

Effect of a metacognitive training program of mentalist skills

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Abstract

Background: Recent researches in Theory of Mind (ToM) relate its development to the development of the metacognitive skills “planning,” “regulation,” and acquisition of “predictive and causal reasoning.” These studies reveal the importance of metacognitive training in the development of mentalist skills. **Method:** In the present work, the effects of training were compared in 20 children, aged between 4 and 5 years. **Results:** Significant within-group differences in the skills of belief attribution and memory attribution were found and a tendency towards significance in the skills of behavior prediction. Significant between-group differences were found in belief attribution, prediction, and memory. **Conclusions:** Mentalist skills training improve attribution, prediction and memory skills in ToM tasks.

Keywords: metacognitive training, mentalist skills, causal reasoning, predictive reasoning, belief attribution.

Resumen

Efecto de un programa de entrenamiento metacognitivo en habilidades mentalistas. Antecedentes: recientes investigaciones en Teoría de la Mente (ToM) relacionan su desarrollo con el desarrollo de habilidades metacognitivas de “planificación”, de “regulación”, así como con la adquisición del “razonamiento predictivo y causal”. Dichos estudios señalan la importancia que tiene el entrenamiento metacognitivo en el desarrollo de habilidades mentalistas. **Método:** en el presente trabajo participaron 20 niños de 4 y 5 años con objeto de comparar los efectos del entrenamiento. **Resultados:** se han encontrado diferencias significativas “intragrupa” en habilidades de atribución de creencia, de memoria y tendencia a la significación en habilidades de predicción del comportamiento. Asimismo se han hallado diferencias significativas “intergrupo” en atribución de creencia, predicción y memoria. **Conclusiones:** el entrenamiento en habilidades mentalistas parece incrementar las habilidades de atribución, predicción y memoria en tareas de Teoría de la Mente.

Palabras clave: entrenamiento metacognitivo, habilidades mentalistas, razonamiento causal, razonamiento productivo, atribución de creencia.

The Theory of Mind (ToM) has been considered the capacity to attribute thoughts, feelings, and intentions to others, as well as the use of such skills to anticipate others' behavior. This theory refers to the capacity to *attribute* and to *anticipate* and is directly related to the capacity to *solve problems of social competence*.

Recent researches (Bartsch & Estes, 1996) reveal the existence of individual differences in the acquisition of mentalist skills. One of the possible explanations to such performance differences is the relation between the development of these skills and the development of metacognitive skills (Kuhn, 1999, 2000). Another variable involved could be subjects' individual differences in the acquisition of causal predictions and causal reasoning (Wellman & Lagattuta, 2004).

For this purpose, we shall analyze investigations that indicate a relation between the development of mentalist skills and that of metacognitive skills. Secondly, we will study investigations about mentalist skills and causal reasoning and lastly, we will examine metacognitive intervention programs for the development of mentalist skills.

Metacognition and development of mentalist skills: Wellman and Lagattuta (2004) found differences in the acquisition of mentalist skills of solving social competence tasks. They attributed them to subjects' different acquisition of metacognitive skills. These investigations emphasize the importance of subjects' acquisition of: Comprehension of their own and other's mental states; Comprehension that action is a product of mental states; and Comprehension of non-cognitive mental states such as desires and emotions.

All of this has been related to awareness of metacognitive aspects such as memory and inference processes (Sodian & Wimmer, 1987). This suggests that a prior analysis of the processes of action prediction (Wimmer & Perner, 1983) and the development of differentiation of appearance and reality (Flavell, Flavell, & Green, 1983) should be performed.

The knowledge of ToM demands an analysis of *knowing how* the mind should be used; which implies a reflection on ideas related to one's own memory and learning. The relation between the development of learning and the increase of metacognitive skills becomes increasingly stronger (Moses & Baird, 1999; Peskin & Astington, 2004).

For Wellman and Lagattuta (2004), ToM is the beginning of *causal reasoning*. During problem-solving processes, frontal and prefrontal areas associated with the development of the metacognitive and executive processes are activated. The two aspects of metacognition are involved in these processes (Efklides,

2009). On the one hand are the *regulation* factors, which facilitate the *inhibitory control* responses, so important in successful processes of ToM problem-solving: these processes are related to the executive function and metamemory. On the other hand, *planning processes* of the problem-solving sequence are involved (Brown, Bransford, Ferrara, & Campione, 1983). For Fernández-Duque, Baird, & Posner (2000), both types of processes are essential in the development of the metacognitive mentalist skills.

Summing up, current research links the acquisition of mentalist skills to the development of metacognitive skills related to planning processes and to regulation processes.

Causal reasoning and Theory of Mind: When assessing future episodes of thinking, reasoning about the future is a key aspect. This type of reasoning increases with age and with the development of the subject's memory (Perner & Ruffman, 1995). Likewise, when acquiring predictions of the future, *planning* (Carlson, Moses, & Claxton, 2004) and *motivation* to understand the task both play an important role (Atance & Meltzoff, 2006).

The skills of *anticipation* and of *planning* the future begin around the age of five years, although they are not totally acquired until later on, as they are subject to contextual factors related to the use of reasoning. It seems that *causal predictions* develop before *causal reasoning*, as the former are based on the detection of causal regularities. Causal explanations can be based on the detection of causal regularities and they require a conceptualization related to more general systems of interpretation. Predictions can be responded to dichotomically but causal explanations have a more profound and complex structure.

Children develop explanations as they progress in predictions (Amsterlaw & Wellman, 2006; Bartsch & Wellman, 1989). Thus, the first level of causal reasoning is predictive judgment. This is based on the detection of causal regularities and on the search for a general interpretation (Legare, Wellman, & Gelman, 2009).

Wellman (1990) uses three important concepts: the belief (what someone thinks or believes) can be erroneous; there is not necessarily any correspondence between believing and knowing; desire (what someone wants), and the relation between desire and belief, which has been called *causal reasoning*. This has been researched through the analysis of stories about moral judgments, perception of the person, and metacognition.

Along these lines, the studies of Wimmer and Perner (1983) analyze children's predictive skill concerning the beliefs and desires of the characters in the story. They conclude that smaller children are unsuccessful in the prediction questions. According to Wellman's (1990) theory, this can be explained because they have not yet developed the concept of belief and therefore, they do not perform any adequate reasoning about belief-desire, or, if they have developed this kind of reasoning, they cannot apply it to false belief-desire reasoning.

A possible explanation is the difficulty at these ages to transform sentences with the verb "think" into sentences that involve action. That is, children tend to carry out a simple transformation of "mentalist verbs" into action verbs (Wellman & Bartsch, 1988). Another suggestion is the experimental subject's incapacity to deal with contradictory beliefs (Wimmer & Perner, 1983).

Likewise, other investigations conclude that the reason for this is the lack of competence in dealing with beliefs or alternative representations applied to the same object or mental state (Flavell, Green, & Flavell, 1986; Gopnik & Astington, 1988), or else that, even if young children understood mental states, it would be

difficult for them to understand the causal relations between them (Forguson & Gopnik, 1988; Leslie, 1988).

Summing up, the hypothesis of Wellman and Bartsch (1988) focuses on small children's (3, 4, and 5 years) difficulty to develop predictive and causal reasoning, especially in false belief tasks.

Metacognitive Training Programs and ToM: Recent investigations (Muris et al., 1999; Tomasello, 2007; Wellman & Lagattuta, 2004) have revealed the relation between the teaching-learning process and the development of mentalist skills. Such mentalist skills begin to be acquired in preschool children within the framework of the processes of interaction between the adult and the children in the classroom (Wellman, 2002). Social interaction in this context contributes to causal comprehension, predictive inference, and, ultimately, to the construction of causal reasoning (Sáiz, Carbonero, & Flores, 2010; Wellman & Lagattuta, 2004). With regard to the school settings, it is important to deal with one's own and other people's mental states (Hughes & Dunn, 1998; Ruffman, Slade, & Crowe, 2002), the description of past experiences (Fivush, 1993), and the inclusion of causal reasoning in conversations (Hickling & Wellman, 2001). It is therefore necessary to use metacognitive dialogues (Frampton, Perlman, & Jenking, 2009; Pramling & Pramling, 2009).

This means that the learner's competence depends on the opportunities provided by the teacher to solve mentalist problems, as well as the metacognitive analysis of the student's errors by the teacher (Sáiz, 2000).

ToM requires a process of recognition and change in the comprehension of the world, and the child must adopt the other person's viewpoint to solve these tasks successfully. To solve this type of tasks, the child must develop verbal skills, working memory skills, and executive function skills. For this purpose, the teacher should begin to teach verbal skills, cognitive-social skills, and metacognitive teaching skills.

Nelson and Narens (1990, 1994) found a relation between mentalist skills and the development of metacognitive processes related to the components of observation and those of control and self-regulation (De la Fuente & Lozano, 2010). Comprehension of other people's mental states involves the use of metacognitive skills because, in order to successfully solve such tasks, the subjects must think about other people's mental states and, as a function of them, modify their own behavior so they can obtain a behavioral change in the other person (Schneider & Lockl, 2002).

The classification of the development of ToM carried out by Flavell, Miller, and Miller (1993) helps us to understand why some normal children do not develop ToM at the age intervals established by traditional ToM researches. Their classification proposes five successive stages:

First stage: Children attribute needs, emotions, and other mental states to others and can use terms such as: know, remember, and think.

Second stage: Children recognize that the mind is related to the physical world. They understand that certain stimuli develop certain mental states and the latter lead to certain behaviors.

Third stage: Children recognize that the mind is separate from the physical world. People can think about the physical world even when the elements or events about which they are thinking are not present.

Fourth stage: The mind can represent present and absent objects and events, taking into account that the representation can be false with regard to the mental state.

Fifth stage: Children learn that the mind is activated through one’s interpretation of reality; mental states lead to emotions, and emotions lead to social inferences.

These authors also proposed this type of training programs for children who present some immaturity when solving this kind of tasks (Steerneman, Jackson, Pelzer, & Muris, 1996), also finding positive results. These programs have been criticized because the results cannot be generalized to other contexts, but the response to the criticism lies in the need to generalize the intervention methodology to family and school contexts in their broadest spectrum.

Within the framework of the studies reviewed, we elaborated a training program to develop mentalist skills to verify whether its application produced an increase in mentalist skills in 4- and 5-year-old children. We proposed the following specific objectives: To prove if the participants trained in the program to develop mentalist skills will significantly improve their skills to solve mentalist tasks after the intervention (analyze intragroup). To prove if the participants trained in the program to develop mentalist skills will significantly improve their mentalist problem-solving skills after the intervention in comparison to their untrained counterparts (analyze intergroup).

Method

Participants

20 participants: 10 boys (mean age: 5.2 years; range: 4.6-5.6) and 10 girls (mean age: 5.3 years; range: 4.7-5.8) enrolled in the third year of Preschool Education. The children belonged to families with a medium socio-economic and cultural level. They were studying a bilingual program, so the class was divided into two groups at certain times. Thus, the program was developed first with one half of the class (experimental group) and the other half was the control group, this group in this time had English class. Due to ethical

reasons, after the research had concluded, the program was applied to the control group. The experimental group and the control group each had 10 participants (5 boys and 5 girls in each group).

Instruments

Theory of Mind Task. False belief task, in the classic outline of Baron-Cohen Leslie, and Frith (1985). Four stories are described to the children and subsequently, the above-mentioned indicators are assessed on the mentalist skills Register.

Mentalist skills Register (see table 1), the following aspects were analyzed (it has a Cronbach’s Alpha of .485): Behavior prediction (this is the prediction about the behavior of another children); Belief attribution (this is the belief about what another children thinks); Experimental question (this is the question about the action of other children); Memory question (This is the question of memory); Reality question (This is the question about the situation now).

Development of a metacognitive training program of mentalist skills (Sáiz & Román, 2010). This program consists of 24 units about metacognitive intervention in mentalist skills. It comprises has aims of unit, assessment indicators, tasks, and materials. The program deals with problem-solving skills in social interaction, self-assessment skills, training in mental verbs and tasks involving first and second order beliefs.

Design

The children were not randomly assigned to the groups but instead the groups were formed depending on the intervention possibilities in the center; orthodoxically speaking, we should refer to treatment group and no-treatment group.

To test the hypotheses, we used two experimental designs; the first one, related to Hypotheses 1 and 2, was a pre-post experimental design with a control group (Campbell & Stanley, 1966).

Table 1

Mentalist skills register [based on the original by Wimmer and Perner (1983) in the version of Baron-Cohen and Frith (1985). Reprinted with permission of CEPE Editorial, Sáiz y Román (2010)]

NAME AND SURNAMES:			
DATE:			
CRONOLOGICAL AGE:			
QUESTIONS	YES	NO	OBSERVATIONS
BEHAVIOR PREDICTION Where will Sara go to look for the marble?			
BELIEF ATTRIBUTION Where does Sara think the marble is?			
CONTROL QUESTION Where was the marble at the beginning of the story?			
REALITY QUESTION Where is the marble now?			
EXPERIMENTAL QUESTION Where will Sara look for the marble?			
MEMORY QUESTION Where was the marble at the beginning?			

Procedure

First phase: the Program for the development of mentalist skills was elaborated (Sáiz & Román, 2010).

Second phase: pretest or initial assessment of the participants of both groups. The following instruments were applied:

- Theory of Mind task of Baron-Cohen et al., (1985).
- Mentalist skills register (table 1).

The assessment was carried out individually in a different room from the classroom, soundproofed and with good light. This assessment was performed in two sessions: in the first one, the ToM task was administered it assessed by means of the Register of mentalist skills (Sáiz & Román, 2010).

Third phase: intervention. The Program for the development of mentalist skills was administered for three months in weekly 45-minute sessions. The person who administered the program in the classroom was an expert in training metacognitive intervention programs (Sáiz & Román, 2010).

Fourth phase: final assessment. In this phase, both groups were assessed, again applying the ToM task, assessed with the Mentalist skills register (Sáiz & Román, 2010).

Data analysis

We used nonparametric analysis because of the sample size ($n = 20$) and because it did not meet other parametric requirements such as randomized distribution of the participants to the groups (control and experimental), homocedasticity, and normal distribution. We used Wilcoxon’s nonparametric matched pairs signed ranks test for two dependent samples.

Results

With regard in the first object, significant pre-post differences were found after the intervention in the experimental group in the following aspects of mentalist skills (Table 2): *Belief attribution* (“Where does Sara think her marble is?”) ($p \leq .046$), and *Memory question* ($p \leq .046$) (“Where was the marble at the beginning?”). However, no significant differences were found in: *Behavior prediction* (“Where will Sara search for the marble?”), although a tendency towards significance was observed ($p \leq .059$); *Experimental question* (“Where was the marble at the beginning of

Indicators of mentalist skills	Assessment			
	Pre-range	Post-range	Z	Probability
Behavior prediction	4	4	1.890	.059
Belief attribution	0	2.5	2	.046*
Experimental question	3.5	3.5	1.633	.102
Memory question	0	2.5	2	.046*
Reality question	2.5	2.5	1	.317

* $p \leq .05$

the story?”) ($p \leq .102$); and *Reality question* (“Where is the marble now?”) ($p \leq .317$).

In the analysis of the descriptive statistics of the experimental group’s responses to ToM, it can be seen (Table 3) that the most relevant changes in the means were in *Behavior prediction* and *Belief attribution* responses. These data are related to the development of predictive and attribution skills during the development of metacognitive and mentalist processes.

Likewise, we performed a within-group analysis (Table 4) of the control group in order to determine whether there were any significant differences with the experimental group in the pre-post phases, to rule out the possibility that the data from the experimental group could be explained by the covariate maturation.

As can be seen in Table 4, no significant pre-post differences were found in the control group, so we can conclude that the differences in the experimental group shown in Table 2 are not due

Indicators of mentalist skills	Mean before	Mean after	Standard deviation before	Standard deviation after
Behavior prediction	0	.600	.000	.500
Belief attribution	0	.777	.000	.440
Experimental question	.444	.777	.527	.440
Memory question	.444	.666	.527	.500
Reality question	.555	.527	.888	.333

Indicators of mentalist skills	Assessment			
	Pre-range	Post-range	Z	Probability
Behavior prediction	0	1	-1	.317
Belief attribution	0	0	0	1
Experimental question	0	0	0	1
Memory question	0	0	1	.317
Reality question	0	1	0	.317

* $p \leq .05$

Indicators of mentalist skills	Mean before	Mean after	Standard deviation before	Standard deviation after
Behavior prediction	.1	.2	.333	.440
Belief attribution	0	0	0	0
Experimental question	.888	.888	.333	.333
Memory question	.222	.222	.440	.440
Reality question	.222	.222	.440	.440

to effects of maturation. Next, we conducted a pre-post analysis in the experimental group (Table 5), finding no relevant differences between the means and standard deviations and the pre-post scores of the control group.

To test the second object was conducted a between-group analysis before the intervention, as seen in Table 6, finding no significant group differences; therefore, the groups can be considered equivalent.

We then conducted a post between-group analysis to verify whether the intervention (independent variable) was effective. As can be seen in Table 7, there were significant differences in the assessment levels of the following mentalist skills: *Behavior prediction* (“Where will Sara go to look for the marble?”) ($p \leq .002$), *Belief attribution* (“Where does Sara think the marble is?”) ($p \leq .003$), *Experimental question* (“Where will Sara look for the marble?”) ($p \leq .046$), *Memory question* (“Where was the marble at the beginning of the story?”) ($p \leq .025$), but not in the *Reality question* (“Where is the marble now?”) ($p \leq .083$).

Table 6
Results of the between-group analysis (experimental and control group) before the intervention

Indicators of mentalist skills	Assessment			
	Range of control group	Range of experimental group	Z	Probability
Behavior prediction	1.5	0	-1.414	.157
Belief attribution	1.5	0	-1.414	.157
Experimental question	3.5	3.5	.000	1
Memory question	2	2	-.577	.577
Reality question	3	3	-.447	.655

* $p < .05$

Table 7
Between-group analysis (experimental vs. control group) after the intervention

Indicators of mentalist skills	Assessment			
	Range of control group	Range of experimental group	Z	Probability
Behavior prediction	0	4	2.899	.002*
Belief attribution	0	5	3.000	.003*
Experimental question	0	2.5	2.000	.046*
Memory question	0	3	2.236	.025*
Reality question	0	2	1.732	.083

* $p < .05$

Discussion

The fact that there are individual differences in the acquisition of mentalist skills is relevant. Such acquisition depends on factors related to the comprehension of mental states (Legare et al., 2009; Wellman, 1990). Moreover, the development of other skills—such as metacognitive skills—related to children’s planning and regulation aspects is increasingly important to explain the development of mentalist skills in small children. The simple acquisition of language, in its morphosyntactic and semantic codes, does not explain the development of mentalist skills (Flavell et al., 1993; Milligan, Astington, & Dack, 2007). This has revealed the relevance of dealing both with the acquisition and the development of mentalist skills in academic contexts.

The use of metacognitive dialogues at early ages in the teaching-learning processes was also found to be relevant (Pramling & Pramling, 2009; Tomasello, 2007; Wellman & Lagattuta, 2004). The results of this investigation reveal—in the within-group analysis—the increase in the trained group of the mentalist skills of Belief attribution and Memory, as well as a tendency towards increase in the skill of Behavior prediction.

As noted, prediction skills are the anteroom of the acquisition of causal reasoning (Legare et al., 2009; Wellman, 1990). In a similar vein, the data from the between-group analysis show that metacognitive training in mentalist skills improves participants’ acquisition of the skills of Belief attribution, Memory, and Prediction.

The application of the metacognitive program has been shown to be effective for the acquisition of mentalist skills. However, we propose longitudinal studies for the analysis of the generalization and transfer processes of these skills. These studies may analyze the reliability of mentalist skills found in many individuals.

Thus, it is important to realize that the development of mentalist skills is related to some aspects of cognitive-linguistic development (comprehension and causal reasoning skills), so it would be relevant to study in more detail the acquisition and development of these reasoning processes in preschool children (Legare et al., 2009; Wellman, 1990). Therefore, we emphasize the importance of research along these lines so we can offer preschool teachers conclusions that allow them to practice these skills in the classroom. This would promote the acquisition of mentalist reasoning, which is important for the acquisition of subsequent competences that are, in turn, necessary for social interaction problem-solving processes.

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