Integrating Conflicting Perspectives

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1. Introduction

"*Theory of mind*" describes the ability to impute mental states, such as beliefs, desires and intentions, to oneself and to other people. Usually we want to know why people did what they did and we wonder what they are going to do next. That is, everyday we try to predict and explain human behaviour. In order to do this we refer to a person's beliefs, desires, emotions, intentions etc. Behaviour is the product of belief and desire: People do things because they *desire* something and *believe* some act will achieve it. For adults it is clear that our assumptions about reality do not necessarily match the real world; but we know, regardless of whether our beliefs are true or not, our beliefs direct our actions. In contrast, it is not until the age of 4 years that children understand that one can be mistaken about the world and that actions can be based on this false belief.

The most widely used measure for tapping these crucial changes in theory of mind understanding around 4 years is the *false-belief task* which was first devised by Wimmer and Perner in 1983. In their standard unexpected transfer task the protagonist puts an object in location A. In his absence the object is unexpectedly transferred to a different location B. Then the protagonist returns for the object, and the child is asked where he will look for the object. In order to answer correctly children must understand that the protagonist will act on the basis of his false belief rather than on the basis of reality. That is, he will look in location A and not in location B where the object actually is. Typically children pass this kind of task around 4 years of age (for a review and meta-analysis, see Wellman et al. 2001).

The umbrella term *executive functions* refers to a long list of higher cortical functions which enable the conscious control of thought and action. Ozonoff et al. (1991) describe executive functions as "the ability to maintain an appropriate problem-solving set for attainment of a future goal; it includes behaviors such as planning, impulse control, inhibition of prepotent but irrelevant responses, set maintenance, organized search, and flexibility of thought and action" (p. 1083). The anatomical correlate for executive functions is believed to be the prefrontal cortex (e.g. Luria 1966).

At about the same age that children master the false-belief task they also improve markedly in self control: Around the age of 4 years children master a host of executive function tests. An example of these tasks is the *Dimensional Change Card Sorting task* (DCCS task; Frye et al. 1995) in which cards bearing pictures that vary in two dimensions have to be sorted first according to one dimension (e.g. colour) and then according to another dimension (e.g. shape). Two target cards, each affixed to one of two sorting boxes, are used. They depict for instance a red apple and a blue pear. The test cards (red pears and blue apples) match one target card on one dimension and the other target card on the other dimension. In the pre-switch phase children are told a pair of rules, e.g. the colour rules: They are asked to sort all the blue ones into the box portraying something blue and to sort all the red ones into the box displaying something red. Typically 3-year-olds have no problems when sorting the cards according to one dimension. In contrast, they usually have difficulties in the post-switch phase when the sorting rules change: Now the cards should be sorted according to the opposite dimension, e.g. according to shape. It is not until the age of 4 years that children continue to sort correctly after the sorting criterion has switched.

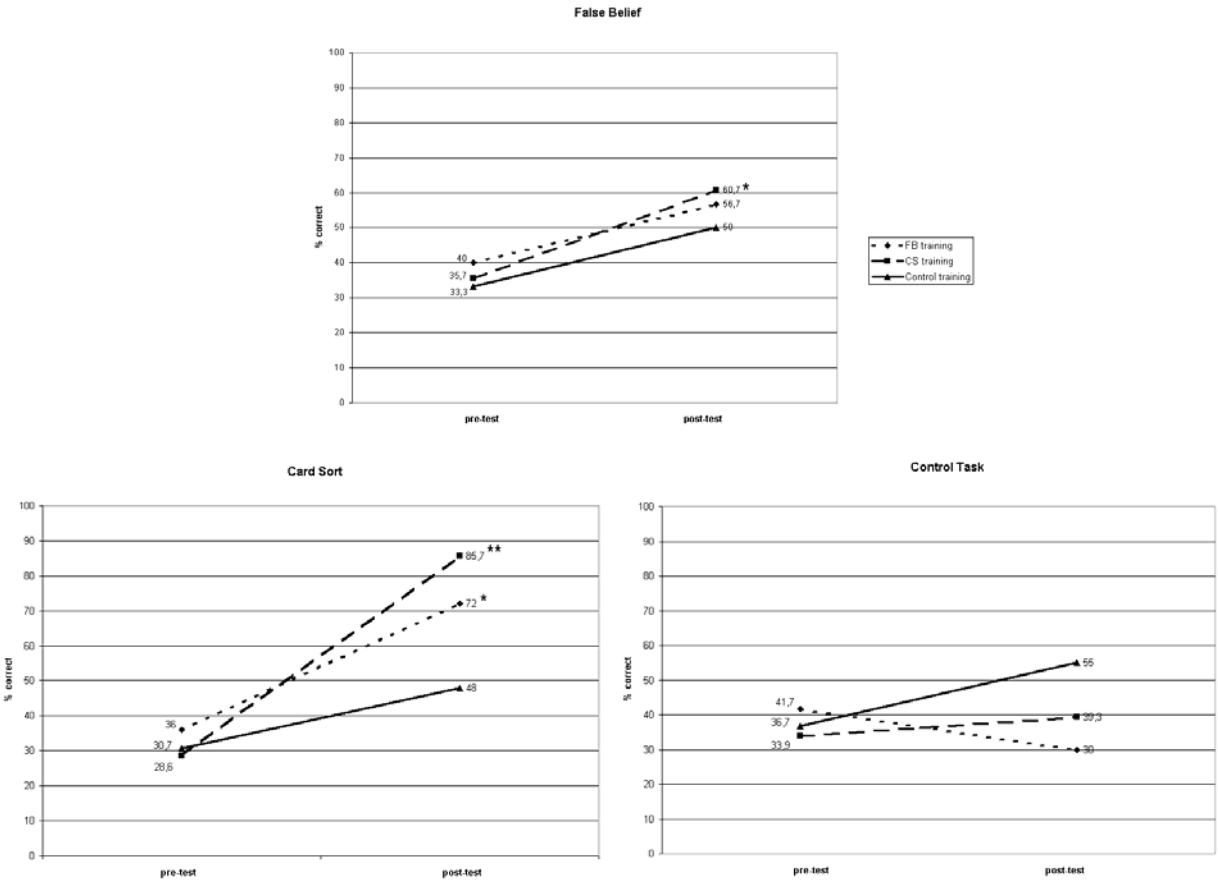
That is, at around 4 years of age children improve markedly on theory of mind tasks (like the false-belief task) and executive function tests (like the DCCS task). Furthermore, several recent studies have demonstrated correlations between theory of mind tasks and executive function tasks in the age range of 3 to 5 years (for a review, see Perner and Lang 1999). Specifically, Frye et al. (1995) and Perner et al. (2002) have reported correlations between the false-belief task and the DCCS even when age and verbal intelligence is partialled out.

Despite a host of correlational research, the specific nature of this relationship between theory of mind and executive functions is far from clear. Correlational studies cannot inform us whether this developmental link is causal. Therefore, in order to gain better insight into this developmental coincidence we put a *training study* into effect.

2. Training theory of mind and executive functions

After a pre-test, 44 children (22 girls and 22 boys) who failed one of two test questions of a false-belief task or sorted more than one card (of five) incorrectly in the post-switch phase of the DCCS were randomly allocated to one of three training groups matched for false-belief and card sorting performance. The false belief (FB) group (8 girls and 7 boys) was trained on false-belief tasks, the card sorting (CS) group (7 girls and 7 boys) was given a training on executive functions using the DCCS, and the control group (7 girls and 8 boys) was trained either on relative clauses or on Piagetian number conservation tasks.

Training started about one week after pre-test. Each child participated in two training sessions within approximately one week of each other. The post-test including three near transfer tasks (a false-belief test, a card sorting task and a control task) and one distant transfer task (a newly developed card sorting task using three different targets and three different test cards) was given about one week after the second training session. The pre- and post-test sessions were conducted by a male experimenter who was blind to the training group membership of the children. Training was carried out by a female experimenter.



Figures 1 presents performance changes between pre- and post-test on the various tasks. The data were analysed in the following way: First, in each training group *false belief* performance at pre-test was compared to post-test performance. Only the card sorting group showed a significant improvement achieving 36% correct at pre-test and 61% correct at post-test. The pre-post-comparison in the false belief group (pre-test: 40% correct; post-test: 57% correct) and in the control group (pre-test: 33% correct; post-test: 50% correct) failed to reach significance.

On the *DCCS task* the card sorting group improved markedly from 29% correct sorts at pre-test to 86% correct sorts at post-test. The pre-post-comparison (36% correct vs. 72% correct) was also significant in the false belief group. In the control group there was no significant difference between pre- and post-test. None of the training groups showed a significant improvement on the *control task*.

On the distant transfer task, the *3-boxes card sorting task*, children in the card sorting group performed better (93% correct) than the other two groups (false belief group: 70% correct; control group: 64% correct). But a significant difference was only found between the card sorting group and the control group.

Concerning the card sorting training one might suspect that children have only acquired a simple response rule like: "If the experimenter suggests playing a new game, I have to reverse my actions." But such a reversal rule cannot be applied to the 3-boxes card sorting post-test used as distant transfer task. Nevertheless, children in the card sorting group were almost perfect (93% correct) in this task, and they performed significantly better than the control group. Therefore, the transfer effects on the 3-boxes card sorting task suggest that children learned something which goes beyond the immediate task context.

To summarize, this training study showed mutual transfer effects between theory of mind and executive functions, at least concerning the false-belief test as an indicator of theory of mind performance and the DCCS task as a measure of executive functions: The false belief training led to a significant rise in card sorting performance, and the executive training significantly increased children's performance on the false-belief task. Perhaps, neither theory of mind is a prerequisite for executive functions nor self control is a prerequisite for theory of mind. In contrast, the present results support the existence of an underlying cognitive factor which is necessary for solving the false-belief test as well as for mastering the card sorting task. Of course, we don't know what exactly children realized or learned during the training. But they might have become aware of the fact that a single entity (e.g. a certain situation or a certain object) can be represented in two different ways.

3. The perspectival relativity of representations

To master the false-belief task or the DCCS children must understand the perspectival relativity of representations. They must recognize that sometimes "…we hold different perspectives about the real world at the same time and place. The only way to bring this information into a single perspective is to mark the contents as different ways in which the world is conceived (represented), i.e., as different perspectives." (Perner et al. 2001, 5)

To clarify, a false belief is a (mis-) representation of reality and must be distinguished from the correct representation of reality. Similarly, in the DCCS the post-switch dimension provides a new perspective on the test cards which conflicts with the pre-switch dimension. In both tasks children must understand that one thing can be connected with two contradicting representations at the same time and place because the salience of the actual location of the object in the false-belief task as well as the salience of the pre-switch dimension in the DCCS prevent children from simply switching perspectives. Perhaps, this *perspective problem* (Perner et al. 2001) can explain the strong developmental relation between the false-belief test and the card sorting task.

Further evidence for this explanation comes from one of our recent experiments: As noted above, in the standard DCCS task children must sort cards, displaying for example a blue apple, first according to colour and then according to shape. If children have difficulties describing this single entity (the blue apple) first as an apple and then as something blue, visually separating the two dimensions should improve their performance. Therefore, instead of cards with, for example, blue apples, we introduced cards displaying an outline of an apple next to a splotch of blue.

We tested 32 children aged 36 to 55 months. Each child was given one of four different versions of the card sorting task: In addition to the standard version, a version with dimensions separated on test and target cards, a version with dimensions separated only on test cards and a version with dimensions separated only on target cards were used.

If colour was detached from shape on test cards children performed significantly better. Separating the two dimensions on the target cards had no significant effect. Thus, children seem to focus their attention on test cards (which have to be sorted), and disentangling the two dimensions on test cards significantly enhances children's ability to switch to another sorting criterion. This might be due to the fact that children must no longer connect one entity with two contradicting representations, that is, they must no longer distinguish between *sense* and *referent*.

This distinction between sense and reference was emphasized in 1892 by the German philosopher and logician Gottlob Frege. He noted that "the morning star" and "the evening star" both refer to one and the same entity, to the planet Venus. These two expressions denote Venus in virtue of different properties that it has (being visible at dawn or at sunset respectively).

According to Frege, the reference of an expression (e.g. "the morning star") is the actual entity corresponding to it (e.g. the planet Venus). In contrast, the sense of an expression, the "mode of presentation", refers to the cognitive concept associated with this expression. This cognitive concept is in some way objective, it is not just a subjective representation held by a single individual (Frege 1892, 29-30). Perhaps, to master the false-belief task and the card sorting task children must understand that one entity can be represented by different – in this case by contradicting – cognitive concepts. The contradiction arises from the fact that in these tasks different "modes of presentation" ("blue thing" vs. "apple"; "is in location A" vs. "is in location B") implicate different actions.

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