

Thesis for the Degree of Doctor of Philosophy (Ph.D.)

**EMOTIONS AND AN EVOLUTIONARY
ESTABLISHED AVOIDANCE RESPONSE IN
FALSE BELIEF TASKS CONDUCTED WITH
5-8-YEAR-OLD CHILDREN**

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The goal of the dissertation

Theory of mind means our capability to identify mental states of other people knowing that their thoughts and behaviors are governed by intentions and emotions. Children very early, by four years of age, become capable of mindreading. False belief tasks are tests measuring mind reading skills. Our research was designed to investigate children's performance on false-belief tasks impaired by task content. Our goal was to activate an early-developing motivational system known as predator-avoidance.

This dissertation describes the results of two research set ups used to investigate predator avoidance in elementary school aged children (kindergarteners, first and second graders). Our main idea was that death or injury from predators has posed a persistent and pervasive threat to young children throughout the course of human evolution and natural selection would have favored early, reliably developing psychological mechanisms in children for predator-avoidance. The first study explored the idea that these evolutionarily-canalized responses, which are strongly reality-based and focused on solving specific adaptive problems, compete with more abstract and domain-general reasoning processes, such as theory of mind. The specific focus of this study was the detailed exploration of those cognitive processes that underlie solving adaptive problems in children. However, the second study was based on the hypothesis that strong emotional responses are evoked when children are faced with a story that incorporates a wild predatory animal chasing a prey with the goal of catching and eating it. In this study our goal was to modify children's emotional states before test taking so photos of growling wild animals and docile domesticated animals were presented for them before the false belief tasks.

With these studies we wanted to gain an answer whether general cognitive abilities, like executive functioning (e.g. inhibitory skills), are the more important when taking these false belief tasks, or achievement on these tasks does not relate to higher level cognitive abilities but to heightened emotional states. In other words: we wanted to know whether Predator Avoidance is based on domain specific or domain general abilities.

The first study

Goal

In this study our goal was to explore those cognitive processes that can predict performance on false-belief tasks involving a predator in 5-8 year old children. It is expected that a canalized response system, triggered by a predator-avoidance task, would impair false belief attributions as children do not focus their attention on the false beliefs of the other person. The purpose of the current study was to determine those aspects of executive functioning, including inhibitory control and working memory that correlates with performance on a Predator-Avoidance task.

Hypotheses

1. According to our hypothesis children would provide more false answers in the Predator Avoidance task than in the Playmate Avoidance task.
2. Supposedly the better inhibitory skills a child possess, the better he/she would do on the avoidance tasks.
3. According to our hypothesis older children would achieve higher scores on the false belief tasks than the younger participants, as they convey higher level cognitive skills.
4. It was hypothesized that children with better working memory would also do better on the false belief tasks.
5. It was supposed that those who have higher executive functioning scores would provide a better achievement on the false belief tasks.
6. We also made an assumption that those who can solve the false belief tasks will be able to provide satisfying explanations for their answer choices.

Methods

In this study, children were given a battery of cognitive tasks designed to measure different aspects of executive functioning, such as memory, working memory and inhibition. Additionally children were presented with two false belief tasks involving predator-avoidance and playmate-avoidance.

Originally 70 children took part in the study of which 61 was chosen for analysis. All participants were tested individually in an elementary school in the USA. All tasks were administered in a single session that lasted about 20-30 minutes. The sessions were videotaped with consent from child and parent. The tasks were administered in the same fixed order:

1. Day/Night Stroop
2. Simon Says
3. False Belief Task (the order of Predator Avoidance and Playmate Avoidance were randomized across participants)
4. Digit Span Forward and Backward
5. Listening Span
6. Counting Span.

The two types of analogous false belief tasks were utilized, Playmate Avoidance and Predator Avoidance, involving two playmates (Horse and Goat) in the first type and predator (Lion) and a prey (Zebra) in the second. In both scenarios one animal character was chasing the other. In the stories, the chased animal saw the chaser hide behind an obstruction (tree or a rock) to have a little rest. Once the animal was hidden, the chased animal went to the pond for a drink, where it could neither see nor hear what the chaser is doing. While the chased animal was drinking, the chaser moved from behind one obstruction (e.g. tree) to the other (e.g. rock). After drinking, the evading animal decided to return home from the pond. It can choose one of two pathways: one goes past the trees and the other past the rock. The child was asked which pathway the chased animal will choose.

The Main Result of the First Study

Data analysis didn't reveal any relationship between level of executive functioning and achievement on the false belief tasks. Children's achievement on the executive functioning tasks did not predict the level of achievement on the false belief tasks.

Second Study

Goal

The result of the first study further strengthened our hypothesis that predator avoidance is an evolutionary adapted response arriving early in development which has no relationship with higher level executive functioning skills.

In the second study it is assumed that this mechanism is rooted in children's rapid change of emotions. An experiment was designed to modify the emotional states of children belonging to the experimental group by presenting photos of animals to the participants that evoke strong emotions from the children. However, in this study four false belief tasks were utilized (instead of two): Playmate Seeking, Prey Seeking, Playmate Avoidance, Predator Avoidance. Where the task content was happy, like the Playmate Seeking and Playmate Avoidance tests, children were presented with photos of cute domesticated animals before conducting the actual test. However, prior to the Prey Seeking and Predator Avoidance Tasks photos of growling predatory animals were displayed to the subjects to modify their emotional states.

Hypotheses

7. It was supposed that members of the experimental group would achieve lower scores in the Predator Avoidance task in contrast with the control group.
8. No differences were expected between experimental and control groups regarding the seeking tasks in general.
9. No differences were expected between experimental and control groups regarding the Prey Seeking Task.

10. According to our hypothesis members of the older age groups (7-8 year olds) would achieve better scores in the seeking tests than member of the younger age group (5-6 year olds).
11. It was supposed that there will be no significant differences in the achievement on Predator Avoidance task regarding the different age groups.
12. It was assumed that children providing a correct answer on the false belief tasks will be able to provide logic explanation for their choices.

Methods

103 children participated in the study, 51 (24 males and 27 females) belonging to the experimental group and 52 (23 males and 29 females) belonging to the control group. Children's age ranged from 5 to 8. Children were tested individually, in a small study room in the kindergarten or elementary school of the participating Hungarian Institutions. The tests were conducted in an approximately 20-minute-long session.

The order of false belief tasks were randomized among participants similarly to the first study. Members of the experimental group were presented pictures of growling, wild animals on the computer screen by a Power Point presentation of 20 pictures changing every 5 seconds. The purpose of the pictures was to evoke emotions from the children which supposedly influence their achievement on the false belief tasks.

Stories were acted out on the same set used in the first study. Besides the avoidance false belief tasks, seeking false belief tasks were also utilized in this study. These were very similar to the avoidance tasks but here the chased animal hid behind the trees and the chaser went to the pond.

Two animal characters (Dog and Pig) being in a friendly relationship acted in the Playmate Seeking task, whereas a predator (Tiger) and prey animal (Deer) were the main characters of the Prey Seeking task. In the stories, the animals were chasing and the chase saw the chased animal to hide behind an obstruction (tree or a rock) to rest. Then the chaser animal

went to the pond, where it could neither see nor hear what the chased animal is doing. While the chaser is at the lake, the chased animal moves from behind one obstruction (e.g. tree) to the other (e.g. rock). Following the chaser decides to look for the chased animal. It can choose one of two pathways: one goes past the trees and the other past the rock. The child was asked which pathway the chaser animal will choose.

The Main Result of the Second Study

The most important outcome of the second study was the fact that children belonging to the experimental group achieved lower scores on the Predator Avoidance Task than children belonging to the control group. Consequently it is supposed that the emotions evoked by the pictures interfered with logic answer choices in the Predator Avoidance task allowing for the conclusion that it activated an evolutionary canalized motivational system.

Summary of Results

To summarize the results of the two studies they were sorted in five major areas: (1) results gained from the false belief tasks, (2) results in connection with the executive functioning tasks, (3) characteristics of different age groups, (4) result based on experimental and control groups and (5) answer choice explanations of false belief tasks.

Results gained from the false belief tasks

Both of our studies proved our original hypothesis: children performed worse in the Predator Avoidance task than in the Playmate Avoidance task (hypothesis 1) or the seeking tasks. While 61% of the participating children provided correct answers in the Playmate Avoidance task, only 36 % of the children discovered the appropriate solution in the Predator Avoidance task. In case of both genders there was a tendency for children provide a correct answer in the playmate Avoidance tasks if they answered the Predator Avoidance task appropriately. These results indicate that there is a tendency in children, independent of gender and age, to do wrong on the Predator Avoidance task and even if they provide correct answers for the seeking tasks and the Playmate Avoidance task.

Results in connection with the executive functioning tasks

Achievement on the false belief tasks were compared to the achievement on the executive functioning tasks in our first study, resulting in no correlations among them which could prove our hypotheses (hypotheses 2,4,5) that children with higher executive functioning skills would do better on the false belief tasks. These results indicate that false belief tasks utilized in our studies required exclusively the presence of domain specific abilities. These results further strengthened the assumption that predator avoidance is an existing psychological adaptation interfering with logic thinking in false belief tasks where a predator chases a prey animal with the intent to eat it.

Characteristics of different age groups

It was observed that the older a child was the better he/she achieved on the Playmate and Prey Seeking tests (hypotheses 3 & 10). These age differences in the seeking tasks prove that older children have an advantage in their cognitive abilities in contrast with younger children. While significant age differences were expected and observed in the seeking tasks, no significant age differences were expected in the Predator Avoidance task (hypothesis 11). Results proved this assumption: in the solution of the avoidance tasks there were no significant age differences. That also proved the hypothesis that predator avoidance is an ability to promote survival which was probably existent in our predecessors and appears as an automatic response in situations of fatal danger.

Result based on experimental and control groups

While there were no significant differences between experimental and control groups regarding the seeking tasks and the Playmate Avoidance task (hypotheses 8 & 9), subjects in the Predator Avoidance task achieved lower scores (hypothesis 7) than member of the control group and this difference approached significance level. The result of this experiment **allows for the assumption** that abilities needed for solving the false belief tasks were inhibited and a more important function took its place, which was the flight reaction, specifically in our study it was promoting the escape of the prey animal.

Answer choice explanations of false belief tasks

Almost half of the children participating in the first study and all of them in the second study provided an explanation why did they choose that particular pathway in the playmate seeking and predator seeking and avoidance tests. Children's explanations were sorted in three categories: belief, avoidance and other. According to our results both in the Playmate and Predator Avoidance tasks children's answers were in the avoidance category (e.g. Zebra doesn't want to get caught/eaten by Lion). Distribution of the three categories of explanation among the correct and incorrect answers were significant in the utilized false belief tasks (hypotheses 6 & 12). In the majority of cases those children responding with an incorrect answer for the task provided an "avoidant" explanation for their answer choices. Supposedly they focused on escaping and logic thinking became repressed.

Publications related to the thesis

Bjorklund, D. F., Grotuss, J., & Csinady, A. (2009). Maternal effects, social cognitive development, and the evolution of human intelligence. In D. Maestripieri & J. Mateo (Eds.), *Maternal effects in mammals*, (pp. 292-321). Chicago: Chicago University Press.

Grotuss, J., Bjorklund, D. F., Csinady, A. (2007). Evolutionary developmental psychology: Developing human nature. *Acta Psychologica Sinica*. Vol. 39 No. 3, 439 – 453.

Lectures related to the thesis

Grotuss, J., Csinady, A., King, A. C., Ellis, B. J. & Bjorklund, D. F. (2009) Theory of Mind and Executive functioning in Predator-Prey Relationships, SRCD Biennial Meeting, Denver, Co, USA.

Csinády Adriána (2008) Elmeelméleti vizsgálatok 5-8 éves gyermekeknél. Tudományos Diákköri Konferencia, Debrecen. (Research of Theory of Mind in 5 to 8-year-old children, Scientific Student Conference, Debrecen, Hungary)

Csinády Adriána (2008) A család méretének és a testvérek számának hatása 5-8 éves gyerekek keresési és elkerülési téves vélekedés tesztekben nyújtott teljesítményénél, IX. Magatartástudományi Napok, Szeged. (The effects of family size and number of siblings on the achievement in seeking and avoidance false belief tasks among 5 to 8-year-old children, 9th Behavioral Sciences Conference, Szeged, Hungary)

Further publications

Molnár, R., Nyári, T., Hazag, A., Csinády, A. & Molnár, P. (2008) Career choice motivations of medical students and some characteristics of the decision process in Hungary. *Central European Journal of Medicine*, 3(4), 494-502.

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Csinády Adriána, Csörsz Ilona és Molnár Péter (2003) Az empátiás készség evolúciós programja és a koragyermekkori szociális környezet hatása segítő foglalkozásúaknál. IV. Magatartástudományi Napok, Pécs. (The evolutionary program and the effects of early social environment on the development of empathy among healthcare workers., 4th Behavioral Sciences Conference, Pécs, Hungary)

Csinády Adriána (2003) Pillanatkép a magyar orvostanhallgatók empátiás készségéről, Magatartástudományi Műhelybeszélgetések, Debrecen. (Empathic abilities among Hungarian medical students, Behavioral Sciences Workshops, Debrecen, Hungary)

Csinády Adriána és Komoróczy Károly (2002) Fájdalom – egy új lehetőség az alapemóciók kutatásában, III. Magatartástudományi Napok, Debrecen. (Pain – a new opportunity to research basic emotions, 3rd Behavioral Sciences Conference, Debrecen, Hungary)