male Expert and showed higher RWA tendencies had higher probabilities of not socially learning. Among those who chose the Female Expert model \((b = -.03, p < .001)\), both women and men scoring higher on RWA showed lower probabilities of not socially learning compared to their same gender counterparts who scored lower on RWA.

Participants’ beliefs about the innateness of gender (i.e., gender theory) also significantly moderated the three-way interaction, \(F(1,35) = 139.35, p < .001\). Simple slopes showed that among those who chose the Male Expert \((b = .16, p < .001)\), women who had stronger beliefs that gender is innate showed lower probabilities of not socially learning. Men who chose the
Male Expert and held stronger gender innateness beliefs had higher probabilities of not social learning. Among those who chose the Female Expert ($b < -.01, p = .843$), both women and men scoring higher on gender innateness beliefs showed lower probabilities of not socially learning compared to their same gender counterparts who scored lower on gender innateness.