Locating learning of toddlers in the individual/society and mind/body divides

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In this paper, theories about learning are discussed in relationship to toddlers locating themselves in space. This is important given the current debate about the mathematics that very young children can or should learn. Regardless of whether learning is seen as an individual or a social activity, learning theories of Piaget and Vygotsky emphasise the cognitive nature of learning and the need for linguistic reflection on that learning. In order not to situate toddlers as deficient or irrational because they do not express their reflections linguistically, I suggest that learning should be considered as problem solving that occurs both with the mind and the body. Using examples of toddlers engaging in spatial explorations, I illustrate how learning mathematics can be reconceptualised in this way.

Toddlers are a special-age group. They have learnt to walk, although as their name implies not always confidently, and have begun to use words to convey meaning to others. These actions are often highlighted by adults as important developmental characteristics as by engaging in them, toddlers appear more adult-like. However, by focusing on the similarities with adults, young children's development can come to be valued only in this regard (James & Prout, 2001). In problematising this valuing of adult-like qualities of toddlers, I critique theories which emphasise the importance of verbal language in learning, including the learning of mathematical ideas around locating.

Rather than just criticising mind/body and individual/social divides that are highlighted in much of the discussions about how young children learn, I argue that there is a need to focus more on what young children can do and how this might provide different insights into the learning processes. I draw on two examples of toddlers' learning to orientate themselves in space with the help of adults and playground equipment to suggest that mathematics for young children would be better considered a set of dynamic, fluctuating activities which children learn through problem solving.

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Meaney, T. (2016). Locating learning of toddlers in the individual/society and mind/body divides. *Nordic Studies in Mathematics Education*, 21 (4), 5–28.

Mind/body and individual/social divides

This section begins with a discussion of the mind/body and individual/social divides which often in discussions of learning are situated as irreconcilable. For example, more than twenty years ago, Cobb (1994) wrote "constructivist and sociocultural perspectives at times appear to be in direct conflict, with adherents to each claiming hegemony for their view of what it means to know and learn mathematics" (p. 13). Through discussing learning as occurring in the mind or the body and as occurring either within individuals or within social interactions, I identify how toddlers' learning is not understood in its own terms but only from the perspective of adults.

The mind and body divide

For several centuries, discussions of thinking and learning have drawn inspiration from the philosopher Kant (Hanna, 2011; Otte, 1998; Radford, 2003; Sinha & de Lopez, 2000), who considered learning to be when sensual perceptions become thoughts and thinking being a process involving abstract ideas that occurs in the mind. For example, at the beginning of their book on *The child's conception of space*, Piaget and Inhelder (1956, p. 3) identify the influence of Kant:

> Kant considered space an a priori structure of "sensibility", the function of thought being merely to submit the data of space perception to a process of logical deduction capable of analysing them indefinitely without ever exhausting their content.

Although acknowledging the importance of perceptions obtained through activity, Piaget and Inhelder (1956) upheld that children's development comes from the building of the mental concepts valued by Kant. Consequently, what is valued as learning is a "privileging internal processes (the slow, sequential attainment of "cognitive concepts") over learning and experience" (Blaut, 1997, p. 153).

For Kant, schemata developed from perceptions of objects to form concepts of those objects (Roth & Lawless, 2002). The mind is necessary for distinguishing between perceptions so that schemata are allocated to appropriate concepts. Nevertheless, because schemata are composed of perceptions, they must also be considered sensual (Radford, 2005a). Schemata act as a bridge between perceptions and concepts, but remain dependent upon culture, including its associated language, because culture indicates what aspects of a situation should be highlighted (Roberts, 1998).

The valuing of mental activity in the learning process contributes to language, as a way of describing abstract concepts, also being valued

more highly than the original actions or the gestures which mediate the interpretation of those actions – "gestures help to link human activity involving objects in the world and language that describes these objects and activities" (Roth & Lawless, 2002, p. 334). Bodily sensations are relegated to simply being pathways to their formation.

Since the mid-twentieth century, Piaget's and Vygotsky's theories have dominated discussions of children's learning. Kant's distinction between the body and the mind appears in the theories of Piaget, explicitly, and Vygotsky, more implicitly. In contrast to Piaget's view that the developmental process enables learning to occur, Vygotsky (1978) considered that it was learning which contributed to intellectual development – "although children's use of tools during their pre-verbal period is comparable to apes, as soon as speech and the use of signs are incorporated into any action, the action becomes transformed and organized along entirely new lines" (p. 24). For Vygotsky, speech allows for abstract reflection which contributes to children solving complex problems. Through reflection, children can include possibilities outside their immediate perceptual environment in their solution plans. Speech is separated from physical actions because it provides a pathway to abstract thinking. Vygotsky reported that when solving a problem some children deprived of the possibility to talk to someone were not able to produce an appropriate solution.

The importance of language for learning appears even when what is under discussion is how the human body interacts with the world, such as locating in space. This can be seen in the following description of spatial learning:

> The representational system afforded by spatial language may provide an accessible introduction to spatial concepts, such as the relationship between objects, as illustrated by words like *under* and *next* to. By directing children's attention to spatially relevant aspects of their environment, language highlights patterns that might otherwise go unnoticed, for example, how one block is situated *under* another is a tower. This spatial language offers a categorical label that emphasizes qualitative divisions in what is otherwise continuous space. As such, spatial language might support spatial reasoning ability. (Ferrara et al., 2011, p. 143)

There are similarities in Piaget's and Vygotsky's theories in regard to the valuing of abstract thinking over bodily actions (Franzén, 2015). In both theories, children's learning and development are connected to thinking which occurs in the mind and which is ascertained but also constructed through the vehicle of language. Piaget noted that children's learning was very different to adults, but saw the stages as developing towards those of

adults. Vygotsky (1978) also distinguished between elementary processes which were biologically inbuilt and higher-order psychological functions – "the history of the development of the higher psychological functions is impossible without a study of their pre-history, their biological roots, and their organic disposition" (p. 46). Although the body can contribute to the mediation of tools, it is through the body, rather than with it, that higher psychological functions are achieved.

The higher valuing of the mind over the body has produced empirical research focusing on how young children use the abstract concepts, generally through examination of their language and other forms of representations (Radford, 2005b). For example, in studies of young children's understanding of space, much attention has been paid to their ability to produce and interpret maps (see for example Marzolf & DeLoache, 1994; Blaut, 1997; Clements, 1998; Uttal, 2000; Huttenlocher, Newcombe & Vasilyeva, 1999). Representing spatial relations, rather than experiencing them with their bodies, is highlighted as leading to mathematizing which is the ultimate goal for learning (Cross, Woods & Schweingruber, 2009).

In contrast to the theoretical and empirical preoccupation with what occurs in the mind, many preschool teachers consider meaningful learning as involving children's bodies. For example, Franzén (2015) found that Swedish preschool teachers emphasised the children's use of their bodies in absorbing mathematical experiences – "when children try to understand the concept of location, they often want to feel altitude. They like to climb up and jump down, to know how high they dare to climb and can jump" (p. 249). The body is not the mere doer of actions, which can later be mathematized, but actually the producer of understandings about location.

The valuing of the mind over the body is part of the Kantian view that rational autonomy was what constituted the essence of being human. From this perspective, young children can be considered as not human – "with Kant 'rational autonomy' became the marker of humanity, which left those who were considered to be not or not-yet rational – including children – in a difficult position" (Biesta, 2007, p. 28). An example of this non-humanising of young children can be seen when Hermer and Spelke (1996) compared young children's spatial re-orientation in a new environment with that of rats. They also labelled children's inability to respond to tasks in the way that adults did as "failure" and concluded that the ability to re-orientate in a new environment was a uniquely human quality, although one which young children did not have. The implication, like Vygotsky's comparison between young children and apes, in the earlier quote, is that young children are not yet human.

Individual and social

The differences between Piaget and Vygotsky's views are often connected to the roles of the individual and the society in learning (Sfard, 1998). Piaget was mostly interested in the outcome of an individual's learning and its connection to children's developmental stage, whereas Vygotsky was more interested in how learning occurred through social interaction.

Piaget and Inhelder (1956) described children's learning as occurring through the assimilation or accommodation of schemata and thus related to the individual, independent of the environment in which they grew up (Sinha & de López, 2000). By handling an object, a child becomes familiar with its features, albeit from the outside, which Piaget and Inhelder (1956) labelled a negative impression. In watching and feeling how the object's attributes – weight, width, colour, texture – change while handling it, a child's schema about these attributes can be elaborated through the process of assimilation, or newly constructed, or reconstructed, through the process of accommodation (Piaget, 1955). Which process operates will depend upon how challenged the original schemata are by the schemata formed from the new experiences (Cobb, 1994). The assimilated or adapted schemata are connected to the child's expanding concept of the object and the meaning that is attached to handling it. From this perspective, children's learning is individual and occurs through biologically-ingrained conditioning – "although social and other reinforcements may influence children's curiosity and cognitive explorations to some degree, basically children think and learn because they are built that way" (Flavel, 1996, p. 200).

In contrast, Vygotsky (1978) considered that learning occurred in social environments, with cultural artefacts providing the possibilities for thinking: "*human learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them*" (p. 88, italics in the original). For him, social interaction through language precedes a child's possibilities for using internal language to reorganize their thinking. For example, he discussed how young children asked to describe someone standing up when they were actually sitting down, usually changed the sentence to be about what they actually saw.

> This tie between perception and meaning can be seen in the process of children's speech development. You say to the child "clock" and he starts looking for the clock. The word originally signifies a particular spatial location. (Vygotsky, 1978, p. 97)

For Vygotsky (1978), children's involvement in imaginative play indicated the reaching of a developmental stage in which they could use objects in different ways to how they were initially perceived. Before this, "the

child is constrained by the situation in which she finds herself" (p. 96). However, there has been little specific research on how the environment affects the learning of very young children (see for example Gramann, 2013). Although ways of discussing spatial orientation are known to be culturally determined (Wassmann & Dasen, 1998; Levison, 1996), generally differences are discussed in regard to the possibilities provided by a specific language (Tversky, 2005).

Although the individual/social aspects of Piaget's and Vygotsky are generally contrasted (Sinha & de López, 2000), they have also been combined (Cobb, 1994; Salomon & Perkins, 1998). For example, in discussing Vygotsky's influence on socio-cultural theory and Piaget's influence on constructivism, Cobb (1994) described their differences as whether what is foregrounded is the "active individual construction" or the "guided participation in cultural practices" (p. 17). For Cobb, "each of the two perspectives, the sociocultural and the constructivist, tells half of a good story, and each can be used to complement the other" (p. 17).

Regardless of whether individual and social perspectives of learning are considered as completely different or two sides of the same coin, these common ways of talking about children's learning have consequences. In particular, they contribute to the view that children can and should be constantly judged to ensure that they are learning appropriately for a developmental time-frame and are provided with challenges so that their progress continues to move towards an adult-like state. In alignment with this, research on young children's learning of spatial orientation has tended to focus on individual children, even if results are combined to present a picture of what all children should or could do (see for example Herman, Shiraki & Miller, 1985; Bartsch & Wellman, 1988; Gelman & Wellman, 1991; Stockman & Vaughn-Cooke, 1992).

Viewing learning as individual and/or social can limit adults' possibilities for understanding what young children are capable of and interested in doing. The differences, rather than deficits, that both Piaget and Vygotsky noted between young children's and adults' knowing and learning can provide possibilities for seeing young children as capable in their own environments and also capable of creating rather than just reproducing cultural knowledge (Lembrér, 2015). Valuing the body in the learning and using of locating skills and knowledge provides possibilities for re-conceptualising what young children can do.

Locating

Locating which also is termed spatial thinking or visuospatial reasoning has long been regarded as a necessary set of skills for adults (Tversky, 2005)

and thus valuable for children to learn at school (Clements, 1998). Bishop (1988) identified locating as one of six universal mathematical activities present in all cultures around the world. Locating is about the relationship between the spatial placement of things and people and the pathways between them.

> During spatial orienting humans use a multitude of information from several senses including but not limited to vision, audition, the vestibular system, and kinesthesis. All these different sources inform human navigators about their movement in the outside world as well as changes in position and orientation with respect to aspects of the environment. This information is further integrated and coordinated with action plans and the behavior of other social agents. (Gramann, 2013, p. 2)

Piaget and Inhelder (1956) identified three stages that children went through from birth to when they began to produce representations of space. The third of these stages begins at the end of the first year of life and thus corresponds to that period when children are labelled toddlers. The main feature of this stage is children's exploration of "the relationships of objects to each other" (p. 12). However, recent research suggests that developing the concepts about locating are more complex that Piaget had originally thought. For example, studies of neural structures indicate that crawling might promote the necessary changes in the hippocampus, necessary for being able to develop mental maps of larger areas (Gramann, 2013).

Research studies on toddlers' locating skills and knowledge usually focus on small numbers of participants. Yet it seems from these studies that toddlers may have already gained a range of skills and understandings about locating themselves and objects in space. Rider and Reisor's (1988) research showed that 12 month old children could use their body, such as "movement of joints, muscles, and vestibular organs" (p. 481) to point to an object that was in another room when their vision was impeded. Yet if they could see the room clearly, they tended to point in the direction of the door through which they had come and from where they had seen the object. By the age of four, children were able to make use of visual cues to help orientate themselves in the same way that adults did. Hermer and Spelke's (1996) research in which children from 18 to 24 months were disorientated showed that children used the layout of the room to reorientate themselves, whereas adults combined their knowledge of the layout of the room with non-geometric information, such as patterning on specific walls. This suggests that rather than using a different set of developmental understandings, adults built of the skills and knowledge that they had already.

In studies about estimating the location of an object, Huttenlocher, Newcombe and Sandberg (1994) found that children before the age of two years could use both "distance information to code particular locations" (p. 116) and "larger segments of space to code locations within a region" (p. 116). As children got older, they became increasingly more able to partition regions into smaller areas, which improved the accuracy of their estimations. In a study of children three and a half to five years old, Bartsch and Wellman (1988) found that even some of the youngest children could reason about differences in the length of two paths by conceiving – "of an encompassing spatial array; one basic feature of which is intervals of firm, inflexible extent" (p. 540).

Other studies investigated young children's comprehension of spatial terms by having them move items or themselves. In an early study, six participating children, who were aged up to three and a half years old, used a teddy bear to act out part of a story, which required an understanding of "over" (Holmes, 1932). 83 percent could correctly show the teddy bear "under" something. Half the children knew the term "on top" and a third knew the terms "behind", "forwards" and "backwards". None of the children could use the teddy bears to indicate "far" and "near". In a more recent study of one child's learning of mathematical terms from the age of two years 5 months to two years 10 months (Hore & Meaney, 2008), the child was able to move himself to show he understood the meaning of "in", "out", "up", "down", "under", "on top of", "behind", and "beside" at the beginning of the study. During the study, the child seemed to gain the meaning of "in front" but did not learn the term "between". Pulverman et al., (2013) suggested that children as young as 10 months but definitely by 14 months have learnt relational terms. Their research showed that the concepts to do with motion and position are in place early, although not in their complete complexity before children begin learning the words. For Pulverman et al. (2013), young children's visual processing of their actions on objects formed these concepts. Ferrara et al.'s (2011) study of three to five year olds interacting with their parents during block play found that spatial language appeared more often when instructions on how to build something were provided. Although these children would no longer be considered toddlers, the role of adults in the interactions is likely to also be important for younger children.

Spatial terms did not appear as first related to the child's own body and then used with independent objects as suggested by Piaget and Inhelder (Gramann, 2013). Rather both kinds of references appeared simultaneously (Sinha & de López, 2000). From these studies, it can be said that toddlers have knowledge and skills about locating which was then refined as they became older. This suggests that children

do not develop location skills and knowledge through a system of simple to more complex concepts as suggested by Piaget and Inhelder (1956). Nevertheless, the focus of this research remained on what was happening in children's minds.

In one of the few studies about how young children develop locating knowledge and skills within social environments, Choi and Bowerman (1991) indicated that the development of 14–16 month old children's spatial language in Korean and in English is related to the activities in which they engage:

> They commented on their own changes of posture or location, such as sitting down, standing up, or climbing up onto chairs or laps; they appealed to adults for help in changing location or to go outside; they asked to be picked up or carried; and they referred to donning and doffing clothing and to object manipulations of many kinds, for example, putting things into a bag and taking them out and putting Lego pieces or Popbeads together and taking them apart. (p. 95)

Choi and Bowerman (1991) suggested that toddlers initially used prepositions as verbs, which indicated actions or motions that the toddlers were performing themselves or that they wished others to do. This suggests that rather than static visual meanings being connected to these terms, toddlers attached meaningful bodily movements. Static conceptions of prepositions seemed to appear towards the end of the second year. They also found that "in" initially also had the meaning of "between", indicating that the term rather than the concept was difficult for young children to grasp, as had been suggested in Hore and Meaney's (2008) study. This study, like many of the others about locating, had a very small sample size with only two English learners and four Korean learners.

Although bodily perceptions contribute to mental strategies for locating, such as determining the longest paths or the learning of spatial terms, the role of the body in the learning continues to be under-recognised. For example, in order to acknowledge the power that the gesture gave to an explanation, Roth (2010) described the unconscious gestures, those unavailable for reflection, of a school child, Chris, as "immanent". Alternatively, Radford (2005a) used the term "embodied" and raised the issue of needing to "disembody" the meaning within a gesture if it is to "endow the scientific conceptual object with its cultural, interpersonal value" (p. 116). For Roth repetitions of the gesture support a change from pre-intentional to intentional movement, which contributed to an understanding of a cube:

> Chris's memory of the cube then is immanent to movements that experience and feel themselves and move by themselves. It is here that we have to seek/find an experience that only belongs to it, the movement. It is precisely then that we no longer have the distinction between mind and a material body – mind is the flesh itself, memory in the movement rather than in some bodily schema or representation that is used to bring the movement about. Mind does not act on the body or instructs it to do what it has to do. (Roth, 2010, p. 13)

In the studies discussed in this section, toddlers' bodies can be considered as providing more than pathways to mental schemata about locating. Their movements support their awareness of the locations of themselves and specific objects. As well, experiences in a range of locations give information, which combines perceptual input, in order to solve different kinds of problems. Specific attributes of the locations provide input about concepts valued by the society, supporting the toddler's awareness that some locating attributes were valued more highly than others, such as the use of spatial terms and interpreting and producing maps.

Locating attributes are made available to toddlers' awareness from their interactions with artefacts, which have socially-valued meanings connected to them (Sinha & de López, 2000). These interactions invoke particular kinds of reflections. Franzén (2015) reported that Swedish preschool teachers of children under three years old consciously provided material that they thought would stimulate the children's mathematical learning through investigation. However, they found that if the material was provided in an unorganised fashion then the children did not engage with it. For examples, beads had to be sorted into specific colour groupings in order for the children to want to make patterns with them. The organisation of artefacts as well as the characteristics of those artefacts influenced the kind of learning that was possible for toddlers to gain. In research with a 12 year old girl, Fyhn (2006) described how the climbing of a mountain in northern Norway enabled the girl to reflect on the angles she formed with her body. By interacting with the mountain, she solved the necessary problems for reaching the summit. However, it was not until the climbing was discussed with the researcher that the reflections on the angles were verbalised and available for overt reflection.

The majority of previous research on locating has focused on young children's learning of location language, including interpreting and producing representations such as maps. Body movements were identified as contributing to toddlers' learning and using locating knowledge and skills, particularly in regard to interactions with both adults and artefacts. Although toddlers were acknowledged as understanding many spatial relationships at the beginning of their second year, there has been

little research that acknowledges the bodily learning. Rather understanding about locating is thought to increase with age and experience, which is then connected to increases in vocabulary knowledge. This kind of research contributes to toddlers not being recognised as human until they can verbally reflect on their experiences with locating. In the next section, I provide two examples of toddlers exploring outdoor equipment within a playground setting. These examples are provided in order to show the kind of insights into toddlers' learning about locating that are available when the focus is on how they use their bodies. In this way, I argue that the focus on the mind distorts views of toddlers as being human.

Two examples of toddlers locating themselves

In 2011–2012, our research group made video recordings at a preschool in a city in the southern part of Sweden. Ethical consent was gained from teachers and parents and discussed with the children for collecting the data and the publication of both videos and still photos in materials resulting from the project. The research focussed on describing the mathematics that children engaged in, using Bishop's six activities (Johansson et al., 2012). As noted earlier, locating is one activity and the ideas discussed in this paper arose from our joint discussions. The material is interesting as it is recorded in naturalistic settings, unlike most previous studies.[1]

The data for this paper are two short videos, the first showing a child walking along a bench is 35 seconds, while the second video is of a different child climbing up and across a climbing frame and is just under 5 minutes long. In neither video do the toddlers use speech as the main form of communication. In the first video, the toddler did not make a sound. In the second video, the child sang to herself and made some soft whimpering sounds as she adjusted her movements to the climbing frame. These sounds became louder when she had traversed the frame and had difficulties getting down. At this point, she also said in Swedish "help me". Apart from these words, the only other time she spoke was to say, "look at me", possibly to the person filming her. These videos were considered relevant for exploring children's non-verbalised learning in relationship to how the mind and body were connected to the individual social possibilities for learning.

A multimodality analysis (Flewitt, Hampel, Hauck & Lancaster, 2009) was made of each child's movements and interactions with an adult and the equipment on which they were climbing. By looking at how the body and individual components of it, gaze, hands, feet, etcetera were positioned, I made inferences about the children's learning and whether that

learning occurred in the mind or body, as an individual or a social activity. This is a similar process to making inferences about older children's understandings from their talking and/or writing.

As in all research, there are power issues (Parks & Schmeichel, 2014) with the researcher as narrator telling the story of the significance of children's interactions. Consequently, the transcription must be seen as a first analysis as it supported the identification of some incidents and features as being important. Following suggestions in Flewitt et al., (2009), tables were created for each video in which changes in different aspects of the child's body were noted and how it was affected by the playground equipment, and any other information such as interaction with an adult. A still photo from the video that showed part of this interaction was included.

From the multimodal analysis of the two videos, I identified incidents, which seemed to be relevant for the discussion of the mind/body divide and then looked for how they related to the individual/social divide. It is these incidents, which are discussed in the next section.

Climbing and locating learning

In the two videos, the children faced specific locating problems, connected to the equipment that they were climbing on. In the video of the child walking along the bench, the child had difficulty getting off the bench. Initially she walked to the end of the bench, turned and walked back. When the child reached the end of the bench, she raised her arms and seemed to be requesting that the teacher pick her up. The teacher used her body to suggest that she had not understand. Then, the child started to bend, perhaps to organise herself to climb down (see figure 1). However, she was not successful and the remainder of the video shows the child and the teacher interacting, non-verbally, as the child attempted to solve the problem, before finally achieving success.

Figure 1. *Attempting to get down*

In the video of the child climbing up and over a climbing frame, the child seemed to meet two problems, recognisable amongst other things by her whimpering. The first problem was when she attempted to return to the bars on the side of the climbing frame from her position of being on the rope frame above the ground (see figure 2). The presence of first one child and then another who blocked her possibilities for retracing her movements, forced her to move forward. The second problem occurred when she reached the other side of the rope frame and needed to climb down. At this point, her whimpering was loud enough to attract the teacher's attention who then helped her to place her legs on the bars so she could climb down.

Figure 2. O*n the climbing frame*

In both videos, the children had the necessary physical capabilities to do the climbing. The problems that they encountered were ones to do with how to locate themselves in space, particularly how to change their position in space. Vygotsky (1978) suggested that solving of problems resulted in children's learning and this did seem to be the case for children in regard to understanding of how to move themselves through space.

Body/mind divide

The child on the bench had difficulties bending down because her bottom became wedged against the bench seat. The bench was not wide enough for her to move forward. Piaget and Inhelder (1956) discussed how very young children did not realise they must turn around in order to sit on a seat. This

Figure 3. *Facing forwards and bending down*

did not seem to be the case here, as after several non-verbal interactions with the teacher, she became aware that she could bend over when she faced along the bench towards the teacher (see figure 3). This enabled her to bend down before moving her legs off the bench and onto the ground.

The reflection about how to adjust her body so that she could climb down seemed to be body-based. Having tried a variety of options for getting down and not having gained assistance from the teacher, she then twisted her body, so it was in alignment with the bench. It may be that cognitive reflections based on sensual information from her sight and touch contributed to her assessment of her options. These may also have contributed to an increased understanding of what it meant to be located "on" the bench rather than "on" the ground. However, the learning could not be considered to be purely cognitive. It was her bodily actions which allowed the child to move safely through space, given the specific features of the bench.

In discussing accommodation and assimilation, Piaget and Inhelder (1956) described the negative impressions of an object that the child touched as forming the schemata. However, it was not the object itself that this child was learning about, rather it was how to interact with the bench in order to change her position in space. The problem solving that this child engaged in was about how to move her body–arms, legs, torso. It seemed that her previous actions on the bench allowed her to reflect upon what else she might be able to do and this supported her to choose alternative actions.

In the other video, the child also seemed to learn about how to co-ordinate her arms, legs and torso to climb up, across and then down the climbing frame. After she climbed up, she reversed her movements so she could climb off the rope framework (figure 4). This moving forward and backwards continued until other children blocked her backward movement. The repetition of moving forwards and backwards suggests that she was solving a particular problem by practising a pattern of movements. It may be that she recognised that she needed to develop what Gee (2003) suggested was "a routinized, taken-for-granted mastery of certain skills" (p. 3).

Figure 4. *Climbing on and off*

It may also be about becoming comfortable so far above the ground and thus needing to know that she could get back if she did not feel that she could move forwards. Stephenson (2003) noted how four year olds often put themselves into "scary" situations, including climbing, to see how it felt. She also noted that for toddlers, "undertaking 'risky' activities was an integral part of their drive to extend their physical prowess and so their independence" (p. 38). This may have been the case with this child who, when unable to go backwards, did move forward, even if the whimper suggested that she was not entirely certain that she could do this. In a study in Norwegian preschools, Sandseter (2009) found that young children would ask for help if they became afraid when up high. It may be that the child in the video was aware that she had such an option. By making a whimpering sound, she alerted the teacher that she might need help in the near future.

The effort of co-ordinating the arms and the legs so that the whole body moved forward and did not slip off took effort. Most of the time the child gazed downwards, rather than at the climbing frame. Only when she needed to ascertain what impeded her moving backwards did she look specifically at something. The lack of involvement of the sight in determining where best to move each body part suggests that it was the feeling of bending and stretching arms, legs, hands and feet that provided information about how to move forward. This suggests that it was bodily, rather than cognitive, reflections that contributed to her learning about how to move.

The regularity of the rope pattern supported the repetition of movements and this may have helped the child learn about partitioning a larger length or area into smaller units. Huttenlocher, et al.'s (1994) research suggested that children had this skill from a young age but refined it as they got older. It may be that using equipment like this contributed to the refinement, although more research would be needed to understand this. As with the other videoed child, the mind may have been involved in learning how to deal with the uncertainty and fear, but the body was not divorced from the problem solving of how to move forward and locate itself in space.

Individual/social divide

In the videos, each child solved location problems relevant to themselves. The learning about locating must, therefore, be considered individual to them as they were connected to the problems they posed and then solved. However, in both cases, the learning must also be considered social, in that what was learnt and how it was learnt was both supported and constrained by the social environment in which the children were operating.

Figure 5. *Asking to be picked up and the response*

The environment impacted on each child's learning in two ways. The first of these was through interacting with the teacher. The second was the features of the objects being climbed over.

In the walking along the bench video, the teacher's contributions did not involve any direct teaching. Rather the teacher acknowledged non-verbally that the child was focused on getting down from the bench and encouraged her to find a solution. In figure 5, the child can be seen using her arms and fingers to indicate that she wished to be picked up. However, the teacher's reaction of spreading her arms in an exaggerated replicate of the child's gesture resulted in the child accepting that the teacher would not pick her up. The outcome of this exchange was that the child made her first attempt to bend down (see figure 1).

In the climbing frame video, the child also initiated an interaction with the teacher by whimpering loudly, when she became stuck. Before making the cry, however, she glanced around to ascertain where the teacher was and then turned her gaze forward. As noted previously, it may be that this child knew that crying would gain the teacher's help. Although the teacher immediately came to her aid, her cries were not of high distress and the teacher did not remove her from danger, as Sandseter (2009) similarly noted in her research. Rather the teacher saw the child's wish for help as a possibility to support her learning how to climb on to the bars from the top of the frame. When the child dropped both legs down to straddle a rope rather than moving on to the metal bars, the teacher moved the legs and placed them on the top bars (see figure 2 and 6). When the child was securely on the metal bars, she shook off any further assistance from the teacher.

Figure 6. *The teacher's support to move the child across to the climbing frame*

This child managed the support that she received from the teacher, who she had first visually found to be close at hand, by choosing to whimper loudly and later by shaking off further help. As a consequence, the child learnt how to move her body when above the ground on a climbing frame. She may also have learnt how to deal with the fear of moving from the rope frame to the metal bars which her hands were not large enough to completely grasp. Dealing with strong feelings, such as fear, is recognised as important learning for preschool children (Stephenson, 2003; Sandseter, 2009). The fact that the teacher did not interfere with the child's climbing may have contributed to the child recognising that her exploration of the climbing frame was a socially acceptable behaviour for a child like her.

The teachers' roles in the interactions were important in helping children to recognise socially valuable knowledge connected to locating. Having an adult close by supported the children to continue their exploration. In both cases, the children controlled the help offered to them, although in the bench video the child was unsuccessful in getting the teacher to pick her up. Both children learnt about how to move and locate themselves above the ground, by manoeuvring different parts of their bodies, such as their arms, legs and torsos. If the teachers were not present, the children may not have been so explorative, because they had to deal with fear, as well as the exhilaration, in solving risky problems (Stephenson, 2003; Sandseter, 2009). As was the case in Ferrara et al.'s (2011) research, the adults' role was important in the children's learning about locating, although not because of the teachers' verbally describing the children's actions. Rather it was that the teachers provided opportunities to take risks, which supported the bodily learning about locating. These teachers like those in Franzén's (2015) research set up the boundaries of the play, but supported the children's learning by allowing them to explore with their bodies.

In both examples, the objects being climbed on affected what could be learnt. The bench and the climbing frame supported the children's exploration of being "above" the ground in a particular way. The objects were cultural artefacts that promoted some possibilities for learning, but excluded others. For example, the bench provided experiences of being horizontally above the ground. As well, the structure of the bench seat both impeded the first attempt to get down but also supported a later attempt with the left hand resting on it when the legs were lowered to the ground (see figure 7).

The climbing frame also had a regularity in the placement of the bars and the connection of the ropes through nodes (see figure 4). The regularity of the distances between the ropes and the bars enabled the child to organise how to co-ordinate the arms and legs in moving up and across

Figure 7. *The bench back as a support for lowering the body to the ground*

the frame. This supported her learning about locating in that it enabled her to feel what it was like to climb across at that height. As noted earlier it may also have contributed to her being able to estimate distances.

Nevertheless, the regularity of the features of the bench and the climbing frame suggests that learning about what it meant to be "up" could be restricted, if other experiences of more irregular objects, such as the tyre behind the teacher in figure 7, were not provided. For Sinha and de Lopez (2000), young children's meaningful language learning reinforced the bodily-learnt, socially significant knowledge of their culture. Language itself does not produce cultural differences in what is noticed. Rather it is through typical interactions with physical objects that young children learn what is culturally significant and this is what is reinforced with language. If children are to learn about being "up" through their bodies, then they need to experience it not only horizontally but also diagonally and vertically. Climbing up and across a climbing frame provided the child with experiences of being horizontal and vertical, but not with diagonal. Climbing on the climbing frame also emphasised the importance of right angles. It was in trying to climb over the outside of a right angle, thus dealing with an angle of 270 degrees that the child became stuck and whimpered for help from the teacher.

In this way, socially acceptable locating knowledge could be limited to the attributes of built objects if children do not also have opportunities to climb natural objects such as trees. Clements (1998) described the situation in which young children over generalised the attributes of triangles because of only being shown "visual prototypes" and recommended that children have experiences with a rich variety of shapes. Sinha and de Lopez (2000) suggested that there might be similar issues with learning about prepositional placement. They considered that embodied learning had to include interactions with different artefacts.

In the videos, it could be said that both children focused on themselves and their own problem solving. However, these were shaped by the social interactions through the interactions with the teachers as well as with the objects in the environment. Both kinds of interactions indicated to the children what was the socially-valued knowledge about locating, not just what it meant to be in different positions in space but what it felt like and how to manage their learning about this.

Conclusion

Toddlers gain many new experiences of the world. Learning about locating themselves in space is just one kind of experience. In this paper, I have argued that emphasising children's learning as being in the mind, rather than the body, and separating learning done by the individual from that of the social environment misrepresents how toddlers learn and in particular how they learn about locating. The risk of this misrepresentation is that toddlers' own ways of learning are dismissed as not being human.

As the two examples show, the children have knowledge and skills to do with locating. They used these skills and knowledge to move themselves above the ground, making use of the attributes of the objects on which they climbed. In so doing, they solved locating problems. Consequently, rather than being a static set of knowledge and skills about locating, which the children absorbed while climbing, it seemed that locating was a dynamic set of problems. It was through solving them that the children learnt what it meant to be located in different places in space and attached meanings, such as fear, to what they were experiencing. How they felt the body move up, across and down was an important part of the learning. The mind might also be involved but the learning cannot be considered as just located there.

Learning occurred in the interaction between the individual children who posed and solved the problems and the social environments in which they operated. The interactions between the children and the teachers and the cultural artefacts that the children climbed on affected the type of learning that were possible for them.

Toddlers may not use language to explicitly reflect on their learning, as adults do, but this does not exclude them from being able to learn. Emphasising the importance of language in learning has tended to position toddlers, with limited language fluency, as insufficient human beings. However, close analysis of these two videos indicate that both children were learning about locating themselves in space. This learning was connected to the problem solving which came about as they experienced difficulties in placing themselves in specific locations, on the ground or on

the vertical bars. It built on understandings that they had already, such as climbing on objects but also used new input that they gained through sight and body movements. What they were climbing on affected their learning and contributed to them coming in contact with socially valued knowledge. It is likely that learning about "up" and "down" will only make sense to toddlers if it is useful in solving the problems that they have set themselves. In order to solve those problems, the body was essential. I, therefore, argue that learning should be considered as dynamic problem solving, where the actions of "doing" leads to "knowing", not the other way around as is often how mathematics is taught in school.

Acknowledgement

This work is dedicated to the memory of Eva Riesbeck who until her retirement was an active member of our research group. She collected many of the videos and contributed to the discussions, which formed the basis for the research documented here. Her passing has left a hole in our hearts.

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Notes

1 Videos from this research project are included in the material used in the web-based professional developmental module for Swedish preschool teachers. These may be accessed from: http://matematiklyftet.skolverket.se/

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