Early development of picture comprehension

Doctoral (Ph.D.) Thesis booklet

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INTRODUCTION

Pictures are among the most common symbolic objects in human cultures. Through interactions with pictures, we can learn indirectly about anything we have never encountered before (e.g. Canfield & Ganea, 2014; DeLoache & Ganea, 2009; Kelemen, Emmons, Schillaci, & Ganea, 2014). Considering the power of this indirect learning and the extensive usage of pictures in human societies, all children must become competent users of the picture mediated knowledge in their early years. Beyond the fact that they can learn from pictures, it has been also a highly investigated question of when and how (e.g. Preissler & Carey, 2004) young children come to master pictures as culturally relevant symbolic objects, and how to improve this understanding (e.g. Callaghan & Rankin, 2002; DeLoache & Burns, 1994).

To answer these questions, previous research has operationalized pictures as “something that someone intends to stand for or represent something other than itself” (DeLoache, 2004, p66). Thus, children have to understand a picture as a representation which has an abstract relation to a referent. Furthermore, children must understand that only human intention makes anything become symbolic. As developmental research demonstrates, it takes years to understand pictures, including their interrelated representational and intentional nature.

The first manifestation of understanding the representational nature of pictures is that infants show precocity in the recognition of people, objects and patterns in pictures (e.g. Dirks & Gibson, 1977). In the second year, children can acquire a verbal label in a picture book reading situation with an adult, and – on the basis of the perceptual similarity – they extend the word to its real referent (e.g. Ganea, Pickard, & DeLoache, 2008; Preissler & Carey, 2004). However, as the extension of a word – acquired in a picture book reading session – to its real referent can be solved on the basis of perceptual similarity without the recognition of the symbol-referent relation, DeLoache (1987, 1991) invented a picture retrieval task that requires representational insight beyond the mere recognition of the similarity. In this retrieval task, children have to use pictures to solve problems in the current reality because they must interpret the symbolic relation and map from a picture to its specific referent.

The retrieval task is always a multi-trial search task in which the same object is hidden in different locations in each trial. In this multi-trial search task, children often make perseverative error, namely in the non-initial trials they often look for the hidden
object where they last saw it (O’Sullivan, Mitchell & Daehler, 2001; Sharon & DeLoache, 2003; Suddendorf, 2003). Kuhlmeier (2005) suggested that young children’s performance could be moderated by their problem with inhibitory control functioning. Therefore, although the retrieval task aims to measure the competence in picture comprehension, children are also required to inhibit their dominant response.

As the successful solution in the picture retrieval task requires representational insight, only 30-month-olds are able to look for the hidden object at the adequate location, 2-year-olds fail to use a pictorial information. In a long series of experiments various modifications were introduced to improve the 24-month-olds’ performance, which proved to be ineffective. 24-month-olds were unable to solve the problem even if they were explicitly informed that the colour pictures with high iconicity showed the current reality and if they perceived the similarity between the objects in the pictures and the actual ones (DeLoache & Burns, 1994).

Research has also revealed how children’s sensitivity to intentions contributes to the understanding of pictures as intentionally created symbolic artefacts. When 3-4-year-olds were asked to draw two different things (e.g. a lollipop and a balloon), they insisted on the original labelling, even though the shape of the drawings were indistinguishable from one another (Bloom & Markson, 1998). Additionally, young children tended to interpret a picture on the basis of social-communicative intentions when resemblance was an inadequate cue to its meaning (Gelman & Ebeling, 1998; Hartley & Allen, 2014a). These results suggest that when young children are required to interpret a picture they consider the creator’s intention.

Postulating an early sensitivity to intentions, including referential intent and its behavioural correlates, Preissler and Bloom (2008) evidenced that intention attribution influences the interpretation of pictures among 26-33-month-olds. Infants were investigated whether they could use someone’s eye gaze as a nonverbal cue of intentions in interpreting an ambiguous drawing. When an adult named his/her drawing, the toddlers later mapped the novel name onto the object the adult had been looking at. The shape of the drawing could not influence the children’s interpretation because it equally resembled the observed and non-observed objects.

To summarize, young children readily interpret a picture as the result of an intention aimed at depicting a real-world object (e.g. Bloom & Markson, 1998). Toddlers also show sensitivity to the social context in which someone intentionally creates a picture, and they are able to infer the referent from the creator’s behaviour (Preissler &
Bloom, 2008). This result suggests a well-developed understanding of the intentional nature of pictures and their symbolic relation to a referent. Nevertheless, this conclusion raises the puzzling question of why it is so demanding to contextualize the mental representation of the pictorial content in the retrieval task and how to facilitate children’s performance. To solve this puzzle, we might focus on the context in which the pictures are displayed in the retrieval task. While the classical task utilizes pre-drawn pictures, without any contextual information regarding the creator’s intention, children are expected to presume that pictures are intentionally created symbolic objects that refer to the current reality (DeLoache, 1987). However, in Preissler and Bloom’s (2008) research, pictures were presented in a social context and children could interpret them by attributing drawing intention to the creator. On the basis of these results, it may be easier for children to interpret the abstract pictorial relation as a consequence of a representational intention rather than to understand pictorial symbols per se without any available social context. This raises the assumption that children’s representational insight could be facilitated by making available the social context in which pictures are created.
THESES OF EXPERIMENT-1

The aim of Experiment-1 was to test the effect of a candidate underlying factor in early picture understanding, namely, the effect of demonstrating how pictures are created in a social context. We assumed that if the social context of picture-creation was available, children would better understand the symbolic relation between a picture and its referent. Since a rapid change occurs in children’s picture comprehension between 24-and-30-months of age, to test our hypothesis we decided to focus on this age range (24-30-month-olds).

1. We assumed that as 30-month-olds are able to recognize the specific representational relation between a picture and its referent (e.g. DeLoache, 1987, 1991), regardless of condition, we would reveal increasing pictorial competence between the ages of 24 and 30 months.

Children in the picture retrieval task are required to find the same hidden object in different locations in each trial. Therefore, although the retrieval task aims to measure the competence in picture comprehension, children are also required to inhibit their dominant response that leads to perseverative errors.

2. We assumed that although the Social Treatment would facilitate children’s picture understanding, the better retrieval performance would not result in less perseverative error; as the response perseveration is the consequence of weak inhibitory capacity.

3. As in young children, response perseveration is mediated by weak inhibitory capacity and additionally, because there is a lack of previous empirical evidence in picture retrieval tasks regarding the effect of response perseveration, we asked an open question whether inhibitory control capacity would be increasing between the ages of 24 and 30 months. If yes, then we would be expecting that regardless of the applied treatment, older children would have less perseverative errors than younger ones.
In Experiment-1A, we tested whether children show better understanding of the representational nature of a picture if they understand the intention that produced the picture in order to represent something other than itself, hence we applied a brief experimental treatment before the retrieval task. We hypothesized that due to this Social Treatment, children would interpret the picture as the result of representational intention and action. This socially mediated representational function of pictures would help them perform better when they are required to use online drawn pictures as a guide for action in the subsequent picture retrieval task.

4. **We assumed that due to the Social Treatment** that explicitly demonstrated the social origin of pictures, **children would better contextualize the online drawn test pictures in the picture retrieval task too.**

In Experiment-1B, our aim was to demonstrate that the facilitative effect of our Social Treatment – introduced in Experiment-1A – was not related to the fact that the Experimenter was drawing the pictures online in the Test phase in both conditions. We expected that due to the Social Treatment, children would contextualize the pre-drawn pictures of the Test phase too. Thus, we could rule out the possibility that the Social Treatment is only effective together with the observation of the Experimenter’s intention and action to draw or that the Experimental treatment would also increase the Control group’s performance in the picture retrieval task.

5. **We assumed that due to the Social Treatment** with the socially mediated representational function of pictures, **24-30-month-olds would better contextualize pre-drawn test pictures too.**
RESULTS AND DISCUSSION OF EXPERIMENT-1

Experiment-1 aimed to investigate an underlying factor that could contribute to the development of interpreting pictures in problem solving. Since toddlers show high sensitivity to the creator’s intention when they interpret drawings in their social context (e.g. Callaghan & Rankin, 2002; Gelman & Ebeling, 1998; Preissler & Bloom, 2008), thus, in Experiment-1, we manipulated the social origin of pictures. We assumed that children would perform better in using pictorial information for problem solving if they could understand a drawing person’s intention and action to visually represent something in current reality.

Experiment-1 provided clear evidence that due to the Social Treatment, children could use pictorial information more effectively; although, the pictures used in the treatment were unrelated to the possible locations of the retrieval task. Note that the facilitative effect did not occur if children in the Control Condition simply followed the identification of the specific referent of pre-drawn pictures without their social context. Furthermore, although in the Test phase of Experiment-1A, we used pictures drawn online in both conditions, children contextualized the test-pictures better only after the Social treatment. At the same time, Experiment-1B unequivocally demonstrated that children could search for the hidden object more successfully even if they had to understand pre-drawn test-pictures whose social origin was not available (See Figure-1. Errorless retrievals in the two conditions of the two experiments).

In the classical retrieval task (DeLoache, 1987), 24-month-olds performed only at the level of chance and 30-month-olds found the hidden object in about 80% of the trials. Although in Experiment-1 a strong facilitative effect was revealed, we did not find an age effect, and children overall performed at a rather low level. This result may derive from the fact that we applied a spatially complex setup (with a two-story dollhouse, including 6 target locations and 12 distractor ones), accordingly, the task could have been demanding for children.

At the same time, the modification in the classical retrieval task was intended to differentiate between the perseverative error and the random search. While we found higher retrieval performance in the Experimental Condition than in the Control Condition, this better performance did not result in less perseveration. Thus, our results are in line with previous research that the perseverative error can be explained by weakness in inhibitory control and random search by limited competence of picture comprehension.
(e.g. Kuhlmeier, 2005). Additionally, with age, children’s tendency for perseveration systematically decreased.

In sum, the Experimental treatment successfully facilitated the toddlers’ understanding of pictorial symbolic objects by introducing the pictures in a social context. Nevertheless, further research is needed to systematically test the effect of the Experimental treatment in different ages and to identify the lower age limit for the social facilitation. Additionally, although the items used in the Treatment phase were not used in the Test phase as either hiding or distractor locations, they were furniture from the dollhouse, thus the question arises, if we would use a separate Treatment and Test phase with different objects, the facilitative effect of the Experimental treatment could be replicated as well. Experiment-2 aims to answer these questions.

**Figure-1**: Errorless retrievals in the two conditions of Experiment-1A and Experiment-1B
Theses of Experiment-2

In Experiment-2 we tested the facilitative effect of the Social Treatment by using a separate Treatment and Test phase with different objects. Additionally, the modifications of the Experimental setup in Experiment-2 enabled us to control for the moderator effect of children’s different verbal level. As the search terrain of the Experiment-2 only consisted of objects that children below the age of 2.5 year are also able to label.

1. We assumed that the Social Treatment would facilitate children’s picture comprehension even if we would use different contexts for the Treatment and the Test phase.

Similarly to Experiment-1, as children in the picture retrieval task are required to find the same hidden object in different locations in each trial, children’s retrieval performance is moderated by weak inhibitory capacity.

2. We assumed that although the Social Treatment would facilitate children’s picture understanding, the better retrieval performance would not result in less perseverative error, as response perseveration is the consequence of weak inhibitory capacity.

Theses of the Experiment-2A

Experiment-2A aimed to identify a lower age limit for the Social Treatment, namely, due to the demonstration of the social origin of pictures at what age do children become able to understand pre-drawn test-pictures whose social origin is not available any more. As Preissler and Bloom (2008) found that 26-33-month-olds readily identify a specific referent of a picture on the basis of an adult’s intentional action (gaze behaviour and body posture), thus, in Experiment-2A, by seeking for the lower age limit of our social facilitation, we decided to focus on 26-month-olds. At the same time, as Troseth (2003) provided evidence that owing to the experience with another symbolic object, 24-month-olds performance could be facilitated in the picture retrieval task. Therefore, we tested whether our Social Treatment could also facilitate 24-month-olds performance.
3. We assumed that due to the Experimental treatment that explicitly demonstrated the social origin of pictures in a separate context then the picture retrieval task, children would better contextualize the pre-drawn test pictures.

4. As there is no empirical data available that evidenced 24-month-olds’ ability to identify a specific referent of a picture on the basis of the creator’s intentional action (gaze behaviour and body posture), we asked an open question whether our Social Treatment – that explicitly demonstrates the social context of picture-creation – would successfully facilitate 24-month-olds’ performance in the picture retrieval task too.

5. As response perseveration is a consequence of weak inhibitory capacity in very young children, due to lack of previous empirical findings, we asked an open question whether there would be a difference in the amount of perseverative errors in the 26-month-old and the 24-month-old age group. If yes, regardless of the condition, 26-month-olds would show less perseverative error than the 24-month-olds.

Theses of the Experiment-2B

Experiment-2B aimed to test that the Experimental treatment would facilitate the 26-month-olds’ performance even if the creator’s intention to represent something would not be verbally elaborated. That is, children could observe an adult’s intention to represent something, however, expect from the creator’s gaze behaviour and body posture no other cue is available to identify her intention.

6. We assumed that owing to the Social Treatment, 26-month-olds’ picture comprehension could be facilitated without the explicit verbal elaboration of the representational intention. That is, 26-month-olds are able to identify the creator’s representational intention from the creator’s intentional action (gaze behaviour and body posture), they do not need to be verbally informed about her intention to draw. Additionally, this increase in the performance would arise even if we would use different contexts for the Treatment and the Test phase.
RESULTS AND DISCUSSIONS OF EXPERIMENT-2

Experiment-2 aimed to test the effect of the Experimental treatment by using a separate Treatment and Test phase with different objects. Thus, Experiment-2 enabled us to conclude that children can generalize their newly acquired knowledge about the social origin of pictures from one context to another.

Additionally, Experiment-2A demonstrated a lower age limit of the social facilitation. While 26-month-olds unequivocally performed better in using pictorial information for problem solving, 24-month-olds rather showed contradictory performance. While in the 24-month-old age group, the Experimental Condition did not outperform the Control Condition in the picture retrieval task, only in the Experimental Condition did children’s performance exceed the level of chance. According to this finding, we cannot unambiguously reject the assumption that the availability of the creator’s intention enabled even 24-month-olds to better contextualize pictures.

Experiment-2A controlled for the effect of language use in the understanding of pictorial representations. Since the picture retrieval task was often criticised that it can be solved without the understanding of the representational relation between pictures and their referent only by using the same verbal label for the depicted object and the picture (e.g. Callaghan, 2000; Callaghan & Rankin, 2002; Hartley & Allen, 2014b). In Experiment-2A, we decided to control for the mediator effect of children’s different verbal level by using equally nameable familiar objects as hiding locations. If children would solve the retrieval task solely by using language codes, the same performance level would be revealed in both conditions. However, as the 26-month-old Experimental Condition outperformed the Control Condition, we could reject this alternative explanation.

Experiment-2A provided evidence that due to the Experimental treatment children could use their newly acquired knowledge about the social origin of pictures in a separate Test phase with novel objects and their representations. However, as children could infer the creator’s intention to draw—similarly to Callaghan and Rankin’s study (2002) but counter to Preissler and Bloom’s study (2008) – not only from the creator’s intentional action but from the creator’s verbal statement (“I am going to draw you something.”), thus, it remained unclear whether the intentional action itself, or the intentional action and the verbal elaboration of the intentional action together could explain the facilitative effect of our Social Treatment. Hence, in Experiment-2B, we applied a nonverbal
Experimental treatment, and we revealed similar contradictory performance as with the 24-month-old age group in Experiment-2A. While the 26-month-old participants in the Experimental Condition did not show better performance in the picture retrieval task than the Control children, only in the Experimental Condition did children’s performance exceed the level of chance. Thus again, we cannot reject the assumption that the Experimental treatment without verbal elaboration of the creator’s drawing intention can facilitate 26-month-olds understanding of pictorial symbolic objects.

Consequently, in Experiment-2, we successfully replicated the facilitative effect of the Social Treatment – introduced in Experiment-1 – in a younger age group, in 26-month-olds (See Figure-2. Errorless retrievals in the two conditions and two age groups of Experiment-2A and of the two conditions of Experiment-2B). Nevertheless, Experiment-2 raised several further questions that future research is required to answer. As the Social Treatment could not facilitate unequivocally the picture comprehension of 24-month-olds and of 26-month-olds in the nonverbal Experimental Condition, however we cannot reject the facilitative effect in these groups either, the question emerges if we modified the procedure of Experiment-2, would the Social Treatment facilitate children’s performance in the latter two groups as well.

**Figure-2:** Errorless retrievals in the two conditions and two age groups of Experiment-2A and the two conditions of Experiment-2B
CONCLUSIONS

- 24-30-month-olds performed better in using pictorial information for problem solving if they could understand a drawing person’s intention and action to visually represent something in current reality.

- The better picture comprehension did not occur if children in the Control treatment simply followed the identification of the specific referent of pre-drawn pictures without their social context.

- Experiment-1A provided evidence that due to the Social Treatment, children could better contextualize the online drawn test-pictures.

- Experiment-1B unequivocally demonstrated that due to the Social Treatment, children’s retrieval performance was facilitated even if they had to understand pre-drawn test-pictures whose social origin was not available.

- Although in the classical retrieval task (e.g. DeLoache, 1987), 24-month-olds performed only at the level of chance and 30-month-olds found the hidden object in about 80% of the trials, in Experiment-1, with 24-30-month-olds, we did not find an age effect.

- While we found higher retrieval performance in the Experimental Condition than in the Control Condition, this better performance did not result in less perseveration.

- As in Experiment-2 we used a separate Treatment and Test phase with different objects, our results confirmed that children can generalize their newly acquired knowledge about the social origin of pictures from one context to another.
In Experiment-2A, we identified the age limit of the social facilitation. 26-month-olds unequivocally performed better in using pictorial information for problem solving if – due to the Experimental treatment – they could understand a drawing person’s intention and action to visually represent something in current reality.

While in Experiment-2A, the Experimental Condition of the 24-month-old age group did not outperform the Control Condition, only in the Experimental Condition did children’s performance exceed the level of chance. Thus, we cannot unambiguously reject the assumption that the availability of the creator’s intention enables even 24-month-olds to better contextualize pictures.

In Experiment-2B, we applied a nonverbal Experimental treatment to answer the question whether the intentional action itself, or the intentional action and the verbal elaboration of the intentional action together could explain the facilitative effect of our Social treatment.

While the 26-month-old participants in the Experimental Condition of Experiment-2B did not show better performance in picture comprehension, only in the Experimental Condition did children’s performance exceed the level of chance.
REFERENCES


