TRANSLATING MODALITIES: PRESCHOOL TEACHERS’ WORK WITH CHILDREN’S MEANING MAKING IN SCIENCE

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ABSTRACT
Children in preschool encounter sensations in their daily activities that could be interpreted as scientific phenomena. As part of these encounters, social interaction and meaning making are important elements in making science available to the children. Children in preschool rely on multimodal communication since they have not yet developed a verbal language. Therefore, this study aims at taking a multimodal perspective to investigate meaning making in science in a preschool setting. Data was collected using observations and audio recordings from one Swedish preschool with 18 children between 1-5 years old and three preschool teachers. Data was analyzed using semantic relationships. However, these relationships were investigated not only within verbal utterances, but in gestures and embodied activities as well. The results show that the preschool teacher verbalizes children’s embodied actions and gestures. In doing so, the teacher not only offers words for children’s activities, but also makes the activities, and participants’ meaning making, explicit to all children in the group. Hence, the teacher is translating modalities. Furthermore, this study shows the importance of attending a multimodal perspective in preschool settings. If attention is only given to children’s verbal output, there is a risk of underestimating their competence in emergent science meaning making. Instead, a multimodal perspective reveals children’s competent meaning making in interaction.

Key words: meaning making, multimodality, preschool, science education

INTRODUCTION
Children encounter what could be called science, or scientific phenomena, almost on a daily basis in their everyday activities both at home and in preschool. They see condensed water drops on a cold glass, experience the pendulum effect of a swing, and realize that there are different flowers and birds. However, when do these occurrences become scientific phenomena? We would argue that science is constructed in social context, through interaction. From this perspective, doing science is a about making meaning in a social context in relation to scientific phenomena. Or at least, it could be argued that the experiences children have during their time at preschool could be seen as the first seeds for later scientific knowledge.

Science in preschool
In Sweden, science is part of the curricula for preschool (children aged 1-5 years). Even though preschool is voluntary, it is part of the school system in Sweden and a majority of Swedish children attend this school form. According to the curricula, preschool promotes development and learning, and a lifelong desire to learn for all children. However, the
foundation for learning in a preschool setting is play. Teaching in preschool is not organized as classroom activities, but rather in playful settings where interaction between children, and between children and teachers, is essential. Preschool teachers play a central role in focusing child attention towards specific phenomena (Pramling & Pramling Samuelsson, 2001), and providing opportunities for children to explore, ask questions, and observe, enabling them to discover new things about the world (Howitt, Upson, & Simon, 2011).

Klaar and Öhman (2012) have, for example, shown that a preschooler explores friction while playing on a slippery slope. Robert (22 months old) is trying to reach the top of an icy hill to be able to slide down the hill on his sledge. However, as he reaches the top, he slowly starts to slide backwards, whereby he bends his knees, puts one hand on the ground and takes small steps. In changing his way of approaching the slippery slope, Robert is able to reach the top. Klaar and Öhman (2012) conclude that learning could be seen as a practical and physical meaning making rather than being conceptual or verbal. As this particular example shows, Robert’s activity could be seen as an embodied experience that could be later used as a building stone in learning about friction.

Larsson (2013) also shows that preschool children are in contact with the phenomenon of friction during their play. However, even though the children spontaneously explore and talk about friction, Larsson (2013) shows that the teachers focus more on the social aspects of children’s actions and intentions, rather than on the content. Larsson argues that there is a risk that children’s actions are not viewed as signs of competence. Content knowledge and pedagogical content knowledge is seen as necessary for the teachers to be able to create space for children’s exploration.

These studies indicate that embodied action play an important role in children’s emergent learning about science. However, there are also indications that it is important for children to have a competent teacher to interact with in their meaning making. Children in preschool differ extensively in their communicative repertoire, from children that have almost no language at all to children who communicate using a wide range of semiotic resources. Since children express themselves not only verbally, but also through gestures, embodied actions, and non-verbal sounds, we would argue that it is important to take a multimodal perspective on children’s meaning making in preschool. Traditionally, many studies on science teaching and learning only take verbal language into account. This approach gives a limited view of children’s meaning-making process.

**Multimodality and meaning making**

After all, studying human interaction is to study the utilization of different sign systems, or modalities, for example speech, gestures (such as pointing), prosody, and use of physical materials (Goodwin, 2000; Goodwin & Goodwin, 2013; Jewitt, Kress, Ogborn, & Tsatsarelis, 2001). As such, analysis of this practice rests on identifying where participants understanding of one another originates, where the heart of the communication lies. Here, Enfield (2011) distinguishes between fine-grained *semiotic dimensions*, wherein one can distinguish between e.g. the speed, angle, and pressure of a certain gesture, and *sensory modalities*, i.e. basic physiological modes of input. The analysis in the present paper rests on the latter, wherein participants’ talk, gaze, movement, and manipulation of physical material are considered.

Mercer views the combination of these modalities as “getting things done” (2004, p. 138), a person’s communicative abilities to make meaning. In our daily lives we rarely rely merely
on talk for our communication, we also combine this with gestures, gaze and prosody. However, before becoming verbally proficient, young children rely to a higher degree than their older peers on embodied actions, prosody, and pointing for their communication with the surrounding world (Enfield, 2011). As such, a multimodal perspective is important in the analysis of interaction including young children.

In their study of very young children’s multimodal interaction, Lerner, Zimmerman, and Kidwell (2011) show how a toddler, Laura, interacts with her caregiver using a combination of gestures, vocal expressions, and gaze. Their analysis demonstrates how the caregiver responds to Laura’s communicative efforts with verbal responses, showing an understanding of an expressed desire from Laura. This can be viewed as a shift between modalities, with the purpose of establishing a joint understanding of the previous utterance (through a three-part sequence), between two participants.

Building on this view of multimodal expressions, this paper investigates the use of different modalities, for example the relation between embodied actions and verbal utterances, as a way of making meaning in science in a preschool setting.

**Aim and research questions**

The aim of this study is to investigate multimodal meaning making in science in social interaction in a preschool setting.

More specifically, the following research questions have been posed:

1. How are relations between different modalities done in preschool meaning making in science?
2. In what way does a multimodal perspective contribute to the understanding of meaning making in preschool science?

**METHOD**

The data in this study was collected in a preschool located in the central parts of a middle-sized city in Sweden. Three preschool teachers work with 18 children between 1-5 years old. One of the preschool teachers, Caroline, was responsible for science and mathematics. All children in the study have their parents’ consent to participate in the study and the children were informed about the study before participating. The preschool teacher also agreed to participate in the study. All names have been changed due to ethical reasons.

**Data collection**

The data were collected through observations, using field notes, audio recordings and photographic documentation with a digital camera. In total, the data consist of 12 h 20 min of observations distributed over seven occasions. During the time of observations, the first author had the role of participating observer. The researcher observed activities both indoors and outdoors and all observations were made before lunch, since this is the time when most children are present and the more planned activities took place. The days that were chosen for observation were those where the preschool teachers intended to teach science and mathematics. The researcher took detailed field notes describing activities, what the children made, their gestures etc. The researcher never interrupted the ongoing activities.
Data analysis
The audio recordings were transcribed and incorporated into field notes making up one document. Photographs were also inserted to give a rich picture of what happened during the episodes.

The first step of the analysis was to roughly organize the extended field note document in activities that had the potential to be about science in a broad sense, and activities that did not include science content. In the more fine grained analysis of theses science episodes, the interaction between the children and the preschool teacher was coded using semantic relationships (Lemke, 1990). Semantic relationship denotes to when several ways of expressing something refers to the same scientific meaning. Originally, semantic relationship were used in order to analyze texts – written or verbal excerpts (Lemke, 1990). However, in this study we infer ‘text’ in a broader sense, including other semantic resources, in line with Fredlund (2013). Using this approach, speech, embodied actions, and manipulation of objects were all seen as potential carriers of semantic relationships, when relevant for the participant interaction. The extended field notes were analyzed by searching for different semantic relationships. This means that we looked for when the same scientific meaning was expressed using different words or different semantic resources. This approach made it possible to see in what way the teacher and the children constructed and co-constructed meaning of science in interaction over time.

RESULTS
The children and teacher construct meaning of scientific content throughout the activities. Verbal language together with the use of artefacts, such as pictures, blocks, written stories, were used to communicate about content. In the following, one particular example has been chosen to illustrate in what way the participants use different modalities, or semantic resources, to communicate about earthworms, their characteristics and their behaviour. In the following, the interpretation of what is said or communicated in the interaction is informed by the participants’ following turn (Goodwin, 2000, 2013; Goodwin & Goodwin, 2013). This implicates that the researchers’ interpretation of one participant’s turn can be validated through the response in the next turn.

Caroline has gathered all the children in a circle on the floor. She tells the children that they are going to make a worm world, which is a plastic terrarium that you fill with dust, sand and leaves. Thereafter, you put earthworms into the terrarium and after a few days you can study how the worms are making tunnels in the dust and how they are dragging down the leaves from the top layer. The children tumble around on the floor, and talk loudly and excitedly, and some of the older children reminisce about when they made the worm world the last time. Caroline and the children talk about worms; what they eat, where they could be found, that they have no eyes and are not able to see, but that they are very sensible to vibrations in the ground. They also sing a song about a worm named Kurt, who is made of paper, with hair and eyes. In the following excerpt, they are leaving the subject of earthworms for a while to eat some fruit before going outside to set up the worm world. However, the children show that they are not ready to leave the worms yet.

1 Erik: [Erik lies down on the floor and crawls towards Caroline]
2 Caroline: [Turns to the whole group] Now I think Erik became an earthworm, actually.
3 C: [Turns to Erik] Here you go Erik, what kind of fruit would you like?
[Turns to the other children:] Now you have to move aside because there is an earthworm crawling on the floor.

[Turns to Erik:] Maybe you would like a leaf instead?

No.

[C holds out the fruit basket, but when Erik does not reach for a fruit, C notices that Erik has his eyes closed] No, of course you’re not looking, you don’t have any eyes. And you don’t hear anything either when you are a worm.

Yes, I’m a worm.

But you can feel instead. Then I take your hand here, there, then you felt that you got a fruit. [Caroline takes Erik’s hand and puts a fruit in it]

Then we shall see. [Turns to Noelia] Noelia, what kind of fruit would you like?

[Noelia crawls towards the fruit basket with her eyes closed].

Then we have the next earthworm crawling.

What kind of fruit would you like?

Pear.

Pear.

I could hear.

Yes could hear, indeed. Here you go. [Hands the fruit to Noelia]. Then you can crawl back to your spot.

In the beginning of this excerpt, Erik is crawling across the carpet (Line 1). Caroline comments on Erik’s movement and thereby makes a connection to the just ended discussion about worms (Lines 2-3: “Now I think that Erik became an earthworm, actually”). In doing so, Caroline acknowledges his action and interprets it as Erik being an earthworm. However, when Caroline tells the other children to move aside, because “there is an earthworm crawling on the floor” (Line 6), she puts into words the semantic relationship that this is a behavior typical for earthworms. In doing so, Caroline translates meaning from embodied action to verbal utterance. Furthermore, she addresses the whole group with her utterance, thus giving the rest of the group the opportunity to share her interpretation. Caroline addresses Erik as a child, but when she talks to the other children about Erik, she talks about him as if he was an earthworm.

Caroline also continues this role-play when asking if Erik wants leaves instead of fruit (Line 7). In this line, she takes the opportunity to recapture the semantic relationship that worms eat leaves, something they have previously addressed. Erik responds with a “No” (Line 8) and Caroline holds out the fruit basket to him. However, when Caroline notices that Erik is not taking any fruit, she looks at him and realizes that he has his eyes closed (Line 9-10). Again, Caroline verbalizes her interpretation of what Erik is doing, namely that he cannot see anything since (as a worm) he does not have any eyes (Line 10-11). Furthermore, she adds another characteristic of earthworms, the fact that they cannot hear (Line 11-12). In doing so, she once more explicates her interpretation that Erik is playing an earthworm, which he also confirms (Line 13: “Yes, I’m a worm”). Thus, when Caroline notices that Erik has his eyes closed (Line 9-10), she makes a verbal translation of his embodied actions, which makes these actions accessible to the rest of the group.

Caroline adds to Erik’s play as she comments that Erik, when he is an earthworm, “does not hear” (Line 11-12), but that he could instead use his sense of touch (Line 14). Caroline adds to this utterance by taking Erik’s hand and putting a fruit in it (Line 15-16). In doing so, Caroline assists Erik in using his sense of touch, thereby translating a verbal modality into an embodied, encouraging Erik to use his sense of touch.
In the following lines, we may see indications for shared meaning as Noëlia, who is next in turn to get a fruit, imitates Erik’s behavior. Noëlia crawls towards the fruit basket with her eyes closed (Line 19). Caroline again interprets this as an attempt to imitate an earthworm. She verbalizes her interpretation, making it explicit to all the children (Line 20). When Caroline asks which fruit Noëlia wants (Line 21), Noëlia answers “Pear” (Line 22). Then, Noëlia herself points out that she was able to hear Caroline’s question (Line 24). In doing so, Noëlia states her awareness that it is not typical for an earthworm to be able to hear. Caroline confirms this by adding “indeed” (Line 25), which signals that this was indeed rather unusual for an earthworm. Caroline then continues the play as she prompts Noëlia to “crawl back to [her] spot” (Line 25-26).

This episode continues, as all children have received their fruits, are eating, and are talking enthusiastically about the worms, their characteristics, and later what clothes they are going to wear as they go outside.

**DISCUSSION AND CONCLUSIONS**

This study investigates meaning making of science in an ordinary Swedish preschool. The results show that the teacher and the children use different modalities to express the same semantic relationships. Talk, embodied actions and gestures complement each other to make meaning of the behavior and characters of an earthworm. Erik and Noëlia express the crawling of the earthworm (Line 1 and Line 19) by using their bodies, actually laying down on the floor and crawling over the carpet. In both these cases, Caroline puts into words Erik’s and Noëlia’s actions. In this way, Caroline phrases the semantic relationship of how an earthworm is moving – it crawls. In contrast to Mercer (2004), who states that a person combines several modalities to make meaning, the present study shows that different persons (the teacher and the children) use different modalities to communicate the same meaning. We introduce the concept *translating modalities*, as a way of describing what Caroline is doing here. She offers a verbal output (Line 6: “there is an earthworm crawling on the floor” and Line 20 “Then we have the next earthworm crawling”). In doing so, she introduces words important for emergent science learning and she also offers this meaning making to all present children. In other words, the teacher translates the children’s embodied actions into verbal utterances.

This type of translation is also seen when Caroline discovers that Erik has his eyes closed (Line 10). He is then playing an earthworm and Caroline puts into words (Lines 10-11) the character of the earthworm that Erik performs with his embodied actions.

The results also show that Caroline suggests embodied experiences for uttered words. When Caroline introduces the fact that earthworms have a sense of touch (Lines 14-15: “But you can feel instead. Then I take your hand here, there, then you felt that you got a fruit.”) she also encourages Erik to experience this himself, as he has his eyes closed, and she guides his hand to grab a fruit from the basket. We suggest that Caroline in this example translates verbal language into children’s embodied experiences and the use of several senses.

Thus, *translating modalities* is defined as when something expressed in one modality – or semiotic resource – is translated into another modality, keeping a similar meaning. Translating modalities is an interactive meaning-making process. This means that the aim of translating between modalities is to seek common understanding. Children use a broad repertoire of semiotic resources as they have still not yet developed a verbal language.
(Enfield, 2011). We suggest that translating modalities could be a way for teachers to enhance children’s verbal language development, by putting words to children’s gestures.

We would argue that when the teacher translates between different modalities she offers opportunities for learning science. This highlights the importance of the teacher’s role in science learning for preschool children. In contrast to Larsson (2013), this study shows a teacher that interprets children’s actions as potential science content. Caroline could have interpreted children’s crawling on the carpet as a disciplinary offence, but instead she sees the competence of the children in relation to the previous topic. To be able to see this, the teacher does not only have to have sufficient content and pedagogical content knowledge (Larsson, 2013), but also have to be aware that children do not always express their science knowledge in words. Even though the teacher’s role is to guide child attention to important science content (Pramling & Pramling Samuelsson, 2001), it is also evident that the teacher’s awareness of multimodality can help them to see children’s emergent meaning making in science.

Furthermore, in putting words to children’s embodied actions, Caroline offers a verbal language for the children’s spontaneous activities. In doing so, she also highlights the activities and connects them to the characteristics of the earthworms for the other children in the group. In other terms, Caroline promotes shared meaning (Scott, 1998) as she makes her interpretation publicly accessible to the other children. By translating between modalities the teacher makes scientific content available to all the children.

In answering the first research question, characterizing the interaction of meaning making in science in preschool, some light have also been shed on our second question. The second question deals with the contribution of a multimodal perspective for meaning making in science.

Our results indicate that semantic relationships could be carried by different semiotic resources, or modalities, as stated in earlier research (Fredlund, 2013). In a preschool setting, where not all children have developed a verbal language, it is of even greater importance to study not only the uttered words, but also to take into account gestures, embodied actions and gaze.

It is interesting to note that if only the spoken words are taken into account, the children only say a few things during the excerpt above. Erik says “No.” (Line 8) and “Yes, I’m a worm” (Line 13) and Noëlia says “Pear.” (Line 22) and “I could hear.” (Line 24). The science content is not visible merely by looking at these few spoken lines. However, taking an interactional multimodal perspective on the activities in preschool reveals a much richer picture of the meaning making process going on together with the teacher. As we can see from the results, the children use other modalities than verbal language to express their understanding of emerging science content. Thereby, we suggest that embodied actions contribute to meaning making in science. It is important to not only look at verbal language as we are trying to understand children’s conceptions of science.

Even though this is a small-scale study, we argue that the results and the ensuing analysis are of great interest for teaching and learning in a preschool setting. Caroline’s interaction with the children in approaching a science content gives new insight into how children could be seen, not only as passive recipients, but as active meaning-making individuals in social interaction, using different modalities to communicate an emergent science content.
However, the children do not become competent actors by themselves, but through the support that Caroline gives their engagement through translating between modalities.

Furthermore, we want to highlight the importance of more studies in preschool taking a multimodal perspective. These studies could help inform and guide preschool teachers in how to notice and interpret preschoolers’ actions and activities as exploring and making meaning in emerging science.

REFERENCES