Chapter 4  Mapping development across time and space: A first step towards a meta-analytic framework

4.1  Conceptual parallels between Montessori and Vygotsky

There is a commonly-held view that Maria Montessori was no theoretician, as her son Mario Montessori (1965, p. ix) writes:

Dr Montessori never wished to - and never was - a theorist of science. Her approach, if an approach it was, borders on the empirical ... What she did was to elaborate an orientation.

While Montessori may not have recorded a fully-elaborated theory, the previous chapter has reviewed the theoretical tradition from which her pedagogy emerged, a tradition which stretches back to the Enlightenment. This tradition locates the origin of consciousness and knowledge in the developing human’s experience of sensory contrast, and in the interpretation of this experience in social contexts through intentional sign use. The same tradition emphasises the significance of liberty in children’s development. Evaluating the liberty which underpins Montessori pedagogy in terms of the liberty of Rousseau, however, as argued in Chapter 3, ignores the provenance of the Montessori objects. Furthermore, analytical approaches which model the development of consciousness as a function of the maturation of internal mental structures also fail to capture the significance given in Montessori pedagogy to the role of the objects in the development of consciousness. This study proposes that an analytical approach more in accord with the provenance of the Montessori objects can be found in the framework proposed by the early twentieth-century Russian psychologist, Lev Vygotsky, a framework with the potential to explore the relationship between the external sensory (material) and internal semiotic (social) realms.

This chapter argues that Vygotsky’s account of ontogenesis, foregrounding the role of semiotic mediation, provides the most effective means for theorising the use of the Montessori objects. There are two main reasons for this. Montessori and Vygotsky share common intellectual antecedents, including the influence of Séguin and the
conceptual metalanguage and influences of their era. Most significantly, Montessori and Vygotsky were concerned with modelling the unfolding of human development as a complex process of evolutionary adaptation. However, I suggest that Vygotsky’s model of human development, as a function of semiotic mediation, offers a more insightful way to understand Montessori’s pedagogy than some of her own explanations.

The chapter begins by establishing the conceptual parallels between Vygotsky and Montessori. This is followed by a review of a theoretical stance which Montessori explored towards the end of her life and which continues to be presented in advanced Montessori teacher-training courses. Vygotsky’s genetic model of development is then proposed as an alternative means for generalising Montessori’s materialised pedagogy. This includes a review of some specific orientations to pedagogy emerging from Vygotsky’s framework: the notion of learning as a region of collaboration, the contrast between everyday and educational knowledge, the developmental trajectory from concrete material experience to abstract knowledge and the value of enriching the representation of educational knowledge through redundancy.

4.1.1 A shared heritage and context

The ‘hero myth’ surrounding Vygotsky (van der Veer and Valsiner 1994, p.2) and the comparable myth surrounding Montessori (See Section 2.3.1 above) can give the impression that their ideas emerged in isolation from the context in which they worked. Such an impression would overlook their ‘intellectual interdependency with ... European and American contemporaries and predecessors’ (van der Veer and Valsiner 1994, p. 6). References to and critical appraisal of, for example, Fechner, Wundt, Baldwin, Janet, Tolstoy, William James, Dewey, Stern, Freud, Clapèrede, Binet, the Gestalt and behaviourist psychologists, Karl and Charlotte Bühler, Köhler and Gesell can be found in the writings of both Montessori and Vygotsky (For example, Montessori 1965b [1916/1918], pp. 24-54; 1983 [1936], pp. 3-12; 1982 [1949], p. 15. p. 45; Vygotsky 1986 [1934]). This section gives a brief review of the overlapping cultural and intellectual heritage shared by Montessori and Vygotsky, as
a means of explaining the commonalities to be found in their research interests, methods, sources of data and writing styles.

Like Montessori (See Section 2.2.2 above), Vygotsky’s legacy has been described as one preserved ‘within an oral culture’ (Bakhurst 2005 [1990], pp. 178-179), and his writing has been described as spoken and ‘flowery’, lacking the referencing conventions expected in equivalent writing today (van der Veer and Valsiner 1994, p. v; p. 1).¹ No reference is made to Vygotsky in Montessori’s published work but she was internationally recognised in the field of pedagogy by the time Vygotsky began formulating his theories. He identifies her pedagogy, on more than one occasion, as the ground from which he launches his proposals. However, scant references make it difficult to determine the source and extent of his knowledge of Montessori’s work (See, for example, Vygotsky 1978, pp 117-118; 1986 [1934], pp. 189-190).

The common research interests and methods of Montessori and Vygotsky reflect a shared experience of the great changes which shaped Europe’s cultural and social history from the late nineteenth century into the early twentieth century. Of greatest relevance to this study is their shared concern for the development of children, those with impaired development and those developing normally, in industrialising Italy and revolutionary Russia (See, for example, Daniels 2005; Knox and Stevens 1993; Montessori 1964 [1909/1912]; Werstch 1985a). The methods used by Montessori and Vygotsky for observing, describing and interpreting children’s development reflect their shared intellectual context. Both valued experimental methods in the empirical tradition of the natural sciences and both used children’s socialising activity as the source of their data. They were interested in the origin and trajectory of children’s development, echoing the legacy of Darwin in the biological sciences and the legacy of Marx in the emerging social sciences of their era. While the parallels between the writing styles, intellectual influences and research interests of Montessori and Vygotsky open up interesting possibilities for a general comparison of their work, this study highlights commonalities which relate to the specific proposal that Vygotsky’s developmental theory can be used as a means of generalising about the nature of Montessori’s pedagogy. The commonalities elaborated below are the use of children’s

¹ See also Cole, John-Steiner, Scribner and Souberman (1978, p. x); Davydov and Radzhikhovskii (1985, p. 39).
socially-meaningful activity as a source of empirical data, a view of development as adaptation and the influence of Séguin’s socially-oriented pedagogy for developmentally-impaired children.

4.1.2 A comparable experimental method

A feature of intellectual life in Europe during the late nineteenth century and early twentieth century was the unfolding confrontation between materialist and idealist world-views. In the context of studying developmental phenomena, Montessori and Vygotsky addressed this issue by focusing on children’s activity as primary empirical data.

Montessori shifted her empirical focus, developed during her association with positivist anthropology, from the physiology of immobile children to ‘the liberty of the child’, where liberty is equated with freely-chosen activity (Montessori 1964 [1909/1912], p. 86; emphasis in original). For Montessori (1964 [1909/1912], p. 12) freely-chosen activity became a manifestation of the child’s developing mental life. Thus, the tradition of liberty in education, which Montessori inherited from Séguin, doubled as a methodological solution to problems arising from the application of the materialist sciences to pedagogy. Through observing and recording children’s free activity, Montessori hoped to avoid drawing invalid conclusions (See Section 3.7.1).

A similar concern lead Vygotsky (1986 [1934], p. 13) to perceive as a ‘crisis’:

... the sharp contradiction between the factual material of science and its methodological and theoretical premises – a contradiction deeply rooted in history of knowledge, revealing a dispute between the materialistic and idealistic world concepts.

Vygotsky addressed this crisis by making ‘socially laden activity’ the specific focus of his experiments (Kozulin 2005 [1986], p. 103). In contrast to experiments designed to ‘determine the conditions controlling behaviour’ characteristic of late twentieth-century experimental psychology, Vygotsky’s experiments were designed to provide ‘maximum opportunity for the subject to engage in a variety of activities that can be observed, not just rigidly controlled’ (Cole and Scribner 1978, pp. 11-12). Children were given problem-solving tasks which allowed the investigator ‘to trace ... consecutive stages of ... development’ (Vygotsky and Luria 1994 [1930], p. 160), with
the aim of explaining how children reach successive levels of development, and from what starting points, rather than describing particular developmental levels as static entities.

In identifying human activity as the source of experimental data Montessori and Vygotsky were influenced by the legacy of Marxist methodology in the emerging European social sciences of the era. From the beginning, Montessori (1965b [1916/1918], p. 9) established the convention in her pedagogy, which continues to this day, of identifying children as workers and describing their developmental activity as ‘work’ or labour:

Let us consider them ... as a social class, as a class of workers, for as a fact they are labouring to produce men.

Montessori’s description of children’s activity as work is an expression of the Marxist view that work, or labour, is an activity which transforms human consciousness.

Similarly, following the Russian revolution, ‘human forms of activity’ became the focus for Vygotsky and his colleagues, most notably Luria and Leont’ev. While their contemporaries studied the ‘biological beginnings in the animal world’ of human behaviour, Vygotsky’s group were interested in human activity and, following Marx, the ‘development of labour as the determining form of man’s relation with nature’ (Vygotsky and Luria 1994 [1930], p. 106). From this starting point, Vygotsky reconciled the subject matter of material psychology, based on descriptions of behaviour as reflex or response, and mentalist psychology, based on introspective descriptions of consciousness (Cole and Scribner 1978, p. 5; Kozulin 2005 [1986], pp. 102-103; Lee 1985). In Vygotsky’s model consciousness is the subject matter of psychology. Consciousness is described by Vygotsky (1986 [1935], p. 170) as ‘awareness of the activity of the mind’, and is explained in terms of its generation from the outside by socially meaningful activity. Thus ‘socially meaningful activity’
became an ‘explanatory principle’ in Vygotsky’s theoretical model (Kozulin 1986, p. xvii; 2005 [1986], pp. 102-103), a principle compatible with the approach to pedagogy taken by Montessori.\footnote{Montessori was also committed to the idea of learning as the development of consciousness, rather than learning as mechanical habit-formation. This commitment is exemplified in her pedagogy and is emphasised in her use of the prefix ‘psico-’ to label regions of her pedagogy, for example, \textit{Psicooritmetico} (Montessori 1971 [1934]).}

After Vygotsky’s death, his colleague Leont’ev elaborated the concept of activity into ‘a unit of analysis that includes an individual and the individual’s culturally-defined environment’ (cited in Cole 1981, p. viii). In the words of Leont’ev, the concept of activity ‘breaks down the distinction between the external world and the world of internal phenomena’ (cited in Cole 1981 p. ix; see also Luria 1979). Leont’ev’s elaboration proposes a direct relation between concrete external practical activity and the structure of consciousness. Practical activity constitutes the purposeful use of objects, mediates reality and generates corresponding intellectual activity (Daniels 2005, p. 9; Kozulin 1986, pp. xlviii-xlix; 2005 [1986], p. 113). Leont’ev organises the concept of activity into a unit of analysis with three layers: activity/motive, action/goal and operation/conditions (Leont’ev 1981; Zinchenko and Gordon 1981). This analytical device has been usefully applied to educational contexts as a means of reasoning about the array of elements, and their relations, which constitute classroom practice (for example, Wells 1999, p. 169-172; Wertsch 1981). Later developments in activity theory have re-emphasised the mediating role of signs, the pivotal feature of Vygotsky’s theory of consciousness (Daniels 2005, pp. 8-11; Davydov and Radzikhovskii 1985; Engeström 1987; Engeström, Miettinen and Punamäki 1999; Kozulin 2005 [1986], pp. 114, 116, 119-120).

The use of the concept of activity in this study, however, returns to the original Vygotskian model in which there is no direct relation between reality and consciousness, but rather a relation mediated by signs (For example, Vygotsky and Luria 1994 [1930]). This study proposes that the provenance, the design and the use of the Montessori objects makes Vygotsky’s original conception of activity, as realising ‘specific, culturally bound types of semiotic mediation’ (Kozulin 1986, xxvlii), a more relevant starting point in their analysis. In contrast to activity theory which is, as Hasan (2005c, p. 146) argues, concerned with ‘concepts relating to ...
non-verbal actions’, the Montessori objects are modelled in this study as discursive resources, requiring an analytical framework, which goes ‘beyond action into interaction’ (Hasan 2005c, p. 146) or, in other words, foregrounds the mediation of signs.

4.1.3 Modelling human development as adaptation

Montessori and Vygotsky both drew on the legacy of Darwin for their models of development. Both modelled development as a process of growth and transformation, unfolding over time through interaction with the environment. Both emphasised the way human children develop, in culturally-diverse and socially-complex ways, beyond the limits of their biological heritage. Vygotsky (1981b, pp. 151-152) summarises this process when he writes that ‘[t]he child develops and changes in his/her active adaptation to the external world’, the external world comprising people and objects.

Towards the end of her life Montessori (1982 [1949], pp. 165-166) described the phenomenon of adaptation in the following way:

... in the period which follows birth ... the mind of man has to fashion itself on what it takes from the outer world ... and so makes every individual into the type of person constituting his racial group. This is how differential continuity is kept going between the various human communities which have evolved each its own civilisation down the ages.

In the continuation of this description of the human child’s potential, adaptation is identified as a ‘creative power’:

The continuity of anything which nature has not fixed, but which evolves gradually as a social pattern must do, is only possible if the new individuals born into it have a creative power, one which can adapt to the circumstances into which they are born (Montessori 1982 [1949], p. 166; emphasis added).

The ‘creative power’ the human child brings to the process of development is a specialised intellectual capacity, or potential. Similarly Vygotsky’s ‘enriched, holistic psychology of human nature’ has, according to Knox and Stevens (1993, p. 13), ‘bequeathed’ a view of the human child as ‘full of unrealized potentials’ which ‘offer a wealth of creative resources’. Echoing Montessori, a child for Vygotsky (1993
[1929], p. 30) was not defined by what he or she lacked and was not ‘simply a small adult’ but at each developmental stage ‘represents a qualitative uniqueness’. The ‘developmental processes in a child’ are analogous to the transformations achieved by a caterpillar becoming a butterfly.

The contemporary interest in the difference between humans and animals (Minick 2005 [1987], p.36) was shared by Montessori and Vygotsky. They also shared the view that the key distinction between humans and animals was the intersection of a human child’s developmental potential with human society. From Itard’s account of the education of Victor (as outlined in Section 3.5), Montessori deduced that human children, unlike the young of other animals, cannot become fully adult when they are deprived of human society. Instead of innate instincts, Montessori argues human children are given special mental orientations through which they fashion the material of their physical and social environment into the means of adaptation. This special mentality, in the Montessori view, drives the child to attend to different aspects of the environment, which then become the means of the child’s adaptation. The means of adaptation are remembered not in the way an adult might remember them but are remembered because they become incarnated as the specifically human mentality the child is in the process of constructing. As a result of the powerful interplay between attention and memory which characterises this period, according to Montessori (1982 [1949], pp. 21-22; emphasis added):

... the child absorbs knowledge directly into his psychic life. ... A kind of mental chemistry goes on within him. ... Impressions do not merely enter [the child’s] mind; they form it. 3

Montessori (1983 [1936], pp. 28-32; 1982 [1949], pp. 53-54) appears to have derived the term ‘incarnated’ from Karl Bühler. Vygotsky (1993 [1931], p. 215) too cites Bühler’s influential 1919 study of the development of a child’s psyche when he describes a child’s first developmental steps as the process ‘of becoming human’, because ‘this period decides the basic choice between animal and human existence’. Vygotsky, however, goes beyond Montessori by articulating a more clearly

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3 A superficial comparison of Montessori’s and Bühler’s writing suggests a dialectic between her earliest writing between 1909 and 1918, his 1919 work on child development and, in the next decade, his work on language functions, and her later work as evidenced in her grammar pedagogy and her model of child development. Vygotsky’s engagement with Bühler’s description of the mental development of the child (Bühler 1930 [1919]) is much more explicit.
differentiated, but compatible, view of both the environment the small child is adapting to and the means of adaptation. The infant’s environment comprises both ‘objects and people’ (Vygotsky and Luria 1994 [1930, p. 116). Adaptation during infancy and beyond, leading to uniquely human forms of behaviour, is achieved by means of ‘the use of tools and human speech’ (Vygotsky 1978, p. 46; emphasis in original).

Tool use and sign use, the two means of human adaptation proposed by Vygotsky (1978, p. 54), are analogous because they are both ‘artificial means’ with a ‘mediating function’ in human activity, but differing in orientation. Tool use is ‘externally oriented’, mediating human interaction with the physical environment; it is ‘a means by which human external activity is aimed at mastering, and triumphing over, nature’. In contrast, sign use is ‘internally oriented’, ‘a means of internal activity aimed at mastering oneself’ (Vygotsky 1978, p. 55; emphasis in original). The origin of sign use, however, lies in activity which is externally-oriented towards other people. What is significant is that a defining characteristic of human adaptation is the reversal of the outward social orientation of sign use to the internally-oriented function of regulating behaviour and mental activity. The process is initiated when tool use and sign use combine in developmental activity during infancy.

While the earliest practical actions of the child, such as grasping for objects or using primitive tools, are purposeful, representing an early form of ‘practical intelligence’, they are not uniquely human, as Karl Bühler, and his contemporaries, had demonstrated to Vygotsky’s satisfaction (Vygotsky 1978, p. 81; Vygotsky and Luria 1994 [1930], p. 101). The adaptation of the human child, however, ‘from the very first days of its development’ is achieved ‘by social means, through the people surrounding him’ (Vygotsky and Luria 1994 [1930], p. 116). In this respect Vygotsky (1978, p. 81) endorses the contemporary research of Charlotte Bühler, which revealed the child’s earliest speech-like behaviour develops as a means for making social contact.  

The union of the human child’s developing practical intelligence (tool use) and developing speech (sign use), Vygotsky (1978, p. 30) argues, transforms the structure

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4 This section draws on two editions of ‘Tool and Symbol in child development’. First, the extracts from the paper edited by Cole, John-Steiner, Scribner and Souberman (1978) and the full text accredited to Vygotsky and Luria (1930), edited by van der Veer and Valsiner (1994).
of the child’s mind. Echoing Montessori’s metaphor of ‘mental chemistry’, Vygotsky specifies the particular structure of this transformation as an ‘alloy of speech and action’ formed in the following way:

... the most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development, converge (Vygotsky 1978 [1930], p. 24; emphasis in original).

In this model the two elements, speech and action, are transformed into a single compound.

The union of speech and action is not a static one in Vygotsky’s model, but a dynamic process marked by phases of developmental transformation. Its first appearance, in the earliest stage of a child’s life, marks this stage as the most significant period of human developmental transformation. The activity of a ‘speaking child’, in Vygotsky’s words, is ‘less impulsive and spontaneous’, and no longer a direct response to the environment, with speech used to plan and organise activity before it is executed. Thus, a speaking child has ‘incomparably greater freedom in [his or her] operations’ and ‘incomparably greater independence from the structure of the given visual and actual situation, as compared to that of the animal’ (Vygotsky and Luria 1994 [1930], pp. 110-111; emphasis in original).  

In Vygotsky’s terms, therefore, the dynamic fusion of speech and action in the early stages of a human child’s development introduces into the process of human adaptation the potential for transcending biological limits and gaining a level of independence and freedom not available to other species, the kind of liberty valued in the Montessori tradition. Within a Vygotskian framework the combination of speech and action is modelled as a single dynamic unit of activity. A closer investigation of the nature of this activity can be achieved by returning to the tradition from which

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5 Vygotsky (1993 [1932], p. 215) credits both Richter and Tolstoy with the following: ‘A greater distance divides a speaking child from a newborn infant than Newton from a schoolboy’. Interestingly, Vygotsky labels the period between birth and the onset of speech the ‘pre-natal’ period in the development of higher psychological functions (Vygotsky and Luria 1994 [1930], p. 148) while Montessori (1982 [1949]) names this period the ‘psychic embryo’, in which psychic ‘organs’, for example, perception and language, develop their specialised functions in a manner analogous to the development of the physiological organs, for example, the eyes and the ears, prior to birth. Similarly, following Zinchenko and Davydov (1985, p. viii) ‘Vygotsky ... viewed higher mental processes as functional systems or organs’.
Montessori pedagogy emerges, specifically to Séguin’s psycho-physiological method, and its focus on the relations between activity, intelligence and the will.

4.1.4 Séguin’s socially-oriented pedagogy

Montessori’s developmental pedagogy and Vygotsky’s developmental theory originated in work with children whose development was impaired and they both looked to Séguin for inspiration. Montessori’s debt to Séguin is well-known but it is less well-known that Vygotsky also drew attention to Séguin as a predecessor, for example, when commending ‘the profound intuition of Segen’s … that the source of idiocy is solitude’ (Vygotsky 1993 [1932], p. 218). The existing Vygotsky literature does not foreground the extent to which he drew from the ideas and practice of Séguin.

Montessori inherited from Séguin (1971 [1866], p. 202) the conviction that education was the appropriate treatment for developmentally impaired children, in particular an education which renders such children ‘more social’. Similarly, Vygotsky (cited in Knox and Stevens 1993, p. 13) advocated a ‘social pedagogy’ which focuses on ‘cultural development’ for handicapped children, because it is not any particular impairment which is the problem, but its social consequence. The ‘retarded child’ has the potential to cover the same developmental path as normal children in the first years of life, but more slowly and with the help of education. Following Séguin, Vygotsky (1993 [1932], p. 216) argues:

> Education makes idiots into men. With the help of education, a severely retarded child goes through the process of becoming human.

Vygotsky (1993 [1932], p. 218; emphasis in original) endorsed the collaborative approach devised by Séguin, arguing that this approach was relevant to the education of all children:

> The developmental path for a severely retarded child lies through collaborative activity, the social help of another human being, who from the first is his mind, his will, his

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6 Translations of Vygotsky’s references to Séguin sometimes use the French spelling and sometimes the spelling ‘Segen’. Vygotsky (1993 [1932], p. 218) cites a Russian translation of a paper by Segen (Séguin). I have not been able to locate an English-language version of this paper.
activities. This proposition also corresponds entirely with the normal path of development for a child.

Here Vygotsky recasts Séguin’s (1971 [1866], p. 83) three elements, ‘activity, intelligence and will’, as constituting the three ‘expressions’ of humanity. Séguin argued all three must be systematically trained if impaired children are to enter fully into ‘a life of relation’. Will and intelligence are developed through sequences of instructional activity, which originate in collaboration, and progress towards independent functioning, with the goal of transforming the child’s interaction with the external world into intellectual ‘power’ (Séguin 1971 [1866], p. 136). This approach has its origin in Itard’s training of Victor, beginning with Victor’s organic ‘wants’ and interests, such as food and warmth, and then, in the tradition of Condillac, progressively intellectualising this sensory experience.

The ‘keystone’ in Séguin’s approach, as identified by Vygotsky (1993 [1935], p. 220), is ‘free will’. ‘Séguin’, Vygotsky (1981b, pp. 167-168) writes, ‘saw the essence of idiocy as the underdevelopment of volition’:

If we understand volition in the sense of mastering oneself, we would be disposed to go along with [Séguin’s] opinion and emphasize that the main source of all underdevelopment in the mentally retarded child is in a defect of the mastery of one’s own behaviour.

Vygotsky (1993 [1935], pp. 220-221) recognises that Séguin viewed the achievement of free will, or self-mastery, as the highest stage of a freedom-oriented developmental process, when, in a discussion of Séguin’s work with ‘severely retarded’ children, he writes:

Séguin does not have in mind only that highest stage in volitional development ... He also suggests that the very foundations, the primary, elementary volitional impulse in these children is destroyed in a most profound manner ... They lack that freedom from which moral will is born.

Following Séguin, Vygotsky (1993 [1935], p. 220) identifies volition as ‘the key factor in all activity, all abilities’, originating in the free expression of primary volition - wants, desires and motivations. Volition can then be trained to become the higher intellectualised, mental faculty of free will. Vygotsky (1993 [1932], p. 219) concludes that ‘[t]hat which is impossible on the level of individual development becomes possible on the level of social development’.
The developmentally-impaired children educated by Séguin displayed involuntary, idiosyncratic behaviours, such as uncontrolled movement, undirected, random sensory perception and impulsive affective responses. Through the use of carefully-designed materials and exercises, this behaviour was brought under voluntary and intellectual control. Considered in the light of Vygotsky’s theory, Séguin’s distinctive materials and exercises appear to fulfil the ‘mediating’ function Vygotsky attributes to sign use. In the same tradition, the Montessori objects are similarly credited with the development in children of voluntary control over physical and intellectual activity and appear to have inherited, and perhaps expanded, the potential to fulfil the mediating and regulating function of signs.

Before examining Vygotsky’s explanation of the role of signs in human development, it will be useful to focus on a line of theoretical thinking, which flickers through Montessori’s publications, and which continues to be presented in advanced Montessori training courses. This theoretical thread is presented in order to pull together the commonalities between the projects of Montessori and Vygotsky, while at the same time, revealing a contrast central to the proposals in this study.

### 4.2 Montessori’s reorganisation of the arrow of time

While Montessori developed a methodological response to address the discontinuity between the materialist and idealist world-views of her era, she continued to search for a theory to explain the developmental phenomena she observed over many decades working with children. The theories she investigated reflected the wider intellectual questions debated during her lifetime.

The period of Montessori’s training as a doctor at the end of the nineteenth century was marked by an increasing awareness of the limits of both experimental science, based on empirical evidence, and the mechanical universe of cause and effect described by Galileo and Newton. The science of thermodynamics, which drew on Newton’s mechanics, generated the law of entropy, a process of change which causes energy and potential to be steadily dissipated and lost, leading to homogeneity and disorder. In the biological sciences, Darwin’s theory of evolution modelled processes
of change and transformation leading to increasing differentiation, order and complexity.

An early attempt by Montessori to reconcile these two competing orientations is found in the introduction to the study of biology which Montessori prepared for student teachers at the University of Rome. Here Montessori (1913 [1910]; pp. 40-41; emphasis in the original) describes living organisms as not only comprising ‘matter and movement’, subject to the laws of Newton’s physics like the ‘stars’ and ‘atoms’, but also ‘vital phenomena’ which ‘tend towards a defined purpose or end’. These phenomena are labelled using Aristotle’s category of ‘final causes’. They include the ‘final cause’ leading embryonic development from undifferentiated cells to a complex individual, and ‘the final cause of psychic action’ as evidenced in the ‘glimmering’ of ‘self-will’ and consciousness in the movement of single-celled organisms towards food and light. Montessori’s inference is that this last characteristic of biological life reaches its highest expression in human consciousness through an evolutionary process of increasing complexity and perfection. At all evolutionary stages the vital phenomena of life seem to be ‘caused’, or their potential seem to be defined, by an endpoint located in the future. This is in contrast to the deterministic Newtonian universe, in which time and movement were modelled as arrows moving in a fixed linear sequence from a cause in the past, through the present, towards the future.

In the first decades of the twentieth century the image presented by Galileo and Newton of a predictable universe was challenged by cosmic and atomic discoveries. By the time Montessori had opened her famous school in 1907, Einstein had described a universe in which the past, present and future were placed in a dynamic relation, dependent on the observer’s perspective. During the 1920s, the new science of quantum mechanics emerged from the discovery that atomic and sub-atomic particles could be described as no more than probabilities within a region and, moreover, were simultaneously perceived as waves. By the late 1920s came the discovery of anti-particles, the mirror image of particles operating in accord with the law of entropy. Anti-particles manifest a future potential flowing towards an absorbing source. During this period, when physicists were providing new models for thinking about complex phenomena, Montessori was elaborating her developmental pedagogy and Vygotsky was elaborating his developmental theory. A feature of their
work was the representation of dynamic relations between the past, present and future, but in importantly different ways.

Montessori continued to describe the phylogenetic evolutionary processes of the biosphere and its continuation and potential perfection in human social life, from the perspective of ‘final causes’. At a conference in Italy in 1950 Montessori presented a model of ontogenetic development which differed from prevailing developmental models associated with the ‘growth’ metaphor. Instead of representing development as a smooth incline, Montessori modelled development from birth to adulthood as an ebb and flow of transformations, pulse-like waves of rapid progress followed by consolidation. She aligned her model to a theory proposed by the contemporary Italian mathematician, Luigi Fantappiè, who attempted to reconcile the physical and life sciences, and science and religion.

Building on Einstein’s relativity and quantum mechanics, Fantappiè described phenomena in terms of the interplay between entropy, in which causes are located in the past and energy is dissipated, and syntropy, in which causes, or attractors, are located in the future towards which energy is concentrated as potential. Similarly, in the Montessori tradition entropy is described as a process of increasing isolation, and syntropy as a process of increasing collaboration and cooperation, summarised in the terms ‘causality’ and ‘finality’. While these terms remain part of the Montessori heritage, they are rarely elaborated or interrogated, and more importantly, the link between this doctrine and the use of the Montessori objects is not clarified.

A recent exploration of Fantappiè’s proposals by Vannini (2005) reveals more about why his doctrine would have been of interest to Montessori. Vannini argues that Fantappiè’s goal was to design a methodology for studying probabilistic syntropic phenomena not amenable to an experimental method oriented to deterministic entropic systems. According to Vannini (2005, pp. 100-102) Fantappiè failed to achieve this goal, but she argues that it can be achieved by using a methodology which studies relations. The approach she advocates is the one proposed by Bateson.

7 See example, Montessori 1946, pp. 26-27.
8 The material on entropy, syntropy and Fantappiè in this section has been adapted from a lecture by Camillo Grazzini, Director, Fondazione ‘Centro internazionale di studi Montessoriani’, Bergamo, Italy (Montessori Elementary Diploma course, 1984-85); supplemented by lecture notes from earlier years, and from Vannini (2005). The Montessori doctrine of causality and finality, and its link to Fantappiè is also discussed in Chattin-McNicholls (1992).
(1979, pp. 9-12) in which living phenomena are not defined by what they are, but in terms of their internal and external relations.\(^9\)

A focus on internal and external relations is a hallmark of Montessori’s reasoning about developmental phenomena, a focus reinforced in the design and use of the Montessori objects. Her interest in Fantappiè’s inconclusive proposals as a means for reasoning about these phenomena, however, foregrounds the distinctions between her tentative explanations and Vygotsky’s more elaborated developmental theory. What distinguishes Vygotsky’s proposals is his use of semiotic mediation ‘for bringing together the natural and the social’ (Hasan 2005 [1995], p. 107) and for modelling the relation between past, present and future in the development of human consciousness.\(^10\)

The doctrine of causality and finality was used by Montessori to re-reorganise the arrow of time as it applies to developmental phenomena. Recasting this doctrine in semiotic terms eliminates the need to traverse challenging terrain at the border of science and metaphysics, an otherwise disconcerting component of Montessori study alluded to by Bruner (1966, p. 34, cited in Kramer 1976, p. 251) when he describes Montessori as ‘a strange blend of the mystic and the pragmatist’.

### 4.3 Biogenetic and sociogenetic development

Montessori’s doctrine of ‘final causes’, or finality, is a doctrine in which living systems are characterised in terms of their progression towards the achievement of future potential, via a series of developmental transformations. With this doctrine Montessori achieved a meta-view of the development of the human species over evolutionary time (phylogenesis), and of human development over the period of human history and over the span of childhood (ontogenesis). This view is an abstraction of the developmental phenomena she observed as she implemented and

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\(^9\) For a further discussion of the science of complexity and emergent phenomena see Hobart and Schiffman (1998, Chapter 9).

\(^{10}\) Semiotic mediation in Vygotsky’s model reorganises consciousness, as will be described in Section 4.3. During this reorganisation the relations between the functions that constitute consciousness change according to dialectical principles. Thus, ‘in the course of development causes and effects become interchanged’ (Vygotsky, quoted in Lee 1985, p. 71). Vygotsky continues: ‘Once higher mental formations have emerged from certain dynamic preconditions, these formations themselves influence the processes that spawned them’.
expanded Séguin’s method. From a similar starting point, Vygotsky developed a much more elaborated model for understanding the processes of development over time, a model he described as genetic. It is Vygotsky’s elaborated genetic model, with its emphasis on semiosis, which I argue offers a more powerful insight into the developmental value of the Montessori objects than Montessori’s own more provisional explanations.

To account for the development of human consciousness, Vygotsky described an ‘integrated system’ of ‘genetic domains’, a system which integrates phylogenesis, ‘sociocultural history’ and ontogenesis (Wertsch and Tulviste 2005 [1992], p. 65). The empirical data of the ‘experimental-genetic method’ (Vygotsky and Luria 1994 [1930], p. 160) were derived from developmental processes observed during children’s interaction with people and objects in the environment. These processes have been termed ‘microgenetic processes’ by Wertsch and others (for example, Wertsch 1985a, pp. 54-55; Wertsch and Hickmann 1987, pp. 252-253; Wertsch and Tulviste 2005 [1992], p. 65). The instructional sequences of Séguin’s method, elaborated in Montessori pedagogy, are located in the domain of microgenesis.

In Montessori’s meta-view of the development of human consciousness, the move from one genetic domain to the next is described as a continuation or perfecting of the previous one (See, for example, Montessori 1973b [1948]; 1982 [1949]). The relations between the domains in Vygotsky’s integrated genetic explanation of human behaviour, however, are modelled differently, as will be explored in the following sections.

4.3.1 A genetic explanation of human liberty, activity and consciousness

In Vygotsky’s integrated genetic explanation of human behaviour, the move from one genetic domain to the next is a shift to a new type of development defined by ‘changes in the form of mediation’ (Wertsch 1985a, p. 19). A change in the form of mediation is described by Vygotsky and Luria (1930, cited in Wertsch and Tulviste 2005 [1992], p. 65) as a ‘critical step’ or ‘turning point’. The phylogenetic turning point in the behaviour of primates is tool use, which ‘crows the organic development of behaviour in evolution’. Tool use is the form of mediation on which human history,
or sociocultural development, is based. Human history begins with ‘the mastery by early humans of their behaviour’ through ‘[l]abor and the associated development of human speech and other psychological signs’. In the domain of ontogenesis, the critical step is the appearance, alongside ‘organic growth and maturation’, of ‘a second line of development ... the cultural growth of behaviour’ (Vygotsky and Luria 1930, cited in Wertsch and Tulviste 2005 [1992], p. 65).

The difference between the phylogenetic and the ontogenetic domains of development, in Vygotsky’s explanation, lies in the relation between organic, or elementary, biological processes and higher cultural processes, ‘higher’ because they appear later in a genetic sense. In the domain of phylogenesis, the evolution of biological processes and higher cultural processes are ‘sharply divided and ... belong to different types of evolution’. In the domain of ontogenesis, however, there is no ‘simple continuation and development’ from lower to higher processes and these two lines of development ‘appear as an interwoven complex combination’ (Vygotsky and Luria 1994 [1930, p. 139). In fact ‘the real history of child behaviour is born from the interweaving of these two lines’ (Vygotsky and Luria 1994 [1930], p. 148).

Where animals solve problems using functions formed biologically, humans have a system of ‘higher’ functions, of a psychological or mental order. Higher functions resemble, and are ‘closely connected’ to, biological functions but they are qualitatively different because they have a social, rather than a biological, history. The relation between the elementary biological functions and higher functions is explained by Vygotsky in the following way:

We call these functions higher functions, meaning by this ... their place in the plan of development, while we ... call the history of their formation, as distinguished from the biogenesis of the lower functions, sociogenesis of the higher psychological functions, having in mind ... the social nature of their inception (Vygotsky and Luria 1994 [1930, p. 132; emphasis in original).

Significantly, within the domain of ontogenesis, Vygotsky claimed that the interweaving of the two lines of development, biological and cultural, is itself the function of a genetic relation, that is, ‘there exist a number of transitional forms between the elementary and higher psychological functions’, transitions relating to the development of symbolic activity, including speech and sign use (Vygotsky and Luria 1994 [1930, p. 148).
The elementary biological functions of ontogenesis identified by Vygotsky include practical action, perception, movement, memory and attention. In their elementary form these are separate processes linked by ‘natural primary ties ... given by the biological organisation of behaviour’ (Vygotsky and Luria 1994 [1930, p. 135). Vygotsky variously describes biological elementary processes as ‘instinctive’, ‘reactive’, ‘involuntary, ‘immediate’ and ‘direct’, and emphasises that they do not become higher forms through maturation, discovery, reasoning or practice (for example Vygotsky and Luria 1994 [1930, pp. 114-115).\(^\text{11}\)

The catalysts for the genetic transformation of elementary biological processes into the higher functions of human activity are the social resources for meaning-making, or semiotic resources, in the child’s environment. In their experiments, Vygotsky and his colleagues uncovered a range of developmental processes in which speech in particular, and sign use in general, lead the human child’s development beyond direct, involuntary, natural forms of adaptation towards higher, indirect, intellectualised functions brought under voluntary control, or, to use Séguin’s term, under the control of free will. The experiments showed that, when speech merges with action in a child’s activity, collaboration becomes possible, first with others and later with oneself, with speech taking on a planning function. In this way the child’s activity is freed from the immediate sensory field and drawn towards a future goal. Thus, from Vygotsky’s experiments emerged a semiotic view of development equivalent to Montessori’s concept of final causes.

4.3.2 The word which makes man’s action free

The human developmental trajectory from biology to culture, from involuntary action to intellectualised action under voluntary control mediated through sign use, is summarised in its most general terms by Vygotsky and Luria (1994 [1930], p. 170; emphasis in original) in the following way:

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\(^\text{11}\) See also Wertsch (1985a, p. 27):

Thus voluntary control, conscious realization, social origins and nature, and mediation by psychological tools characterize higher mental functioning in Vygotsky’s account. Elementary mental functioning, in contrast, is characterized by control by the natural environment, an absence of conscious realization, individual origins, and a lack of mediation by psychological tools.
... if at the beginning of development there stands the act, independent of the word, then at the end of it there stands the word which becomes the act, the word which makes man’s action free.

For Vygotsky and Luria (1994 [1930]), sociogenesis, in all its manifestations, has its origins in the convergence of speech and practical action, a convergence which underpins the Montessori method.

Speech and practical action, in Vygotsky’s model, begin as two separate functions for connecting the child with the outside environment: practical action for making sensory contact with objects, and speech, or speech-like behaviour, for making social contact with others. Very early these functions converge in practical activity, a critical step leading to, in the words of Vygotsky and Luria (1994 [1930], p. 109):

... the birth of those specifically human forms of behaviour that... later create intellect and go on to become the base of labour: the specifically human form of the use of tools.

The convergence of speech and practical action reorganises the relations between the natural functions of perception, movement, attention, volition and memory, unifying them into systems of higher functions. Once speech and action merge, the child undertakes practical activity ‘with the help of not only eyes and hands, but also speech... a unity of perception, speech and action’. At the same time the child achieves ‘incomparably greater freedom ... and incomparably greater independence’ from the ‘actual situation’ (Vygotsky and Luria, 1994 [1930], pp. 109-110). This process comprises a series of developmental transformations over time.

Three ontogenetic transformations described by Vygotsky and Luria, relevant to Montessori pedagogy, are summarised in the following sections: the shifting relation between speech and action, the reorganisation of the relations between perception and movement, attention and volition and the reconstruction of memory.

4.3.3 The shifting relation between speech and action

Practical use of the Montessori objects is always combined with an exact language. The significance of this aspect of the Montessori tradition is illuminated by Vygotsky’s explanation of the shifting relation between speech and action in developmental activity.
In Vygotsky’s account the relation between speech and action begins to shift when a child intentionally uses speech, or speech-like gestures, to ask others for help to carry out an action. When this happens, speech not only has an interpersonal function, but also an interpsychological, or intermental, function. In other words the child’s speech is used to direct the action of another to enable the child to share in the mental ‘know-how’ of that other. A further step is taken when the child, while carrying out an action, accompanics it with talk. With this step the child’s speech, while still external, has become intrapersonal, talking to the self, and intramental, reflecting the child’s practical ‘know-how’ to the self.

The next critical step occurs when speech ceases to merely accompany the child’s action and becomes concentrated at starting points and turning points in the action. With this step, speech is ‘beginning ... to precede action and throw light on the conceived of but as yet unrealized action’ (Vygotsky and Luria, 1994 [1930], p. 120). The relation between speech and action has shifted. Intrapersonal, intramental speech is now used to predict, plan and direct action towards future goals, the planning function of speech having emerged from the earlier reflective function. The final transformation occurs when externalised intrapersonal, intramental speech is reconstructed internally as thought, a process Vygotsky (1978, p. 56) calls ‘internalization’.

In summary, what begins as an external, interpersonal and intermental, or social, phenomenon evolves into an external intrapersonal, intramental phenomenon, and then transforms into the internal, intrapersonal, intramental phenomenon we call thought, while retaining the social, dialogic, interactional nature of the speech from which it has evolved. At this point, the child may appear to have returned to the way of acting before speech and action converged, but the developmental trajectory has not closed a circle by returning to the starting point. Instead it has inscribed a spiral ‘passing through one and the same point at each new revolution at a higher level’ (Vygotsky and Luria, 1994 [1930], p. 153). The spiral trajectory initiated when practical action and speech converge is illustrated in Figure 4.1.
4.3.4 The reorganisation of the relations between natural functions

Before practical action begins to merge with speech, Vygotsky’s experiments reveal that an infant’s perception begins by being passive and ‘integral’, or holistic (Vygotsky and Luria 1994 [1930], p. 125). Passive perception is described by Séguin (1971 [1866], p. 62) as ‘the incapacity of [the] will to control the organs of [perception]’. For example, when vision is passive, the child ‘sees by chance, but never looks’. Perception, however, is transformed with the genesis of the communicative function of indication, a function central to the use of the Montessori objects.

The communicative function of indication evolves from an infant’s earliest grasping movements. When a child’s attempts to grasp an object are interpreted by others as a pointing gesture, gradually, through social interaction, the infant comes to give the gesture the same meaning (Vygotsky 1978, p. 56; Vygotsky 1981b, pp. 160-161, cited
in Wertsch 1985a, p.64). In this way a movement, which begins as an attempt to act on the world of objects, expands its meaning through social interaction. Once the movement has evolved into a socially-meaningful gesture, it can be used consciously to act on others in the social world and it has become a form of mediation through which perception is activated and consciously controlled.13

As the child learns to talk, speech combines with and supersedes the pointing gesture to further transform the relation between indication and perception into one of labelling. Indication through labelling or naming, that is, by ‘the singling out of a given object from the entire situation perceived by the child’, is, according to Vygotsky and Luria (1994 [1930], p. 125), the first and primary function of speech. They continue by describing the critical ontogenetic step generated by this form of mediation:

... the word intrudes into the child’s perception, singling out separate elements overcoming the natural structure of the sensory field ... the child begins to perceive the world not only through its eyes, but also through its speech ... 14

Using the communicative function of indication, the child can analyse the visual field, picking out salient elements and interpreting them on the basis of socially-meaningful relations learned through speech. Perception becomes verbalised, and over time is reconstructed in socially-meaningful ways, enabling the sharing of experience with others in the culture. In this way holistic, natural, passive perception evolves into analytical, social, verbalised, active perception.

As well as being tied to natural movement, as in, for example, a grasping movement or expressive gesture, natural perception is also tied to the function of affective

12 See also Hasan 2005 [1995], p. 110.
13 See also Minick 2005 [1987], p. 46:
... when the infant cries or reaches for an object, the adult attributes meaning to that behaviour. Though the infant has no communicative intent, these acts nonetheless function to communicate the infant’s needs to his caretaker ... the infant is included in the communicative social activity before he has the capacity to use or to respond adequately to communicative devices.
14 Vygotsky (1978, p. 32) also draws attention to the way a child accompanies labelling with the redundant use of gesture:
Simultaneously ... the child embellishes his first words with very expressive gestures, which compensate for his difficulties in communicating meaningfully through language. Nevertheless, it is ‘by means of words’ that children overcome ‘the natural structure of the sensory field’ and form a ‘new (artificially introduced and dynamic) structural center’. In this way:
... [t]he child begins to perceive the world not only through his eyes but also through his speech. As a result, the immediacy of ‘natural’ perception is supplanted by a complex mediated process ...
impulsive volition. During an experiment recorded by Vygotsky and Luria (1994 [1930], pp. 127-129) the relations between these functions were reorganised when external signs were incorporated into activity. Four-year-old and five-year-old children were asked to make selections by pressing keys. The children used movement to identify and choose the keys they wanted with movement constituting ‘the process of selection itself’. In other words perception and volition were tied to movement, hand and eye moving as one with the process of choosing. When external signs were introduced to help slightly older five-year-old and six-year-old children to make selections, the signs intruded and broke the tied relation between perception, movement and volition. The children used the signs to direct their perception and to make their choice, only then moving to enact their choice. In this way sign use intervened to reconstruct perception, to control volition and to delay movement, giving the children voluntary, and thus conscious, control over these actions. Arguably, it is this same developmental pattern which is activated during use of the Montessori objects.

Perception is also tied to attention, the conscious control of which is critical to the success of practical activity (Vygotsky and Luria 1994 [1930], p. 132). The genesis of indication contributes to the child’s control of attention. Objects consciously singled out through gesture, or speech, become socially-meaningful centres of attention, standing out against the background of the sensory field. This critical step ‘frees the child’s attention from the power of the immediate situation’ and places it under the control of meaning. In this way, meaning directs and regulates attention, and controls and structures the child’s perception of the sensory field.

As the functions of perception and attention evolve through the mediation of indication and other communicative functions, the child is also able to redirect attention in order to control the structure of the ‘time field’ in socially-meaningful ways (Vygotsky and Luria 1994 [1930], pp. 132-134). In other words, the child becomes able to act in the present, drawing on the experience of past activities while attending to an endpoint, or goal, in the future. This past activity and future goal become active agents in the activity. Representing the past or the future in speech, whether expressed externally or internally, extends the time field for practical activity backwards and forwards. This opens up two new developmental moves: the move
away from involuntary action towards voluntary action and the reconstruction of memory (See also Vygotsky 1986 [1934], pp. 168-170).

When, through sign use, an intention to act is consciously postponed and located in a future time, movement comes under voluntary control. When a child uses speech, whether spoken to others or to the self, to attend to and plan a future action, the future action is consciously used to control and direct action in the present. In this way an affective impulsive intention comes under the control of a consciously selected socially-meaningful goal. It evolves into an action under voluntary control, representing ‘the mastering of one’s own behaviour with the assistance of symbolic stimuli’ (Vygotsky and Luria 1994 [1930], p. 135). Thus, in semiotic terms, Vygotsky weaves into this explanation of a child’s developmental activity the significance Ségui places on the development of the ‘will’ and the significance Montessori places on the role of ‘final causes’.

The spiral trajectory initiated by the reorganisation of perception, movement, attention and volition through sign use is illustrated in Figure 4.2.

![Figure 4.2: The re-organisation of the relations between natural functions](image-url)
4.3.5 The reconstruction of memory

Montessori (1965b [1916/1918], pp. 60-61) describes the objects used in her pedagogy as ‘external stimuli’, which leave the kind of ‘psychic’ impressions that ‘make liberty possible’. On the basis of this description it can be argued that the Montessori objects and their use foreshadow the role given to external signs in Vygotsky’s account of the reconstruction of memory from its elementary function to its socially-mediated higher function.

Elementary, natural memory, or mneme as it was called by both Montessori and Vygotsky, is described by Vygotsky as ‘the immediate impression of material by the simple after-effect of actual experiences’ in the external world (Vygotsky and Luria 1994 [1930], pp. 142-143), evoking the mind as tabula rasa at its most direct and basic. Natural memory is tied to perception, but phylogenetically this tie was broken by early humans when they began to use ‘external signs’ as an ‘indirect’ or ‘instrumental’ means of memorising, for example, ‘notched sticks and knots, the beginnings of writing and primitive aides-mémoire’ (p. 143).

Like all signs, artificial means for remembering emerge from interpersonal meaning shared with others. Instead of being directed outwards towards others, the meaning is reversed and directed inwards, intramentally, towards the self in order to extend memory beyond its biological limits. In other words, the impression-receiving potential of the mind’s tabula rasa is shaped by mediated experience, in which external, artificial means are used to control memory consciously. Once memory is reorganised through the use of signs, it becomes a sociocultural phenomenon with the potential to develop from its external social intermental origins to an internalised intramental phenomenon. In this way direct ‘mechanical’ memory evolves into ‘logical memory guided by meaning’, a type of memory that can be deliberately and consciously used (Vygotsky 1986 [1934], p. 166). The reorganisation of memory, using external indirect or instrumental means, is described by Vygotsky and Luria (1994 [1930], p. 145) as the ‘sign function of auxiliary stimuli’.

The use children make of auxiliary means for remembering also follows a developmental trajectory, as outlined by Vygotsky and Luria (1994 [1930], pp. 148-152). Children aged from four to six years use real and depicted objects to remember
the meanings of words if the meaning is linked to the properties of the object. For example, a drawing which brings to mind the properties of a bucket is used to remember the meaning bucket. The external auxiliary means used by older children for remembering, however, include arbitrary signs, which they use to solve tasks otherwise too challenging. According to Vygotsky and Luria (1994 [1930], pp. 154-156) children up to the age of ten or eleven years demonstrate ‘particularly rapid growth of outward indirect memorizing’ of this kind. Children older than ten or eleven cease to find outwardly-oriented signs so useful and they can even become a hindrance. Memory continues to be cultural and indirect, achieved with the help of signs, but sign-use turns inward and memory is further reorganised. Memory is now achieved through the logical use of ‘concepts’. The spiral trajectory in which memory is reorganised through the use of signs is illustrated in Figure 4.3.

![Figure 4.3: The reconstruction of memory](image-url)

**Figure 4.3: The reconstruction of memory**
The most intensive use of the Montessori objects occurs between the ages of three and ten years, matching the most intense period of ‘outward indirect’ memorising identified by Vygotsky. Montessori pedagogy designed for this period of ontogenesis is the focus of Chapters 6 and 7.

4.3.6 The ontogenesis of higher mental functions: an overview

Emerging systems of higher mental functions, as described by Vygotsky and Luria (1994 [1930]), appear twice in the domain of ontogenesis: on the outside as social interaction and practical action involving sign use and on the inside as a mental phenomenon retaining traces of their social origins. This general characteristic of the ontogenetic development of higher psychological functions is summarised by Vygotsky (cited by Wertsch and Hickmann 1987, p. 252):

> Any higher mental function was external because it was social at some point before becoming an internal, truly mental function. It was first a social function between two people. The means of influencing oneself were originally means of influencing others or others’ means of influencing an individual.

In this section I have proposed a Vygotskian framework to account for the genesis of higher mental functions over time, as a semiotic reformulation of the concept of final causes used by Montessori to explain the developmental phenomena generated by her elaborations of Séguin’s objects.

This section has traced how the natural functions of practical action, perception, movement, attention, volition and memory are reorganised, through sign use, into systems of higher psychological functions in ways which liberate human mental functioning from temporal and spatial constraints. In this account, the origin of higher mental functions is found in the dynamic fusion of speech and action in children’s activity. The use of speech and other signs results in natural functions being guided and controlled by meaning. Conscious, voluntary control of the functions, through meaning, intellectualises them, and they evolve into systems of higher mental functions. The first appearance of the functions in their higher form, that is, in a form guided by meaning, is in external, shared social processes. Later the higher forms of the functions, still guided by meaning, are reversed, turning inwards and contributing to the systemic reorganisation of the child’s consciousness (See also Vygotsky 1986...
Vygotsky (2004b, p. 376) summarises the evolution of natural functions into functions mediated by meaning:

> The cultural development of any function ... consists of a person’s developing a series of artificial stimuli and signs in the process of mutual living and activity. The social behaviour of the personality is directed by means of these and they form the basic means through which the personality masters its own processes of behaviour.

From a Vygotskian perspective, the period of ontogenesis in which a child is at school is characterised by a series of transitions marking the evolution of elementary mental functions into external socially-shared higher mental functions, and, finally, into internalised and individualised higher mental functions. Such transitions are a function of changes in forms of mediation. The next section will explore the nature of these changes with particular reference to Montessori pedagogy and its origin in the method of Séguiin.

### 4.4 Semiotic mediation as microgenesis

Vygotsky’s developmental explanation of higher psychological systems is oriented to the timeframe of ontogenesis. The interactive developmental activity in which the Montessori objects are used, however, occurs within the timeframe of a school day, in the domain of *microgenesis*, a term not used by Vygotsky. In the service of developing generalised explanations of ontogenesis, however, his experiments enabled the observation of microgenetic interactive processes between children and the people and objects in their environment (for example Vygotsky and Luria 1994 [1930], pp. 157-161), something he described as grasping ‘the process in flight’ (Vygotsky 1978, p. 68).

The term *microgenesis* has come to be used by those who apply a Vygotskian framework to the observation of interactive processes within adult-child dyads or classroom activity (for example, Wertsch 1985a, pp. 54-57; Wertsch and Hickmann 1987, pp. 252-253, Zinchenko and Gordon 1981). A microgenetic analysis is concerned with interactive processes in which ‘individuals become acquainted with a skill, concept, or strategy within a limited observational session - often a matter of minutes or at most hours’ (Wertsch and Hickmann 1987, p. 252). The aim of such an
analysis applied to the Montessori objects is to account both for their use in terms of microgenetic critical steps, that is, in terms of changes in forms of mediation, and for their contribution to ontogenetic transitions from intermental to intramental functioning. To illustrate critical steps relevant to a microgenetic analysis, the next section returns to the physiological method of Séguin, a method which has already been introduced as a common predecessor of both Montessori’s pedagogy (Section 3.6) and Vygotsky’s theory (Section 4.1.4).

4.4.1 The microgenesis of Séguin’s method

Séguin’s method (1971 [1866]), which has been described as ‘far in advance of its time’ (Ruvin and Cordasco 1971, np), predates Montessori and Vygotsky in advocating a socially-oriented education for all children. Séguin lead the way by developing detailed pedagogical solutions to the educational challenges posed by this educational orientation. Looking forward from Séguin’s practice to Montessori’s pedagogy and Vygotsky’s theory offers a new perspective on both, given their work is more commonly approached in the English-speaking world through comparison with later twentieth-century developments.15

Séguin belonged to the French lineage of humanitarian work in this field, initiated by Pinel, Itard’s master, at the time of the French Revolution (See Section 3.5). From this tradition, a generation after Séguin, emerged Pierre Janet, who has been identified as the origin of Vygotsky’s concept of sociogenesis (van der Veer and Valsiner 1988).16

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15 The reading of Séguin’s method in this section is based on the 1866 English revision of the original 1846 French work, a revision undertaken following Séguin’s emigration to America in 1848. The English revision was republished in facsimile in 1907 and again in 1971. The text reveals problems of translation, from one period of history to the next as well as from one language to the next, problems parallel to those experienced when reading English translations of both Montessori and Vygotsky. The uneven history of Séguin’s publications since 1846 is outlined by Ruvin and Cordasco (1971), a history characterised by unauthorized translations and limited availability, as encountered by Montessori at the end of the nineteenth century (1964 [1909/1912], pp. 34-37).

16 In the late 1890s, already reasonably well-known in her field in Europe, Montessori visited ‘all of the existing institutions for deficient children’ in Paris, largely to further her research into Séguin’s work (Kramer 1976, p. 89). At that time Pierre Janet had recently been appointed director of the female asylum in Paris. Furthermore, a brief bibliographic reference for 1894 indicates that Janet had written the preface for a new French edition of Séguin’s publications. It seems quite possible, therefore, but it is not recorded, that Montessori met Janet. The use being made of Séguin’s equipment in the Parisian institutions at the time of her visit, however, convinced Montessori (1964 [1912], p. 36) that his method was no longer properly understood.
That the origin of a genetic explanation of consciousness should come from this French tradition is further supported by the following words written by Séguin (1971 [1866], pp. 198-200) to describe the foundation of his method:

... the law of evolution of the function of the senses ending in intellectual faculty [in which] perception producing simple notion, faculty producing ideas more and more complex and abstract, are the extreme terms of the chain ...

From this foundation Séguin designed instructional sequences, which fashioned a microgenetic bridge between the involuntary, idiosyncratic behaviours of children with developmental impairment and culturally-meaningful, intellectual ‘faculties’ under voluntary control. In Séguin’s method, learning to control movement of the limbs consciously, specifically the hand, is a step on the pathway towards purposeful work. Transforming passive sensory perception into conscious ‘active’ perception is a step towards formal education. Bringing impulsive, affective responses under conscious control becomes the basis for learning ethical behaviour and bringing to consciousness ‘the instinctive language of cries’ is a step towards ‘social communication’ (Séguin 1971 [1866]) p 153). Séguin’s account of his method provides a rich tapestry of microgenetic detail and a significant portion of Séguin’s method evolved into Montessori pedagogy still in use today. The microgenetic detail of Séguin’s method also foreshadows some of Vygotsky’s most well-known proposals, arguably even filling in some of the gaps in these proposals.

Vygotsky has been criticised for failing ‘to account for the development of natural processes that arise from the organism’s experience with the external, physical world’ (Werstch 1985a, p. 46). With developmentally-impaired children, however, natural processes, including movement, sensory perception and affective responses, cannot be taken for granted. Séguin’s microgenetic sequences use a variety of mediational means to train natural functions systematically, and, in this way, build a base from which social functions can evolve. Séguin follows Itard’s lead by locating the origin of his microgenetic sequences in the domain of affect and its natural expression in wants and desires. This is because a want or a desire is a natural, involuntary means for making meaning, in other words, a natural, involuntary and elementary means of semiotic mediation.\(^\text{17}\) For example, recalling Itard’s experience with Victor, Séguin (1971 [1866], pp. 148-149) describes the ‘natural’ origin of a microgenetic sequence

\(^{17}\) See also Vygotsky (1986 [1934], pp. 10-11) on the relation between affect and intellect.
for leading children from ‘passive hearing’ to ‘active audition and intense listening’.
The sequence begins when environmental sounds come to be signals of something the
child wants or cares about, that is, the sounds come to have meaning for the child:

The sounds of noises are like hieroglyphics of phenomena, meaning the thing producing
the noise; one means pouring rain, another means the rushing of winds; one means
sawing wood, another means the frying in the pan which awakens the child’s appetite.
The wild boy educated by Itard did not hear the report of a pistol discharged, behind his
head, but heard the fall of a nut upon the floor. If water be poured from one vessel into
another near an idiot apparently deaf, at a time when he is very thirsty, he will turn his
head and go for a drink. What a field to awaken the attention and make the organ ready
and sensible!

Once the child is able to attend to these natural signals by endowing them with
meaning, attending to the meanings of social signs becomes attainable.\textsuperscript{18}

Functioning which appears to be natural in the case of normal children underpins the
development of what have become known as ‘spontaneous concepts’. Séguin
recognised that for children with developmental impairment these concepts will not
emerge spontaneously, but have to be learned through systematic instruction. Once
they have been learned, however, higher level functioning becomes possible, even for
those overcoming developmental obstacles. Vygotsky (1986 [1934], p. 207) did not
have the opportunity to study the genesis of spontaneous concepts, but he does
propose that, for children developing within the normal spectrum, spontaneous
concepts are also a product of instruction, specifically in his view, ‘of preschool
instruction’. Microgenetic instructional sequences in which apparently ‘natural’
functions and ‘spontaneous’ concepts are consciously given attention and significance
as the origin of further development is a feature Montessori pedagogy inherited from
Séguin.

Excerpts from Séguin’s method, representing an earlier stage in the genesis of both
Montessori’s pedagogy and Vygotsky’s theory, are used in the following sections to
establish ways, within a Vygotskian framework, the instructional detail relevant to the
use of the Montessori objects can be organised. There are two ways the Montessori
objects and their use can be viewed within a Vygotskian framework. First, the use of
the objects can be viewed in spatial terms, as a region of collaboration. Second, their

\textsuperscript{18} Vygotsky, cited in Wertsch (1985a, p. 90) distinguishes between ‘signalization’ and ‘signification’ in
the following way: ‘Signification is the creation and use of signs, that is, artificial signals ...
[S]ignalization [is] the passive reflection of natural connections of various kinds of agents.
use can be viewed in linear terms as a microgenetic echo of the spiral ontogenetic trajectories through which Vygotsky describes children progressing from intermental to intramental functioning by means of semiotic mediation. At the microgenetic level, in the tradition of Séguin, the developmental spiral carries children’s functioning from concrete, everyday knowledge to abstract, educational knowledge through the mediation of semiotically-charged objects.

4.4.2 Learning as a region of collaboration

Both Montessori and Vygotsky model ontogenesis in terms of potential. Montessori (1964 [1909/1912], pp. 37-38) addresses the notion of potential at the level of microgenesis when she argues it is a mistake for teachers to place themselves ‘on a level with the one to be educated’, for example, ‘by approaching [a child] with games, and ... with foolish stories’. Instead the teacher must interact with the future potential of the child, by calling to ‘the man which lies dormant within the soul of the child’.

Vygotsky addresses the notion of potential through his concept of the zone of proximal development, in which the child’s potential is modelled as a region within which learning can take place in collaboration with others. In Hasan’s words (2005a, p. 11), ‘Vygotsky made the brilliant suggestion that a mind in interaction with another extends its potential’. This concept brings to mind Séguin’s advice to educators, endorsed by Vygotsky (1993 [1932], p. 218), to be for the child ‘his will, his mind, his activities’. Séguin exemplifies this advice in the microgenetic sequence he proposes for teaching developmentally-impaired children conscious, voluntary control over their movement.

Séguin’s microgenetic sequence for teaching control over movement begins with the teacher moving the child’s limbs. The teacher next performs movements for the child to imitate, followed by a series of graduated exercises designed to hand over, incrementally, independent control over movement. Control of movement, even with the help of others, writes Séguin (1971 [1866], p. 98), creates ‘a reflex action on the

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19 See also Werstch (1985a, pp. 71-72).

According to Vygotsky, instruction in the zone of proximal development ‘calls’ to life in the child, ‘awakens’ and puts in motion an entire series of internal processes of development ...
intellect and will”, leading to an ‘intellectualisation of the muscles’ (p. 100). The children demonstrate they can control their movement independently and voluntarily when they choose to hold themselves completely still in ‘positive immobility’, or when they negotiate an obstacle course successfully, because ‘to walk among so many difficulties is to think’ (Séguin 1971 [1866], p. 108).

In summary, this microgenetic sequence has three phases. The first two phases are collaborative, with the teacher controlling the movement by moving the child’s limbs, followed by the child moving his or her own limbs in imitation of the teacher. In the third phase, the child voluntarily applies the newly-learnt, and not yet firmly established, control of movement to problem-solving tasks. During the third phase the teacher observes for evidence of development. This three-phase microgenetic pattern reappears in Montessori pedagogy as the three-period lesson.

Séguin (1971 [1866], pp. 158-159) identifies a gap between collaborative learning and evidence of development, when he writes ‘[t]he chances are that what the child learns today, he will not show at once; but occasion will bring it out later’. He describes this gap as double progress. The idea of double progress is expressed in Montessori pedagogy as the principle of indirect teaching, that is, helping at the periphery where the child comes in contact with the external world and then waiting for evidence of internalisation to be manifested later in the child’s voluntary activity (Standing 1962 [1957], pp. 234-237).

The idea of double progress is articulated by Vygotsky (1978, p. 86) in terms of the two developmental levels which limit the zone of proximal development: the level at which the child operates independently and ‘the level of potential development’, defined as that which a child can do ‘under adult guidance or in collaboration with more capable peers’. Learning occurs in the region which lies between these two developmental levels, and hence, reversing the Piagetian sequence, ‘the developmental process lags behind the learning process’ (Vygotsky 1978, p. 90). Vygotsky uses the zone of proximal development to examine instruction directed at
developmental potential and assessment of developmental potential. This explanation of learning in the zone of proximal development recasts Vygotsky’s sociogenetic explanation of ontogenesis at the level of microgenesis.

The microgenetic practicalities of teaching in the zone of proximal development can be illustrated by Séguin’s proposals concerning the teaching of reading (1971 [1866], pp. 184-185). He emphasises that the subject matter ‘must be of interest to the child’, while at the same time, ‘it must not be too familiar’ otherwise the child’s attention will wander, but neither must it be ‘too much above the comprehension’ or it ‘would proffer no stimulus, through curiosity, to intelligence’. Montessori (1964 [1909/1912], p. 168) elaborates this approach by allowing children, developing within the normal spectrum, to choose ‘didactic materials in which they show themselves to be interested’. The interest she refers to is the type of interest children display when playing (Montessori 1965b [1916/1918], p. 37). A child’s spontaneous playful interest in an object or an activity is seen in Montessori pedagogy as a manifestation of a sensitive period.

Sensitive periods are used in Montessori pedagogy as a guide for teachers when matching activities to a child’s potential. Montessori’s sensitive periods are equated by Vygotsky (1986 [1934], p. 189; emphasis in original) with the zone of proximal development:

For each subject of instruction, there is a period when its influence is most fruitful because the child is most receptive to it. It has been called the sensitive period by Montessori and other educators.

These periods, Vygotsky continues, are not explained ‘in purely biological terms’, but are a function of social collaboration:

Our investigations demonstrated the social and cultural nature of the development of the higher functions during these periods, i.e., its dependence on cooperation with adults and on instruction.

Vygotsky concludes by citing Montessori’s success in teaching four-year-old and five-year-old children to write as ‘a striking example of the strong influence that instruction can have when the corresponding functions have not yet fully matured’. A

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21 Séguin also advises (1971 [1866], pp. 175-176) that, before an exercise descends into either ‘inattentive routine’ or ‘unmeaning exuberance’, it is important to provide children with a new challenge.
sensitive period, as an indicator of a zone of proximal development, is opened up by ‘a minimal ripeness of functions’. Instruction within this period is instruction oriented towards the future and to the child’s strengths. Instruction oriented to the past and to the child’s weaknesses, argues Vygotsky (1986 [1934], p. 189), leaves the child ‘at the preschool stage’. The relation between functions ‘just beginning to mature and develop’ and the zone of proximal development is summarised by Vygotsky (1978 [1935], pp. 86-87):

The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the “buds” or “flowers” of development rather than the “fruits” of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively.22

While emphasising the role of collaborative instruction in the zone of proximal development, as Painter (1999, p. 27) comments, ‘Vygotsky did not specify the exact nature of the more capable partner’s contribution’. Vygotsky (1978 [1935], p. 86), however, does provide five general suggestions about the kind of microgenetic processes which might characterise such instruction. These suggestions can be summarised as follows:

1. showing children ‘various ways of dealing with [a] problem’
2. using ‘different modes of demonstration’
3. running through ‘an entire demonstration’ then asking children to imitate it
4. initiating ‘the solution’ then asking children to finish it
5. asking ‘leading questions’

The first and second techniques in this list advocate the representation of educational knowledge in multiple redundant forms. The third technique, performing an action and asking children to imitate it, aligns with the first phase of Séguin’s three-phase microgenetic pattern and the fourth and fifth techniques align with the second and third phases of this pattern. The representation of educational knowledge in multiple forms will be addressed in more detail in Section 4.4.5 below, and the Montessori reformulation of Séguin’s instructional pattern, the three period lesson in subsequent

22 More recently, Deacon (1997 p. 126) has described the same phenomenon as the ‘critical period effect’ of immaturity.
chapters. The remainder of this section will be used to review the use of imitation to initiate a microgenetic sequence within the zone of proximal development.

Imitation is a mode of instruction emphasised by Vygotsky in his explanation of the zone of proximal development because of its value in both instruction and assessment. For Vygotsky (1978 [1935], p. 88) imitation is not necessarily ‘mechanical’ and, therefore, of less value than ‘independent activity’. Imitation, by its very nature, is collaborative social activity under the guidance of another. In the zone of proximal development imitation is ‘diagnostic’ as well as instructive, because what children can imitate goes ‘well beyond the limits’ of what they are capable of doing independently. Vygotsky (2004a, p. 372) also describes imitation as a function which, like other mental functions, evolves from natural to higher forms.

Imitation on the pathway to a higher level of functioning, in the words of Vygotsky (2004a, p. 372), ‘assumes a certain understanding of the significance of the action of another’. A child’s willingness to imitate demonstrates that what is being imitated is becoming significant, or meaningful, to the child. Imitation, from this perspective, can be compared with dialogue, an interactive activity in which meaning is shared and constructed collaboratively. A child’s recognition of an action as significant, or meaningful, although not yet understanding its meaning in the way the adult does, expresses itself in the child’s interest, which in Montessori pedagogy indicates a sensitive period, or, in Vygotsky’s more abstract term, a zone of proximal development. The use of imitation in collaborative activity, inherited from Séguin’s method, is a feature of the way the Montessori objects are used, a feature which Vygotsky’s framework endorses. However, the imitative use of the Montessori objects is the basis of the criticism by the Deweys that Montessori pedagogy restricts creative and intellectual freedom, the criticism accepted by Boyd, Kilpatrick and those who have followed their lead.23

Montessori pedagogy recognises different sensitive periods in which children become receptive to instruction in different areas, or disciplines, of educational knowledge.

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23 In Vygotsky’s framework there is a parallel between the genesis of the function of imitation and the genesis of a child’s use of language. When a child first recognises the meaning of a word, it is only the beginning of a genetic pathway. While the child’s and the adult’s understandings of a word’s meaning may coincide in terms of practical activity, the child is only starting out on the path towards the adult’s conceptual understanding of the word (Vygotsky 1986 [1934], pp. 121-124).
The different disciplines of educational knowledge are cultural products, that is, products of human history. Thus, in Montessori pedagogy the sensitive period represents a developmental moment in which human history and ontogenesis have the potential to interact in the service of development (Wertsch 1985a, p. 75; p. 80). The next section focuses on the relation between everyday and educational knowledge in Montessori’s pedagogy and Vygotsky’s theory.

4.4.3 Everyday knowledge and educational knowledge

In the Montessori method educational knowledge is materialised in the form of sets of manipulable concrete objects, presenting children with appealing sensory problems which are solved by identifying, naming and comparing the properties of the objects. The problems involve children making choices between contrasting representations. The source of this approach is, as ever, Séguin’s method which, in the tradition of Condillac and Itard, is ‘founded upon [the] principle [of] comparison’ (Séguin 1971 [1866], p. 206). Séguin (1971 [1866], p. 165) describes materials, the prototypes for the Montessori objects, as both ‘instruments of perception’ and ‘matrices of comparison’.

The objects can be considered as forms of sensory mediation, which direct children’s perception, and attention, to generalisable properties. These properties are presented as systems of meanings in two modes. First, they have an external concrete expression, the objects, but they can also be expressed in language, making possible both external social interaction and the internalisation of the meanings, enabling a critical developmental step from the perspective of Vygotsky’s genetic model. Séguin (1971 [1866], p. 209) describes this step in the following way:

Children are our witnesses; unlike animals, they never perceive single, but compound phenomena; from sensational these become instantly idealized by comparison. Mere impressions being compared, become ideas susceptible of combination, and of themselves producing any number of ideas ...

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24 See also Séguin (1971 [1866], p. 95):

We must never confide to automatic memory what can be learned by comparison, nor teach a thing without its natural correlations and generalizations; otherwise we give a false or incomplete idea, or none, but a dry notion with a name: what enters the mind alone, dies in it alone; loneliness does not germinate anything. The contact of two perceptions produces an idea ... the contact of two or more ideas with each other gives rise to ... ideas of an abstract order.
This section uses Vygotsky’s model to explore the nature of educational knowledge in order to understand more about its representation in the Montessori objects.

From early infancy, in Vygotsky’s framework, children learn to perceive and attend to the world through meaning constructed in interaction with others. In this way children learn concepts, ‘the development of concepts and the development of word meanings [being] but two forms of one and the same process’ (Vygotsky 1986 [1934], p. 160). Significantly, and counter-intuitively, in Vygotsky’s framework, when a child learns ‘the term or word meaning denoting [a] new concept’, it is the start, not the finish, of the development of the concept towards its role in the system of higher mental functions (Vygotsky 1986 [1934], p. 159). Learning a concept begins the development of generalised perception, for example, recalling Itard’s experience with Victor, who moved from using the meaning book as the proper name for one particular book to using it to identify books in general.

In dialogue with Piaget’s proposals, Vygotsky distinguishes two types of concepts, spontaneous and non-spontaneous. Spontaneous, or everyday, concepts are learned by the child unconsciously and unsystematically in interaction with people and objects in everyday life. Non-spontaneous, or ‘scientific’ concepts, are the concepts learned consciously and systematically through instruction in the formal disciplines of school learning. Scientific concepts enable ‘humans to carry out mental activity in a way that is maximally independent of the concrete context’ (Wertsch 1985a, p. 104). There is, however, a ‘reciprocal dependence’ between everyday and scientific concepts (Vygotsky 1986 [1934], p. 160). Because ‘the process of acquiring scientific concepts reaches far beyond the immediate experience of the child’, previously acquired everyday concepts mediate ‘between the world of objects and the new language’ of scientific concepts (Vygotsky 1986 [1934], p. 161).25

Everyday concepts are ‘empirical’ concepts based on sensory perception, which, to use Vygotsky’s example, equates meanings such as flower and rose. An ‘empirical’ everyday concept begins to transform itself into a scientific concept when the child learns how to reorder these meanings into a system, or hierarchy, of concepts related according to different levels of abstraction. Within such a hierarchy the meanings

25 The term ‘scientific concepts’ has also been translated as ‘academic concepts’ (See van de Veer and Valsiner 1994, p. 369n).
flower and rose are no longer equivalent, but appear at different levels of abstraction, flower being a superordinate category of which rose is one class. Because ‘higher’ systems of meanings of this kind tend to be learnt consciously, these systems can be applied consciously and deliberately to everyday life. In this way, the higher systems of meanings of educational knowledge filter downwards and reshape the child’s everyday experience (Vygotsky 1986 [1934], pp. 171-173).

The importance of systematic formal learning in educational disciplines is emphasised by Vygotsky (1986 [1935], pp. 177-179). In contrast to training based on ‘habit formation’ in order to build skills such as typing, systematic instruction in the formal, cultural disciplines of educational knowledge plays a role in the formation of the higher functions, characterised by ‘awareness, abstraction and control’. For example, with reference to the genesis of the higher function of attention, Vygotsky (1981c, p. 238) writes:

The transition from passive attention to active attention is decisive in marking the change from natural to cultural processes.

Evoking both Séguin and Montessori, Vygotsky continues by proposing that the critical microgenetic step underlying this transition is the child actively making a choice between ‘competing’ representations. This same microgenetic step is called ‘polarisation of the attention’ by Montessori (1965b [1916/1918], p. 60), a step she describes in the following way:

The child … begins to fix his attention. He makes his first comparison, his first selection, in which he exercises his judgement. Therefore he exercises his intelligence (Montessori 1964 [1909/1912], p. 338).

Thus, manipulating concrete objects on the basis of a system of contrasting meanings represents for Montessori, as it did for Séguin (1971 [1866], p. 95), the first step in a passage to abstraction in which the manipulation of objects precedes the ‘intellectualisation’ of the ‘ideas of an abstract order’ they represent, foreshadowing the spiral ontogenetic trajectories from natural to higher functions proposed by Vygotsky. The prototypes for the Montessori microgenetic sequences are those designed by Séguin for developmentally-impaired children. In the next section some illustrative examples drawn from Séguin’s methods will be used to explore the

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26 The middle-class child in Painter’s study (1999) learnt some everyday concepts in shallow taxonomies. This type of learning, Painter argues, prepares the child for later success at school.
foundations of the Montessori conception of learning as a passage from concrete experience to abstract concepts.

4.4.4 Learning as a spiral trajectory from concrete to abstract

The spiral in its material form embodies the potential to lift energy to higher levels in fluid media such as water and air, a potential that Vygotsky’s proposals suggest applies to human consciousness as well. This use of the spiral metaphor by Vygotsky is pre-dated by Séguin’s use of the same metaphor in the following compelling distillation of his socially-oriented pedagogy for developmentally impaired children:

Sensation perceived like a notion, notion fecundated to an idea realized in life itself, such is the unbroken spiral of our teaching, and through teaching, of our action on idiocy. From collecting the sparse powers of muscles and nerves disconnected by the absence of will, to the gathering of the faculties in the act of thinking, our progress has been a constant ascension on the steps leading from isolation to sociability (Séguin 1971 [1866], p. 209).

In the tradition of Condillac, Séguin’s pedagogy trained the senses of developmentally-impaired children, using comparison to systemise, and thus generalise, sensory perception. Séguin (1971 [1866], p. 199) describes the senses as the ‘passages’, or media, through which perceptions reach the mind. Not only can the senses be improved through training, they can also be augmented artificially by ‘spectacles, telescopes, microscopes, algebra, compasses, electrometers’. In this way Séguin draws attention to ways human perception can be mediated through both physical and semiotic means. While spectacles, telescopes and microscopes extend the capacity of the visual sense beyond the limits of impairment or the immediate visual field, algebra, compasses and electrometers are instruments which mediate and extend perception using the culture’s semiotic systems: systems of mathematics, of navigation and of measurement. ‘In this manner’, writes Séguin (1971 [1866], p. 199), ‘all the senses natural and artificial, physical or moral, are doors to the various passages leading into the focus of impressions wherefrom radiates all expression’. He continues:

Thus, education connects a small body with all bodies, a small intellect with the general laws of the universe, through specific instruments of perception.
The impressions made by the concrete objects reveal which of ‘our many sensations’ are ‘deemed worthy of reflection and registration’ (Séguin 1971 [1866], p. 133). In other words, the objects single out sensations which are meaningful and generalisable within the child’s social and cultural setting, both everyday and educational. In what Séguin (1971 [1866], p. 96) describes as ‘the double process of teaching’, each sensory impression is matched, and unified, with an expression form, for example, movement, music, drawing, and ultimately, language. Activity with Séguin’s concrete objects, therefore, incorporates both the convergence of action and speech in Vygotsky’s explanation of ontogenesis, as well as the double-sided unity which constructs meaning in the Saussurian sign.

Expressed in Vygotskian terms, Séguin’s microgenetic sequences lead children through a series of critical steps, from concrete to abstract, each step achieved through the use of an external mediational means. These sequences reflect the series of transitions which mark the ontogenetic developmental spiral from natural to higher mental functions. A sequence of this kind is the one designed by Séguin (1971 [1866], p. 160) to lead children from ‘passive vision’ to ‘active vision’, and on to writing and reading.

The first microgenetic step in the sequence is the fixing of visual attention, for which Séguin (1971 [1866], p. 163) devised forms of mediation equivalent to the teacher moving the child’s limbs as a first step towards independent control of movement. These included a theatrical light show in which silhouettes, fire-works and kaleidoscopes were projected in a dark room. The next step is via visual ‘matrices of comparison’, forms of mediation which train children’s visual attention to distinguish generalisable ‘properties of bodies’ such as colour, shape, size and distance (Séguin 1971 [1866], p. 165). These forms of mediation are used first to distinguish difference, or contrast, and later to recognise similarity, or analogy. To distinguish plane shapes, for example, the children are given ‘knowledge of a few typical forms’, in this case, the names of idealised geometric shapes represented in concrete form as wooden insets which fit exactly into matching frames, objects based on Itard’s design and still used in Montessori classrooms, as seen in Illustration 4.1.

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27 Vygotsky (1986 [1934], p. 163) cites Claparède’s research that ‘proved by very interesting experiments that awareness of difference precedes awareness of likeness’.
Once learnt, the geometric shapes become ‘matrices of comparison’ through which visual attention in the wider environment is mediated, and consciously controlled. Similarly, attention to relations of size and distance is mediated, and consciously controlled, through instruments and systems of measurement.28

When Séguin (1971 [1866], p. 177) links the microgenetic steps described in the previous paragraph to the children later learning to read, he foreshadows Saussure’s account of meaning based on relational valuer:

... we take advantage here of differences, there of analogies, in form as well as in sound, to enforce the meaning of each by its correlative: in this respect our training is, not so much one of memory, as one of comparison ... it is the hand, creating its own reading matter.

Comparison continues to underwrite the method when the child reaches the stage of learning to write and read. For Séguin (1971 [1866], p. 181), the teaching of reading is ‘a study of contrast and analogy’ between shapes, sounds and ‘configurations’. Reading proper ‘begins by words, each word having a shape ... and a meaning; ... to write and to read implies the understanding of that meaning.’ Building on Itard’s technique, Séguin teaches writing and reading by comparing both the shape and meaning of words. While the comparison of each word’s shape is ‘presented according to their difference or analogy of form’, the comparison of each word’s meaning is achieved through a comparison of grammatical variation.

28 The first system of measurement offered to children, even in America, by Séguin (1971 [1866], p. 167; emphasis added) was ‘the French Mètre, whose divisions into tenths are more sensible than those of the yard’.
Analogous to the way knowledge of geometrical shapes mediates attention to the generalisable *shapes* of the objects used by the child, grammatical categories become ‘the matrix of comparison’ for attending to the generalisable *meanings* of the words used by the child. Séguin’s grammar-based reading lessons (1971 [1866], p. 185ff) progress from names (nouns) and qualities (adjectives) to actions (verbs) and relations (prepositions). In activities, which echo the child’s sensory experience of contrast when using the concrete objects, the meanings of the words in each category are acted out by the children ‘to render the exercise lively and active without confusion’.

In summary, Séguin represents entry-level meaning systems of the culture in concrete, or ‘sensible’, form, as a mediational threshold through which the meaning systems of educational knowledge become accessible. Each system of meaning is repeatedly represented in a series of increasingly abstract forms of mediation designed to guide the child along a spiral trajectory towards conscious mastery of the system. It is this characteristic of Séguin’s method which Montessori appropriated and elaborated. Describing the Montessori objects as representations of sign systems, forms of mediation, located on a trajectory from concrete to abstract will be a feature of the analysis of their use in Chapters 6 and 7.

Séguin’s ‘unbroken spiral’ of teaching evolved into Montessori’s microgenetic instructional sequences, or *passages to abstraction*. That these sequences can be understood in terms of semiotic mediation, even though they were designed before Vygotsky coined this term, is a central thesis of the present study.

In what could be described as a theoretical reformulation of the methods of Séguin and Montessori, Vygotsky uses the principle of semiotic mediation to explain how a child’s consciousness is lifted in a spiral trajectory of critical steps beyond involuntary, natural adaptation tied to the immediate time and place to consciously-controlled intellectualised functioning relevant to the child’s culture. Each critical step, or developmental transition, in the spiral trajectory is ‘linked with the introduction of a new form of mediation ... or to a more advanced version of an existing form of mediation’ (Wertsch 1985a, p. 22). These ontogenetic processes, generated by the dynamic fusion of speech, action and thought, are generalised by Lee (1985, p. 79) in terms of ascending levels of abstraction:
When speech and thought begin to interweave in action, a dialectic is set up in which the reversible nature of signs allows the child to ‘bootstrap’ himself up through the various levels of abstraction present in the language.

The reversibility of signs refers to their capacity to be directed both outwards towards others as a means of interaction and inwards towards the self as a means of extending the consciousness beyond the temporal and spatial limits of the present. When turned inward, Lee (1985, pp. 79-80) continues, signs become the ‘silent means in goal-directed activity’. Because signs are ‘structured along principles of reversibility and generalization’, they later become the ‘causes of the child’s behaviour’, involving a ‘reversal of cause and effect’. The reversibility of signs, thus represents a convergence, in Vygotsky’s semiotically-oriented model, of Montessori’s notions of *final causes* and *passages to abstraction*.

In terms of the Vygotskian framework, the Montessori objects are external mediational means which, literally, put within children’s grasp knowledge over which they will later have internalised, voluntary control. Manipulation of the objects mediates the knowledge both sensorially and semiotically because it is represented in both an external, action-oriented sensory form and in a linguistic form. The linguistic form is like a gateway, with Janus-like potential both to be part of external social interaction and to be directed inward. When the locus of control of the activity shifts from the concrete and sensory via the social to the mind, the knowledge is internalised, the point at which, as Montessori teachers say, the child ‘lets the material go’. 29

The first sets of concrete objects offered to the child by Montessori educators systematise and generalise, in concrete form, everyday knowledge about sensory properties such as colour and texture. Children manipulate the objects during matching and ordering activities, experiencing empirically and linguistically both the properties of the objects, and the meaning relations into which the properties enter. For example, properties might realise small systems of meaning such as *red-blue-yellow* or *rough-smooth* and meaning relations such as *darker than-lighter than*, *rougther than-smoother than* and *the same as*. Although oriented to everyday

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29 Montessori (1965b [1916/1918], p. 64) emphasises that ‘[i]t is essential that the child’s attention should not be directed to the objects when the delicate phenomenon of abstraction begins … this may dissipate the attention, render the exercises mechanical, and cause the child to pass by his psychological moment of ascent without perceiving it and seizing it’.
concepts, the objects have a generalising function, and can for this reason be thought of as entry-level symbol systems of the culture, or proto-scientific concepts. Following experience with concrete objects in which the properties of everyday concepts are materialised and systematised, children are presented with concrete objects materialising systems of meaning that encode educational knowledge, including systems of geometric shapes and animal classification systems. As children gain control of the systems of meanings represented by the concrete objects, in other words, as the meanings are internalised, the concrete objects are gradually abandoned.

In summary, interaction with the Montessori objects guides children’s perception so they attend to reality in ways which match the structures of the meaning systems encoded by the objects. Attention to the wider environment mediated through these generalised meaning systems singles out culturally-relevant properties so they stand out against the otherwise undifferentiated sensory background. In this way, the child is able to identify, for example, dark blue objects in contrast to light blue ones, triangular shapes in contrast to square ones or fish in contrast to amphibians. Importantly, the materialised meaning systems are always used in tandem with a related means of expression, typically language but also movement, visual arts or music, that is, meaning-making resources shared by others in the child’s culture and social group.

When Montessori offered Séguin’s objects to normal children, she observed that they responded to the sensory problems built into the materials with playful interest from the age of about three. This interest suggests, within a Vygotskian framework, that using concrete representations of educational knowledge in activities involving systematic comparison and choice brings this type of knowledge within the zone of proximal development of very young children, just as happened for developmentally-impaired children. Moreover, because the design of the objects includes inbuilt guidance and ‘control of error’, children developing normally are able, and actually prefer, to solve the sensory problems independently. In the next section, I will argue that the developmental force of the Montessori objects, and their potential for independent use, is further enhanced because the meanings encoded by the objects are represented in multiple forms.
4.4.5 Representation enriched by redundancy

This section explores a key component, in the tradition of Séguin, of Montessori pedagogy, the enrichment of microgenetic sequences, or *passages to abstraction*, through the use of multiple, or redundant, representations. This technique recalls the multiple representations of geometric shapes Itard made for Victor, beginning with three-dimensional forms, then progressing via two-dimensional forms to outlines. Similarly, Séguin’s ‘unbroken spirals’ of teaching can be viewed as a microgenetic sequence of different modes, or different ways of representing a concept, beginning with the most concrete mode of representation and progressing to increasingly abstract modes of representation. This same idea reappears in the suggestions Vygotsky (1978 [1935], p. 86) offers teachers when working in the zone of proximal development, that is, showing children ‘various ways of dealing with [a] problem’ and using ‘different modes of demonstration’. This section will explore the developmental potential of this technique.

In a microgenetic sequence, following Séguin, the ‘impression’ made by a concrete representation is always matched to an ‘expression’. An expression form combined redundantly with concrete representation achieves the function of indication. This function originates in the pointing gesture and is realised in language as labelling and naming. Indication, following Vygotsky, is the primary function of speech.

Vygotsky placed the function of indication at the beginning of the genetic trajectory of *generalisation*. Indication foreshadows ‘early levels of generalization and … social interaction’ while ‘more advanced levels’ are made possible by ‘the symbolic function of speech’ (Wertsch 1985a p. 96). Generalisation is a term Vygotsky (1986 [1934], pp. 8-9) uses interchangeably with ‘generalised concept’ and ‘word meaning’. Thus, in his framework, the genesis of generalisation from primary to higher forms conflates with the genesis of language use and concepts. This genesis can also be described in terms of a transition from ‘signals’ to true signs, or ‘symbols’. When a word is used as a ‘signal’, its use is ‘concrete’ and ‘context-bound’, referring to ‘something that is physically present to the senses’ (Hasan 2005 [1992], p. 81). When a word is used as a symbol, it signifies an internalised meaning, with the potential to refer to phenomena beyond the immediate sensory field.
From a Vygotskian perspective, therefore, redundant concrete representations of educational knowledge, such as the Montessori objects, are forms of mediation which shift children from the indicative, or signalling, function of language to the symbolic function of language. Language used as a redundant expression of what is also represented in concrete form is indicative, directing the child’s attention to salient elements of the concrete representation. Increasingly abstract modes of representation lead the child to the point where representation and expression are unified in language, giving it a symbolic, signifying function (Minick 2005 [1987], pp. 46-47; Wertsch 1985a, p. 89). This dynamic progression accords with what Wertsch (1985a, p. 33; emphasis in original) describes as Vygotsky’s ‘overarching principle of development ... the principle of decontextualisation of mediational means’, a principle defined in the following way:

The decontextualisation of mediational means is the process whereby the meaning of signs becomes less and less dependent on the unique spatiotemporal context in which they are used.

In other words, decontextualisation is understood in multimodal microgenetic terms as the increasing transportability of educational knowledge, from signalling, anchored in a specific context, to symbolic representation which is freely recontextualisable. Each new mode of representing a concept in a microgenetic sequence, in the tradition of Séguin, is redundant in both its relation to previous and subsequent modes and in relation to its expression in language. Each new representation of the meaning can also be considered as a new, and more decontextualised, that is, recontextualisable, form of mediation, a potential microgenetic turning point or critical step in the child’s progress towards symbolic control of the concept. Decontextualisation, in this sense, does not suggest that children are learning to control meanings that have no context, a misleading interpretation which, as Schleppegrell (2004) argues, can be drawn from some late twentieth-century uses of the term in the context of school education. Instead, it refers to the introduction, into an immediate familiar social context, of meanings, in multimodal form, which later children will be able to control, independently of the mediational means, and to transfer, in symbolic form, to the specialised, more generalised, social contexts construed by educational knowledge.

Thus, the sequential presentation of multiple, or redundant, representations of educational meanings has the potential to lead children from the control of a
materialised concept, through indication, to abstract symbolic control of the concept. These multiple representations of meaning can also be presented simultaneously, providing a further means of regulating a child’s early steps in meaning-making, as exemplified by Séguin when teaching developmentally-impaired children to understand spoken language. When teaching children to comprehend speech, Séguin (1971 [1866], p. 154) used both the voice and a musical instrument, a ‘tympanum’, to accent significant words. This was done ‘to teach the meaning of words as representatives of entities, properties, actions or commands’ because ‘the accents or emphasis will better mark their intellectual value than all possible commentaries’. In other words, the signalling of relevance and significance is represented first, in the grammar and intonation patterns of the language, and, second, by the musical instrument. The second representation mediates the first, regulating and enhancing comprehension. The signalling is exaggerated at first but follows a ‘slow decreasing progression’, in other words, it is gradually diminished, until a command is given ‘for which the child must make a choice of his own judgement’. At this point the delivery must not ‘influence him to follow our own idea instead of his free will’.

In an echo of Séguin’s technique, Wertsch (1985a, p. 78) gives an account of Vygotsky requesting a patient with Parkinson’s disease to walk. The patient was unable to comply until ‘pieces of white paper were ... arranged on the floor to indicate the locations of a sequence of steps ... [the patient] was able to walk by treading sequentially on the pieces of paper’. Vygotsky’s explanation for this effect was that two sets of stimuli were given. The second set, the pieces of paper, mediated the patient’s response to the first set, the verbal commands, and in this way helped the patient to control his behaviour.

In summary, in Séguin’s method, and its elaboration in Montessori pedagogy, redundant multiple representations of mediational means focus, direct and strengthen microgenetic sequences in two ways. First, a microgenetic pathway is carved out by an instructional sequence, which begins with a concrete representation of a concept, or meaning, indicated redundantly by its expression in language, and culminates in independent symbolic control of the concept. The artificially carved-out microgenetic pathway can be conceived of as a reinforcing strand of a more general ontogenetic pathway. Second, the developmental pathway is further deepened and strengthened
when the sequence begins with simultaneous multiple representations of the same meaning, including at least one external concrete representation to mediate, and thus regulate, meaning-making. This progression again culminates in the child’s internalisation and symbolic control of the concept.

4.5 Conclusion

In this chapter I have argued that the pedagogy inherited by Montessori from Séguin is most effectively theorised through Vygotsky’s model of development. Vygotsky models human development as a process of adaptation, which can be studied from the perspective of different timeframes, including the timeframe of human history or evolutionary time (phylogensis) and the timeframe of childhood (ontogenesis). Viewed from the perspective of ontogenesis, human consciousness develops through activity in which the child interacts with people and objects in the environment. The cultural products of human history become the means of the child’s adaptation. The means of adaptation are tools, for interacting with and mastering the natural environment through practical action, and signs, for interacting with others in the social environment and for mastering oneself through meaning.

In early infancy, practical action (tool use) and speech (sign use, or meaning-making) merge in the child’s activity. With this convergence the child takes the first developmental step towards the freedom which characterises human consciousness. Once action (tool use) and speech (meaning-making) have merged into a single unit of activity, the temporal relation between them shifts until action is guided by meaning. In this way the child’s consciousness is freed from the spatial and temporal limits of the immediate environment. At the same time the natural, involuntary functions of perception, movement, attention, volition and memory are socially mediated through meaning and are reorganised into a higher system of verbalised, analytical and logical functions under voluntary control. The structure of this higher system of consciousness is a reflection of its origin in social interaction, and more generally, in semiotic mediation. The ontogenetic pathway from natural to higher functions is a spiral of turning points, each one activated by a new form of mediation lifting the child’s development to the next level.
In this study, the development of human consciousness, as it relates to Montessori pedagogy, is viewed from the perspective of microgenesis, the child’s micro-interactions with people and objects. The Montessori objects are forms of designed mediation representing educational knowledge in concrete form. The objects are deliberately and systematically introduced into a child’s activity to lead development. The objects are introduced when the child displays an interest or desire to work with them, in other words, when the child manifests a sensitive period, an indicator of a zone of proximal development in which collaborative, interactive activity with the materials will be the most developmentally fruitful. The objects are introduced, and abandoned, according to their location in a sequence of increasingly decontextualised mediational means. The sequence carves out a developmental pathway from concrete representation to abstract expression, from redundant, regulating, external representation to internal symbolic control. The microgenetic pathway tracks and reinforces the development of the meaning of words, from their primary indicative function to their higher symbolic, signifying function.

The Montessori objects and their use in pedagogy, following Séguin (1971 [1866], p. 291), can be thought of as an ensemble of redundant resources composed of movement, language and objects. It is within the contour of this ensemble that material processes (environment, practical action and social interaction) are unified with non-material (affective and intellectual) processes. While the Vygotskian framework is a means for describing and explaining these processes, it does not completely resolve the question of analysis. In order to analyse the instructional ensemble represented by the Montessori objects and their use, it is necessary to define what is being analysed and to select an appropriate unit of analysis. The question of analysis has its origin in Vygotsky’s theory, but it is resolved in this study by drawing on social semiotics.

Significantly, Vygotsky’s theory, as argued by both Wertsch (1985a, 1990) and Hasan (2005 [1992], 1996a), does not provide an appropriate unit of analysis for modelling semiotic mediation. This issue will be addressed in Chapter 5, which proposes the complementary, socially-oriented analytic approaches of Halliday and Bernstein as the means for analysing the pedagogic ‘force’ of the educational meanings encoded in
the Montessori objects. Thus, Chapter 5 represents the second step in the development of a meta-analytical framework to apply to the Montessori objects and their use.