Does Training in Inhibition and Working Memory Influence Analogical reasoning and Theory of Mind in Young Children?

Kristina Gotseva-Balgaranova (kgotseva@nbu.bg)
Milena Mutafchieva (mmutafchieva@nbu.bg)
Department of Cognitive Science and Psychology, New Bulgarian University, Montevideo 21, Sofia, Bulgaria

Abstract

The present study was conducted to determine the effect of inhibition and working memory training on analogical greasoning and theory of mind in young children. We present the results of 58 4-year-old children who were given a pre-test and post-test with analogical reasoning tasks and false beliefs tasks. Between the pre-test and the post-test a specific training was provided. Children were divided in three groups according to the type of the training: a) group with inhibition training; b) group with working memory training; c) control group with conservation tasks training. Each training was 7 days long, 25 minutes per child every day. The results showed a significant increase in the post-test results of the groups undergoing inhibition and working memory trainings. The performance of the children tested was significantly better on the post-test in comparison to both the pre-test and the control group. The results clearly indicated the relation of inhibition and working memory to analogical reasoning and false belief understanding, and also the importance of training such executive functions in order to increase other cognitive abilities.

Keywords: analogical reasoning; theory of mind; false beliefs; training; inhibition; working memory

Introduction

Our main research question explored whether there is an effect of executive functions on analogical reasoning and False Beliefs (FB) understanding.

Why is this question so important? Analogical reasoning and FB as a part of Theory of Mind (ToM) are recognized as crucial abilities in early cognitive development. ToM is at the core of social development (Premack & Woodruf, 1978) and analogical reasoning is essential to human cognition (Hofstadter, 2001). There is clear evidence that both are influenced by EF but most of the data are coming from correlational studies. The possibility to train EF and transfer the effects of training to analogy and FB would mean finding a way to support children's social and cognitive development.

Different definitions of analogical reasoning agree that it requires inference about relations. Precisely, reasoning about the similarity of relations that are held within the domain, rather than making inference about the similarity between features of objects (Gentner, 1983). So analogy can be defined as the ability to think about relational patterns (Holyoak, Gentner & Kokinov, 2001).

Some theoretical ideas and empirical data suggest that reasoning by analogy is an early-developing ability, present at around 3–4 years of age (Gentner, 1983; Goswami & Brown, 1990) or that even 13-month-old children can solve problem analogies depending on their knowledge on the situation (Chen, Sanchez & Campbell, 1997). Two main types of analogies are usually used for measuring the ability in early childhood – problem solving analogies and classical analogies. A well-known problem analogy is the "Genie problem" (Holyoak, Junn & Billman, 1984). In such tasks children are presented with two problems – the base and the target. The successful solution depends on the ability to map the relational structure of the base to the relational structure of the target and to transfer the solution from the base to the target (Gentner, 1983). Classical analogies always follow the structure ***A:B::C:D*** (for example: ***hand:gloves::feet:socks***). There are hypotheses claiming that they are harder for young children because they require more comparisons of the alternatives (Collins & Burstein, 1989; Chen, Sanchez & Campbell, 1997).

The connection between WM and analogy making is hypothesized by Halford (1993) who claimed that most important ability in analogical reasoning is storing conflict information in the WM and processing complex relations in parallel. In addition, the theory of cognitive complexity and control (CCC) claimed that inhibition plays a central role in analogical reasoning. The first possible answer that comes to mind is an association but it is not a relevant analogical answer. Thus the inhibition of this association is needed in order to make the right inference (Zelazo & Frey, 1998). Zelazo and Frey claimed that 3-year-olds have difficulties with this inhibitory mechanism and systematically make similar mistakes that can also be related to some memory limitations. According to the CCC theory, what is hard for young children is to "arrange" the relations in hierarchy and this overloads the WM (Zelazo & Frey, 1998). Manipulating the relations is difficult for young children because they need a certain WM capacity (Halford, 1993).

There is enough evidence to suggest a relation between analogical reasoning and the development of EF, especially inhibition and WM. In reasoning by analogy the selection of a common relational structure requires the inhibition of salient features of the other alternatives. A series of experiments found that if the association between A and B or C and D is weaker and the WM was overloaded, children display difficulties in response inhibition and thus, choose an irrelevant answer (Thibaut, French & Vezneva, 2010). In fact, when a young child is trying to establish structural similarity and this is in conflict with the tendency to rely on surface similarity, the inhibitory control and WM are needed

in order to make the right inference (Morrison et. al., 2004; Viskontas et. al., 2004).

The other main concept in the present paper is Theory of mind (ToM), which is a special competence for understanding the mind. It is our intuitive understanding of one's own and other people's mental states, such as thoughts, desires, beliefs, intentions, etc. When it comes to human species, this ability takes on a central role in consciousness and social cognition (Perner, 1998). By definition ToM is a specific cognitive ability to understand others as intentional agents. We interpret others' mental world and need to understand that their mental states could differ from our own, as well as from reality (Preemak & Woodruf, 1978).

ToM is an early-developing ability between 3 and 5 years of age, if measured with standard verbal tests (Wellman, Cross & Watson, 2001). At around 3 years of age they understand desires and true beliefs. At this age they interpret the mental world based on their own knowledge and are able to understand a true belief (TB) situation as long as a conflict with reality does not exist (Wellman & Bartsch, 1988). The next developmental step is false belief understanding, which is a prerequisite for the development of ToM, although by definition it refers to all mental states. FBs are different from our own beliefs and also different from reality. The most widely used standard tests for measuring this ability are "Sally-Anne" (change of location task) (Baron-Cohen, Leslie & Frith, 1985) and "Smarties" (deceptive box) (Perner, Leekam & Wimmer, 1987).

According to Perner (1998), in FB task inhibition is needed when there are two simultaneously existing schemes competing over which is more relevant to the given situation. He claimed FB tasks are, by their nature, executive inhibition tasks, because most FB tasks follow exactly this common structure of competing schemes (Perner, 1998). Performance on FB tasks is related to performance on EF tasks (Carlson et. al., 2004; Devine & Hughes, 2014). Furthermore, according to the emergence account, EF are a premise for the emergence of FB understanding, and children need a certain level of EF to recognize the possibility of having two perspectives regarding one and the same situation (Carlson & Moses, 2004). Standard FB tasks pose quite a challenge to young children and if they have difficulties with inhibitory control, they might give the wrong answer. The common mistake they make might also be explained by the last information held in the WM, which is exactly the wrong answer (Wellman & Bartsh, 1988). Limited working memory itself causes children to try out different strategies (Carpenter, Call & Tomasello, 2002). A well-developed WM alone is not enough, but in combination with inhibition, the influence on FB might be crucial to the relation between EF and FB (Carlson, Claxton & Moses, 2015).

A deficit in the data cited above is that the majority come from correlational studies. To the extent of our knowledge, after 20 years of research in the field, there was only one study to include EF training, precisely inhibition (with card sorting exercise). The results showed that after the inhibition training, children performed significantly better on the FB post-test. There was no other improvement measured, even after the FB training (Kloo & Perner, 2003).

With regards to analogical reasoning, a longitudinal study with 539 participants confirmed the relation with EF. Initially children were tested at 54 months of age with tests for EF, vocabulary, memory and attention. The second test consisted of classical verbal analogies (for measuring analytical thinking) and was done when children were 15 years of age. Results showed clear relations between early EF and later analytical thinking. Significant relations to short term memory and attention were not found (Richland & Burchinal, 2012).

Experimental Study

The goal was to test whether training in inhibition and working memory could improve children's performance on analogy and FB tasks. In addition, we conducted different training programs in order to test their influence on both abilities of interest separately.

Hypothesis: A) Training inhibition will significantly improve children's performance on FB and analogical tasks; B) Training WM will significantly improve children's performance on FB and analogical tasks.

Design: A mixed design was used.

Within-subject factor with two measurements: pre-test and post-test for each child with FB tasks and analogy tasks. Also the improvement in inhibitory control, WM and conservation were tested.

Between-subject factor with three levels: A) experimental group (EG) with inhibition training; B) EG with WM training; C) control group (CG) with conservation tasks training.

Dependent variables: A) children's scores on the FB tests and on the analogy tests; B) children's performance on inhibition, WM and conservation tasks.

Independent variable: the type of training in each group.

Stimuli

The FB test consisted of 4 videotaped tasks – 3 FB and 1 TB, which was used as a control task. In the FB task the child had to adopt the perspective of the protagonist regarding the content of a container, which was changed while s/he was outside the room. The test question was always the same "What is in the bag according to…?" Key aspects of the story's structure are presented in Figure 1. Initially, a book was in the bag and while the princess (the protagonist) was outside the room, a dice was placed in the same bag. In the TB situation the protagonist is present while the object is changed.

Figure 1: Images from one of the videotaped stories showing how the FB is created while the protagonist is not present.

The analogy test consisted of 10 tasks – 7 classical analogies (A:B::C:D, Figure 2) and 3 problem analogies, such as the "Genie problem" (Holyoak, Junn & Billman, 1984), which was used originally in our test.

Figure 2: An example of classical analogy used in the analogical test.

For the inhibition training various tasks were used: card sorting tasks and motor inhibition tasks (Diamond, Kirkhman & Amso, 2002); other Stroop-type tasks with cards of fruit and vegetables in unusual colors.

WM tasks were divided in two categories for both components (Badeley & Hitch, 1974): A) visuo-spatial sketchpad – memo games, Corsi-block test adapted for children (Vandierendonck et. al., 2004), picture recognition tasks, etc.; B) phonological loop – audio tapes with lists of animals, objects, numbers, colors, which should be recalled in different sequences (for example: the list is "dog, elephant, bee", one way of recalling is by rearranging them according to size, starting with the biggest one).

For the conservation training standard tasks of Piaget were used with real objects like coins, play-doh, paper clips, plastic cups, etc.

Procedure

The procedure of the study consisted of 2 measurements for each child in each group (pre-test and post-test, both consisting of FB and analogy tasks). The groups differed by the type of training provided (inhibition, WM and conservation). Each of the three trainings lasted 7 days, 25 min. of individual work per day. Every day children solved different tasks with an increasing level of difficulty. The analogy test and FB test were the same for each phase of the study. The pre- and post-test phases lasted 2 days each, because children were testes with FB and analogies in different days. The post-test phase started the day after the training finished. The procedure was double blinded and every day different expert worked with the children during the tests and the trainings, in order to diminish the comfort in working with one and the same person every day. Feedback for the participants was provided only during the trainings, no matter if the answer was correct or wrong, the experimenter helped the child to explain the logic of the solved task. Participants were not informed in any way that the tasks might be related to FB or analogy tasks.

The whole period for finishing a procedural cycle was 2 weeks for each child. The original language of the study is Bulgarian and the cited instructions are translated in English for the current paper.

During the FB test participants were excluded from the final sample if answered correctly to the three FB tasks or wrong to the TB task (3 children excluded because of this criteria). Children were also removed for having maximum score on the analogy test (2 children excluded).

Regarding the training phase in each group, the inhibition, WM, and conservation training programs were conducted under similar conditions regarding duration and increasing difficulty of the used tasks.

In the inhibition training every day children were exposed to 6 different exercises. An example for easier task is the card sorting task "day and night" (Diamond, Kirkhman & Amso, 2002) where children have to say day to the moon and night to the sun. The tasks with higher level of difficulty have changing rules as for example, the child has to sort cards in two boxes according to shape (small and big stars and small and big balls). Than the rule is changed and the cards should be sorted according to color (all the blue shapes in one box and all the red shapes in the other box). The motor inhibition tasks are games like: *"If I knock on the table once, you knock twice, and if I knock twice, you knock once"*. Harder tasks of this type include for example arms and legs ("*If I clap with my hands, stomp your feet, if I stomp my feet, you clap with your hands"*).

In the WM training every day children were exposed to visuo-spatial sketchpad and phonological loop exercises. Easy tasks for the first component are picture recognition tasks *("How many ducks were there in the picture you saw?"; "What was the color of girl's dress on the picture you saw?"*, etc.). For the last days in this training the tasks are memory-card-games with 6 pairs of animals or Corsi-block test with 3 or 4 glowing squares. Example of an easy phonological loop exercise is when the child has to remember 3 animals and make a backward recall. For the last days the audio tapes consist of 4 or 5 digits, colors that have to be recalled rearranged according to a rule.

The level of difficulty in the conservation training is based on the used dimensions for the child's and experimenter's sets. Dimensions like number were used during the first days, for example two sets of an equal number of coins. The experimenter transforms one of them by spreading it farther and asks "*Does this row have more coins or this row have more coins?"*. Dimensions like volume and weight were used during the last days of this training.

Participants

The final sample of the study consists of 58 children with an average age of 54 months, divided as follows: A) EG inhibition – 20 children; B) EG WM – 18 children; C) CG – 20 children. The sample was balanced according to gender.

Results

The statistical analysis was done in SPSS, Repeated measures analysis. The results for each comparison are shown in Figure 3, Figure 4 and Figure 5.

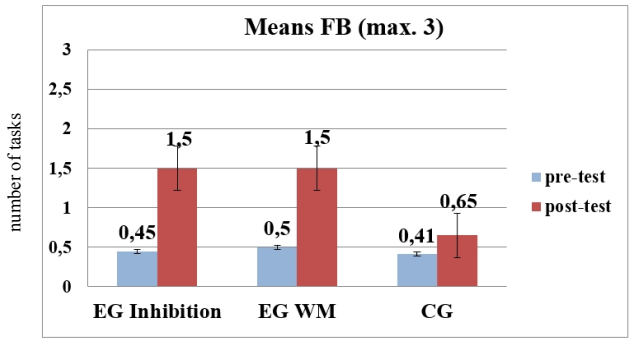

Figure 3: Means for FB measurements in all groups.

The results for FB understanding showed that there was a main effect of the manipulation, F(2;55)=3.61, *p=.034* and an effect of the within-subject factor, F(1;55)=18.24, *p<.001*. The interaction between the variables (type of training and FB performance) was with a marginal significance, F(1;55)=2.51, *p=.090*. The within-subject analysis showed an effect of the inhibition and WM trainings, but not of the conservation task training. In the EG inhibition children were significantly better on the post-test in comparison to the pre-test (F(1;19)=18.26, *p<.001*), and the same applies to the EG WM (F(1;17)=7.65, *p=.013*). There was no improvement between the pre- and post-test in the CG (F(1;19)=0.432, *p=.519*). Between-subject analysis presented with effect size (ES) showed that on the pre-test all children were at a similar starting level (EG inhibition and CG, ES=0.07; EG WM and CG, ES=0.14; EG inhibition and EG WM, ES=0.06; *p=.918*), differences were not expected to occur in this phase. In the post-test it turned out, that there are big differences between some of the groups: A) no difference between the two experimental groups, ES=0 (*p=1*); B) but there is a difference between the EG inhibition and the CG, ES=0.86 (*p=.012*); C) also a difference between the EG WM and the CG, ES=0.84 (*p=.015*).

The whole test for analogical reasoning consists of 10 tasks (7 classical + 3 problem analogies), so the final score (max. score) is 10. The means for the pre-test phase are: EG Inhibition, M=4.35; EG WM, M=4.39; CG, M=4.55. For the post-test: EG Inhibition, M=7; EG WM, M=6.94; CG, M=5.

There is an effect of the within-subject factor, e.g. the children are better on the post-test (F(1;55)=78.566, *p<.001*). There is no effect of between subject factor (manipulation effect, F(2;55)=1.3, *p=.284*). Keeping in mind that some researchers claim that perhaps the abilities that underlie classical and problem analogies could be not the same, we decided to analyze the data separately for both types of tasks.

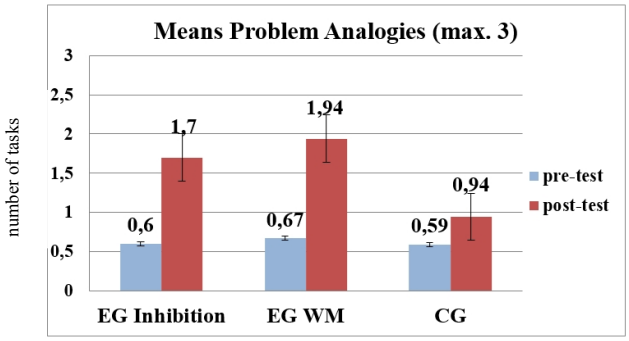

Figure 4: Means for problem analogy measurements in all groups.

For problem analogies the analysis showed a main effect of the manipulation, F(2;55)=5.09, *p=.009* and also an effect of the within-subject factor (the difference between pre-test and post-test), F(1;55)=6.27, *p<.001*, there is an interaction between the variables, F(2;55)=6.17, *p=.004*. All these results are caused by differences in the experimental groups. The interaction between the variables means that the training provided determined children's success on FB and analogy tests. There was an effect of both trainings in the two experimental groups and children significantly improved their performance on problem analogy tasks during the post-test in comparison to the pre-test – EG Inhibition, F(1;19)=29, *p<.001*; EG WM, F(1;17)=32, *p<.001*. In the CG this difference (F(1;19)=4.41, *p=.083*) is a marginal one, which was rather unexpected, because the mean values were almost equal. A more detailed look at the results showed that this difference was due to the increased results of two children, who solved an additional task on the post-test in comparison to the pre-test. Between-subject analysis for the pre-test in effect size showed that children started at the same level (EG inhibition and CG, ES=0.07; EG WM and CG, ES=0.17; EG inhibition and EG WM, ES=0.02; *p=.86*), but in the post-test the groups differ as follows: A) slight difference between the two experimental groups, ES=0.3 (*p=.35*); B) big difference between the EG inhibition and the CG, ES=1 (*p=.002*); C) big difference between the EG WM and the CG, ES=1.3 (*p<.001*).

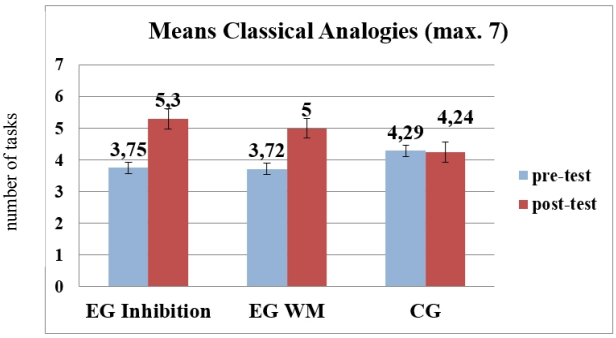

Figure 5: Means for classical analogy measurements in the three groups.

For the classical analogies there was no main effect of the manipulation, F(2;55)=0.308, *p=.736*, but there was a significance of the within-subject factor, F(1;55)=28.85, *p<.001*, also an interaction between the variables, F(2;55)=6.86, p=*.002*. Within-subject analysis demonstrated that the increase in the EG Inhibition was significant, F(1;19)=24.71, *p<.001* as well as in the EG WM, F(1;17)=21.2, *p<.001*. In the CG there was no difference between the two measurements, F(1;19)=0.023, *p=.88*. Between-subject analysis showed that the balance of the sample between the groups for the pre-test was good, because there are no differences between the groups (EG inhibition and CG, ES=0.14; EG WM and CG, ES=0.17; EG inhibition and EG WM, ES=0.02; *p=.74*). In the post-test the differences presented in effect size are medium and only one is significant: A) between the EG Inhibition and the CG, ES=0.6 (*p=.048*); B) the EG WM and the CG, ES=0.5 (*p=.15*); C) between the two experimental groups, ES=0.18 (*p=.625*).

Additional within-subject analysis showed that the performance on every 7-days-trained ability improved significantly between the 1st and last day of performance: A) inhibitory control, F(1;19)=28.97, *p<.001*; B) WM, F(1,17)=12.9, *p=.002*; C) conservation, F(1;19)=5.04, *p=.037*. These results demonstrated once again the effectiveness of the EF trainings and their relation to FB understanding and analogical reasoning. The ability to understand conservation increased too, but did not transfer to the measured abilities.

Discussion

After the results in the present study, we can state that children significantly improved their performance on FB and analogical tasks after training in inhibition and WM. Such results are not common in previous studies, which used mostly correlations. To the extent of our knowledge, there was only one study with inhibition training and transfer to FB (Kloo & Perner, 2003). In our study there was no improvement in children's results in the CG, so we can say that our trainings had an effect. We can also state that the present effect was not due to learning effect because of the identical tasks on the pre-test and post-test. In future research we will try to find out whether this effect remains stable over time. There are studies showing that the effects of such training programs in EF could be retained over a period of one year regarding academic abilities (Dias & Seabra, 2016).

In addition, we can conclude that children's success in solving FB and analogical tasks depends on inhibition and WM. All of the children tested performed significantly better on all post-tests used in comparison to the pre-test. Regarding FB understanding, there is evidence demonstrating that this ability depends on good inhibitory control (Perner, 1998; Kloo & Perner, 2003) and also on WM (Carpenter, Call & Tomasello, 2002; Rubio-Fernandez & Geurtz, 2013). According to Carlson *et al.*, the FB task is a conflict inhibitory control task and requires effort, as well as good inhibitory ability, and WM participation for holding and manipulating the whole information in order to give the right answer (Carlson, Moses & Breton, 2002). As mentioned above, the combination of inhibition and WM might be crucial to FB understanding (Carlson, Claxton & Moses, 2015).

The results concerning the analogy test are very intriguing. They showed within-subject differences in classical analogies. Additional analysis showed that even on the pre-test children's success is above the chance level (T(54)=14.56, *p<.001*). We can explain this with the fact that it is possible for the children at this age to already have the ability to solve classical analogies. This claim is in contradiction with other explanations that problem analogies are easier for young children (Collins & Burstein, 1989). On the other hand, Goswami and Brown (1990) explained that if children have enough knowledge about the objects and the relations, they could solve classical analogies even at 3-4 years of age. The children tested showed high success in classical analogies in all groups, even in the CG, but the within-subject differences showed a significant improvement only in the experimental groups where children were provided with trainings in EF.

Regarding problem analogies, between-subject differences were found as well as within-subject ones. Children performed significantly better on the post-test rather than the pre-test in both EGs. Unlike the classical analogy tasks, here the between-subject analysis showed significant differences with the CG. Present results for the whole analogy test are consistent with previous claims that both inhibition and WM are needed for an analogy task to be solved (Morrison et. al., 2004). This provides additional evidence in support of our hypotheses.

Another aim of the study was to isolate the influence of inhibition and WM on FB and analogy. For now, we can statethat there was no difference between the two EGs regarding the FB test and problem analogies. This is consistent with the claims of Carlson, Moses and Breton (2002) and Morrison et. al. (2004). In the future we plan to add another EG with training in inhibition and WM together in order to see if the effect will be stronger. Our contribution to the field is the finding that each of these factors is enough to have an effect on children's ability to solve FB and problem analogies. Regarding classical analogies, we managed to isolate the effect of inhibition, which is again consistent with previous studies (Thibaut, French & Vezneva, 2010). It is logical to conclude that pictorial classical analogies require more inhibition rather that WM because all the alternatives necessary to make the inference are visible and children might need less WM capacity.

Correlation analysis was made using the performance on FB and analogy pre-tests (before the training manipulation) and we found that both abilities are highly positively correlated (r=0.6**, *p=.008*), which means that they are related and change in one direction. After the other results presented in the paper we can assume that both abilities are influenced by the trainings in inhibition and WM.

Finally, children showed significant improvement during the 7-day trainings, which means that they became better on the inhibition or WM tasks, and transfer to FB and analogy tests was observed. This data is consistent with claims that EF could be developed through training and that is one way for other educational or cognitive abilities to be improved (Diamond, 2012). Usually EF training programs are larger and we succeeded in showing an effect after short training programs of only 7 days. We plan to find out whether this effect remains stable over time, because such an achievement could have far-reaching practical implementations and to serve as a tool for improvement of cognitive and social abilities in young children.

Acknowledgments

We would like to express our acknowledgments to Izabela Atanasova, Teodora Achova, Dara Vasileva, Aleksandra Sarkizova, Elena Mihaylova and all the students that invested their time and efforts in realizing the study.

References

Baddeley, A. D. & Hitch, G. J. (1974). Working memory. In: *The psychology of learning and motivation*, 8, 47-90. New York Academic Press.

Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985) Does the autistic child have a 'theory of mind'? *Cognition*, 21, 37-46.

Carlson, S. M., Claxton, L. J., & Moses, L. J. (2015). The Relation Between Executive Function and Theory of Mind is More Than Skin Deep. *Journal of Cognition and Development*, 16(1), 186-197.

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development*, 11, 73–92.

Carpenter, M., Call, J., & Tomasello, M. (2002). A new false belief test for 36-month-olds, *British Journal of Developmental Psychology*, 20, 393–420.

Collins, A. & Burstein, M. (1989) A framework for a theory of comparison and mapping. In S. Vosniadou & A. Ortony (Eds.) *Similarity and Analogy*. Cambridge, UK: Cambridge University Press, 546-565.

Devine, R. T., & Hughes, C. (2014). Relation between False Belief Understanding and Executive Function in Early Childhood: A Meta-Analysis. *Child Development*, 85(5), 1777-1794.

Diamond, A. (2012a). Activities and programs that improve children's executive functions. *Current Directions in Psychological Science*, 21(5), 335-341.

Diamond, A., Kirkham, N., & Amso, D. (2002). Conditions under which young children can hold two rules in mind and inhibit a proponent response. *Developmental Psychology*, 38(3), 352-362.

Dias, N. M. & Seabra, A. G. (2016). Intervention for executive functions development in early elementary school children: effects on learning and behaviour, and follow-up maintenance. *An International Journal of Experimental Educational Psychology*, 1-19.

Gentner, D. (1983). Structure – Mapping: A Theoretical Framework for Analogy. *Cognitive Science*, 7, 155-170

Goswami, U. & Brown, A.L. (1990). Higher-order structure and relational reasoning: Contrasting analogical and thematic relations. *Cognition*, 36, 207- 226.

Chen, Z., Sanchez, R. P., & Campbell, T. (1997). From beyond to within their grasp: The rudiments of analogical problem solving in 10- and 13-month-olds. *Developmental Psychology*, 33, 790-801.

Goswami, U. & Pauen, S. (2005). The Effects of a "Family" Analogy on Class Inclusion Reasoning by Young Children. *Swiss Journal of Psychology*, 64(2), 115-124.

Halford, G. (1993). *Children's understanding: The development of mental models.* Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey.

Hofstadter, D. R. (2001). Analogy as the Core of Cognition. In: Gentner, D., Holyoak, K. J., Kokinov, B., eds. *The Analogical mind: Perspectives from Cognitive Science,* 499-532. Cambridge, MA: MIT Press.

Holyoak, K. J., Gentner, D, & Kokinov, B. (2001) Introduction: The place of analogy in cognition. In Gentner, D., Holyoak, K. J., Kokinov, B. (Eds.), *The Analogical mind: Perspectives from Cognitive Scince*, 1-20. Cambridge, MA: MIT Press.

Holyoak, K. J., Junn, E. N., & Billman, D. O. (1984). Development of analogical problem solving skill. *Child Development*, 55, 2042-2055.

Kloo, D. & Perner, J. (2003). Training transfer between card sorting and false belief understanding: helping children apply conflicting descriptions. *Child Development*, 74(6), 1823-1839.

Morrison, R. G., Krawczyk, D. C., Holyoak, K. J., Hummel, J. E., Chow, T. W., Miller, B. L., & Knowlton, B. J. (2004). A neurocomputational model of analogical reasoning and its breakdown in Frontotemporal Lobar Degeneration. *Journal of Cognitive Neuroscience*, 16, 260-271.

Perner, J. (1998). The meta-intentional nature of executive functions and theory of mind. In P. Carruthers & J. Boucher (Eds.), *Language and thought,* 270-283. Cambridge University Press.

Perner, J., Leekam, S. R., & Wimmer, H. (1987). Three-year olds' difficulty with false belief: The case for a conceptual deficit. *British Journal of Developmental Psychology*, 5, 125-137.

Premack, D. & Woodruf, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences*, 1, 515-526.

Richland, L.E. & Burchinal, M. R. (2012). Early executive function predicts reasoning development. *Psychological Science*, 24(1), 87-92.

Rubio-Fernandez, P., & Geurts, B. (2013). How to Pass the False-Belief Task before Your Fourth Birthday. *Psychological Science*, 24(1), 27-33.

Thibaut, J. P., French, R. M., & Vezneva, M. (2010). The development of analogy making in children: cognitive load and executive functions. *Journal of Experimental Child Psychology*, 106(1), 1-19.

Vandierendonck, A., Kemps, E., Fastame, M. C. & Szmalec, A. (2004). Working memory components of the Corsi blocks task. *British Journal of Psychology*, 95(1), 57-79.

Viskontas, I.V., Morrison, R.G., Holyoak, K.J., Hummel, J.E., & Knowlton, B.J. (2004). Relational integration, inhibition, and analogical reasoning in older adults. *Psychology and Aging*, 19, 581-591.

Wellman, H.M. & Bartsch, K. (1988). Young children's reasoning about beliefs. *Cognition*, 30, 239-277.

Wellman, H.M., Cross, D., & Watson, J. (2001). Meta-analysis of theory of mind development: The truth about false belief. *Child Development*, 72(3), 655-84.

Zelazo, P. D. & Frey, D. (1998). Cognitive complexity and control: The development of executive functions. *Current Direction in Psychological Science*, 7, 121-126.