

The effect of relational training on intelligence quotient: A case study

Rosa M. Vizcaíno-Torres¹, Francisco J. Ruiz², Carmen Luciano¹, Juan C. López-López¹,
Adrián Barbero-Rubio¹ and Enrique Gil¹

¹ Universidad de Almería and ² Fundación Universitaria Konrad Lorenz

Abstract

Background: Relational training protocols based on Relational Frame Theory (RFT) are showing promising results in increasing intelligence quotient. This case study aimed at analyzing the effect of a training protocol in fluency and flexibility in relational responding on intelligence quotient with a 4-year-old child. **Method:** The child's cognitive and psychomotor development was evaluated before and after the implementation of the training protocol using the McCarthy's Aptitudes and Psychomotricity Scale (MSCA). The training protocol consisted of a multiple-exemplar-training (MET) in relational framing in accordance with COORDINATION (Phases 1 and 2), OPPOSITION (Phase 3 and 4), and COMPARISON (Phases 5 and 6). The MET protocol was implemented in approximately 12 hours throughout five and one half months. **Results:** The training was effective in establishing relational responding in OPPOSITION and COMPARISON frames as well as in promoting fluency and flexibility in all the three types of trained relations. After this training, the child showed an increase above 1.5 SD in the General Cognitive Index of the MSCA (from 106 to 131). **Conclusions:** This case study adds further empirical evidence of the potential of RFT training to improve cognitive abilities and intelligence.

Keywords: Relational frame theory; Intelligence; Multiple-exemplar-training; Derived relational responding.

Resumen

El efecto del entrenamiento en comportamiento relacional sobre el cociente de inteligencia: un estudio de caso. Antecedentes: los protocolos de entrenamiento relacional basados en la Teoría del Marco Relacional (TMR) están mostrando resultados prometedores en el incremento del cociente de inteligencia. El objetivo de este estudio de caso fue analizar el efecto de un entrenamiento en fluidez y flexibilidad en comportamiento relacional sobre el cociente de inteligencia en un niño de 4 años. **Método:** se evaluó el desarrollo cognitivo y psicomotor del niño a través de las Escalas de Aptitudes y Psicomotricidad de McCarthy (MSCA). La intervención consistió en un entrenamiento relacional en múltiples ejemplos para enmarcar en COORDINACIÓN (Fases 1 y 2), OPOSICIÓN (Fases 3 y 4) y COMPARACIÓN (Fases 5 y 6). El entrenamiento se aplicó en 12 horas aproximadamente durante cinco meses y medio, y resultó eficaz en generar comportamiento relacional para enmarcar en OPOSICIÓN y COMPARACIÓN y en promover fluidez y flexibilidad en los tres marcos relacionales. **Resultados:** el niño mostró un incremento superior a 1.5 DT en el Índice Cognitivo General del MSCA (de 106 a 131). **Conclusiones:** este estudio añade evidencia al potencial de los entrenamientos basados en la TMR para mejorar las habilidades cognitivas e inteligencia.

Palabras clave: teoría del marco relacional; inteligencia; entrenamiento en múltiples ejemplos; respuesta relacional derivada.

Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001) is a functional-contextual approach to complex human behavior that holds two main premises with important implications for the training of linguistic and cognitive abilities.

The first premise is that fluency and flexibility in different patterns of arbitrarily applicable relational responding, or relational framing, underlie language and cognition (e.g., Hayes et al., 2001; Luciano, Valdivia-Salas, Berens, Rodríguez-Valverde, Mañas, & Ruiz, 2009). Relational framing means responding to one event in terms of another where the relationship between the two events is not based on nonarbitrary features but on arbitrary relational cues (e.g., *same as*). For instance, consider the case of a boy with a snake phobia who is told that *serpiente* is the Spanish

word for snake (i.e., *snake is the same as serpiente*). Later, he gets scared when hearing the sentence "there is a serpiente in this room," because of the arbitrary relationships between "serpiente," "snake," and an actual snake. Fluency in relational framing refers to the ease to derive relations, whereas flexibility refers to the ability to relationally frame stimuli under different relational cues, contexts, and formats.

Examples of relational framing are relating stimuli in accordance with coordination (*is, same as*), distinction (*is different from*), opposition (*is opposite to*), comparison (*more than, less than*), hierarchy (*is part of, includes*), etc. Each type of relational framing is defined according to three properties: mutual entailment, combinatorial entailment, and transformation of functions. Mutual entailment involves the bidirectionality of stimulus relations: if A is related to stimulus B, then B is related to A in a particular way. For instance, in relations of coordination, if A *is the same as* B, then B *is the same as* A (e.g., if *serpiente* is the same as *snake*, *snake* is the same as *serpiente*). Combinatorial entailment means that two or more stimuli that have acquired the property of mutual entailment can be combined. For example, if A is related to B and

Received: June 30, 2014 • Accepted: January 21, 2015

Corresponding author: Carmen Luciano
Facultad de Psicología
Universidad de Almería
04120 Almería (Spain)
e-mail: mluciano@ual.es

B is related to C, then C and A are related in a particular way. Similarly, with relations of coordination, if *A is the same as B* and *B is the same as C*, then *A is the same as C* and *C is the same as A* (e.g., if *serpiente* is the same as *snake* and *snake* is the same as an actual snake, *serpiente* is the same as the actual snake and vice versa). Transformation of functions means that the function of a stimulus can change the functions of other stimuli that are mutually or combinatorially related. In the previous example, if C acquires a fear-eliciting function, then B and A will have the same eliciting function due to the mutual and combinatorial relations of coordination, respectively (e.g., the boy get scared when hearing the sounds “serpiente” and “snake”). Importantly, recent empirical evidence has found that abilities in relational framing correlate with performance on standardized intelligence tests (for a review, see Cassidy, Roche, & O’Hora, 2010) and specific cognitive skills (e.g., Ruiz & Luciano, 2011). Indeed, psychometric measures of intelligence can be deconstructed in terms of the specific relational responses necessary to solve their items (Cassidy et al., 2010).

The second premise with implications for the training of linguistic and cognitive abilities is that all patterns of relational framing are generalized operant behaviors that are learned through multiple exemplar trainings (MET). MET consists of a process in which multiple examples of mutual relations, combinatorial relations and transformations of functions with a particular pattern of relational framing are provided, using multiple sets of stimuli. Empirical evidence supports that relational frames such as coordination, opposition, or comparison can be trained through MET (e.g., Barnes-Holmes, Barnes-Holmes, & Smeets, 2004; Berens & Hayes, 2007; Luciano, Gómez-Becerra, & Rodríguez-Valverde, 2007).

Taken together, the previous premises point to the idea that linguistic and cognitive abilities might be established and improved through MET in different patterns of relational framing. Preliminary evidence is showing that training based on RFT can lead to significant increases in intelligence for both normally and developmentally delayed individuals (Cassidy, Roche, & Hayes, 2011; Ruiz, Suárez, & López, 2012). In Cassidy et al.’s first study, four normally developing children, aged from 8 to 12 years, were matched against a no-treatment control group and received automated METs throughout two years (15 hours in total) to promote fluency in stimulus equivalence and relational framing according to opposition and comparison. Experimental participants showed significant improvements in IQ (mean = 27.25 points) while control participants remained roughly the same. In a second study, an improved training protocol was implemented throughout nine months (approximately two 90-minute sessions per week) with eight schoolchildren, aged 11 to 12 years, who showed educational and behavioral difficulties. The implemented training protocol included: (a) control tasks designed to preclude the possibility of extraneous sources of control over relational framing and IQ responding, (b) remedial training to accelerate the generalization of relational framing when it was slow to emerge, and (c) a greater number of stimulus sets to ensure generalization of relational framing. All but one participant improved their IQ scores above 1 *SD* (mean = 13 points) and pre-post differences were statistically significant. Lastly, in Ruiz et al. (2012), a 4-year-old, autistic child showed an improvement of 35 IQ points after six months of treatment, with 2-3 hours per week, mostly based on MET to establish and provide fluency and flexibility with the most basic relational frames.

The current study aimed at adding additional evidence to the improvement of intelligence measures by training fluency

and flexibility in relational framing according to coordination, opposition, and comparison in a normally developing 4-year-old child. Unlike the only study conducted with normal developing children (first study of Cassidy, Roche, & Hayes, 2011), the actual protocol involved the establishment of relational framing according to opposition and comparison because these repertoires were absent, and included fluency and flexibility training in- and out-session in daily interactions.

Method

Participants

CR, a boy who was 3 years and 8 months old at the beginning of the study, was the participant of this case study. According to his parents’ reports, he was a healthy, happy, and occasionally shy boy. He was at the appropriate stage of social development and grade level for his age although he did not stand out in any particular subject. He was enrolled in Preschool during the period of the study.

CR’s mother, a first year Ph.D. student, administered all tests and relational trainings, which were carried out in a room at CR’s home that had several bookshelves, two tables with computers, two chairs, and a piano. Training trials were conducted on a small table adapted to CR’s height with two chairs facing each other on which the experimenter and the child sat.

Instruments

McCarthy’s Aptitudes and Psychometricity Scale (MSCA; McCarthy, 1988). The MSCA is a widely used psychological test that provides normative T-scores (i.e., $M = 50$ and $SD = 10$) in several areas of development for children from 2 years to 8.5 years: verbal, perceptual-manipulative, numerical, motor skills, and memory. A general index, the General Cognitive Index (GCI), is also obtained by adding the verbal, perceptual-manipulative and numerical subscales, which has a mean of 100 and a standard deviation of 16. This index can be seen as an intelligence quotient. The MSCA provides 90% confidence intervals for the scores on every scale and the GCI. The GCI has very good psychometric properties and there is evidence of its factorial and predictive validity (Kaplan & Sacurzo, 2012). Very strong correlations have been found between the GCI and the Wechsler Preschool and Primary Scale of Intelligence and the Stanford-Binet Intelligence Scales. The Spanish adaptation by TEA Ediciones was used in this study.

Materials

When presenting the training and testing trials, a 50cm × 30cm × 10cm box was used as a physical barrier between the researcher and the child at the time of touching or naming the stimulus. On some occasions, stimuli were presented using a computer program (Microsoft PowerPoint®), and an Apple laptop (MacBook Pro, 15.4 inches). A video camera (Sony Handycam HDD LCD Wide®) was used to record sessions and the child’s responses.

Procedure

The design of this study was $N=1$. The main dependent variables were the scores obtained by CR in the MSCA. This instrument was

administered before and after the introduction of the independent variable: a training protocol in relational framing. Figure 1 shows the six phases of the training protocol. Phases 1, 3, and 5 were dedicated to the evaluation, training, and testing of relational framing according to coordination, opposition, and comparison, respectively. In Phases 2, 4, and 6, fluency and flexibility were promoted in the use of the above-mentioned relational frames (Phase 2: coordination; Phase 4: opposition and coordination; Phase 6: comparison and opposition).

The study lasted approximately five months during which ten sessions were conducted: five to administer the above-mentioned instrument and five to apply the training protocol. The study began when the child was 3 years, 7 months and 23 days old, and finished when he was 4 years and 11 days old.

Pre-intervention assessment. The MSCA was administered during three sessions in the first week of the study according to the guidelines provided by the test developer.

Training protocol. The protocol designed was based on the following guidelines presented in Barnes-Holmes et al. (2004), Berens and Hayes (2007), and Luciano et al. (2009): (a) evaluation of the relational repertoire, (b) sequential and errorless training, (c) firstly training with nonarbitrary relations and then with arbitrary relations, (d) use of several sets of stimuli with several dimensions and functions, (e) use of different training formats, and (f) assess transformation of functions through mutual and combinatorial entailment. During all phases, CR's correct responding was followed by positive social feedback and intermittently by a happy face sticker. CR was told that he could change the stickers for some prizes at the end of the day. Incorrect responding was followed by the experimenter saying: "No, CR, that is not right" or "No, that is not correct." A sad face sticker was also added intermittently. The stickers and social feedback were faded across trial phases: in Phase 1, they were provided every three correct responses; in Phase 3, every six correct responses; and in Phase 5, every eight correct responses. In Phases 2, 4, and 6, some informal trials

were presented to CR every day involving relational framing according to coordination, opposition, and comparison depending on the specific phase of the study (Phase 2: coordination; Phase 4: opposition and coordination; Phase 6: comparison and opposition; see details below).

Phase 1. Evaluation of relational framing according to COORDINATION. This phase assessed CR's most basic relational repertoires and commenced when he was 3 years, 8 months, and 4 days old. As in Luciano et al. (2007), a generalized and delayed naming test (auditory-visual mutual relations) was first conducted with receptive and productive trials. Five unknown objects were used: three to assess productive mutual relations and two to assess receptive ones (see Figure 2). In a receptive trial, CR was told that a particular object, for instance, was called corkscrew and was asked to produce that word. Then, after 60 minutes, CR was asked to take the corkscrew between an array of several stimuli. In a productive trial, CR was told that a particular object, for instance, was called padlock and was asked to produce that word after a 60-minute delay. Figure 3 shows that CR responded correctly to all trials.

Subsequently, four visual-visual conditional discriminations (B1-A1, C1-A1, B2-A2, C2-A2) were trained in a *many-to-one* matching to sample procedure with three comparisons. Afterwards, mutual (A1-B1, A1-C1, A2-B2, and A2-C2) and combinatorial relations (B1-C1, C1-B1, B2-C2, and C2-B2) were evaluated. The trials were presented on sheets that were covered with a cardboard.

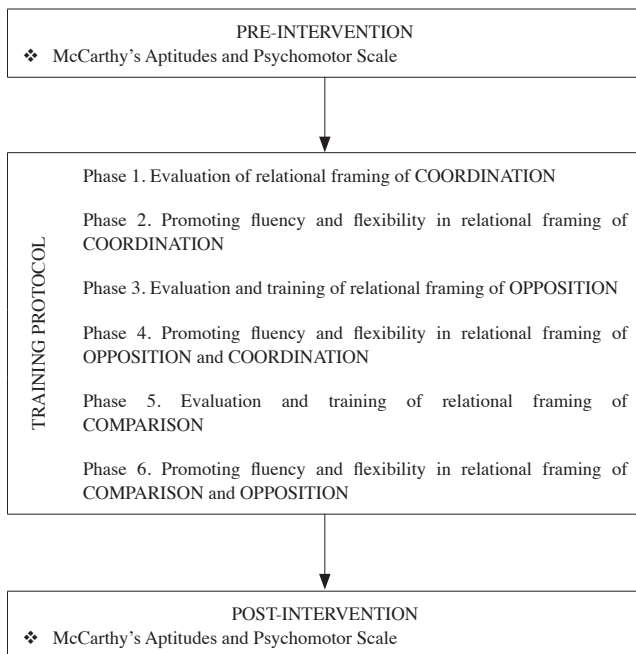


Figure 1. Design sequence















Stimuli for auditory-visual relations		Stimuli for visual-visual relations		
	"Candado"	A1	B1	C1
	"Dedal"			
	"Tornillo"	A2	B2	C2
	"Cinta métrica"			
	"Sacacorchos"	A3	B3	C3
				

Figure 2. Stimuli used in Phase 1

The sample stimuli were presented in the center of the upper third of the sheet and the comparisons appeared in line in the lower third of the screen. A typical trial was as follows: the experimenter presented the sample by sliding the cardboard off the top of the sheet. Then, while discovering the lower portion of the sheet, the experimenter pointed to the sample and said: “CR, what goes with this?” or “tell me what goes with this.” When CR learned the previous relations, the derived mutual and combinatorial relations

were tested. The whole procedure was conducted using 80 trials (64 training trials and 16 test trials, two per relation) in a single session. CR responded correctly to all test trials (see Figure 3).

Phase 2. Promoting fluency and flexibility in relational framing according to COORDINATION. The experimenter generated diverse opportunities in everyday language activities with new examples with arbitrary relations and asked for responses in different contexts and changing functions so that the same stimuli

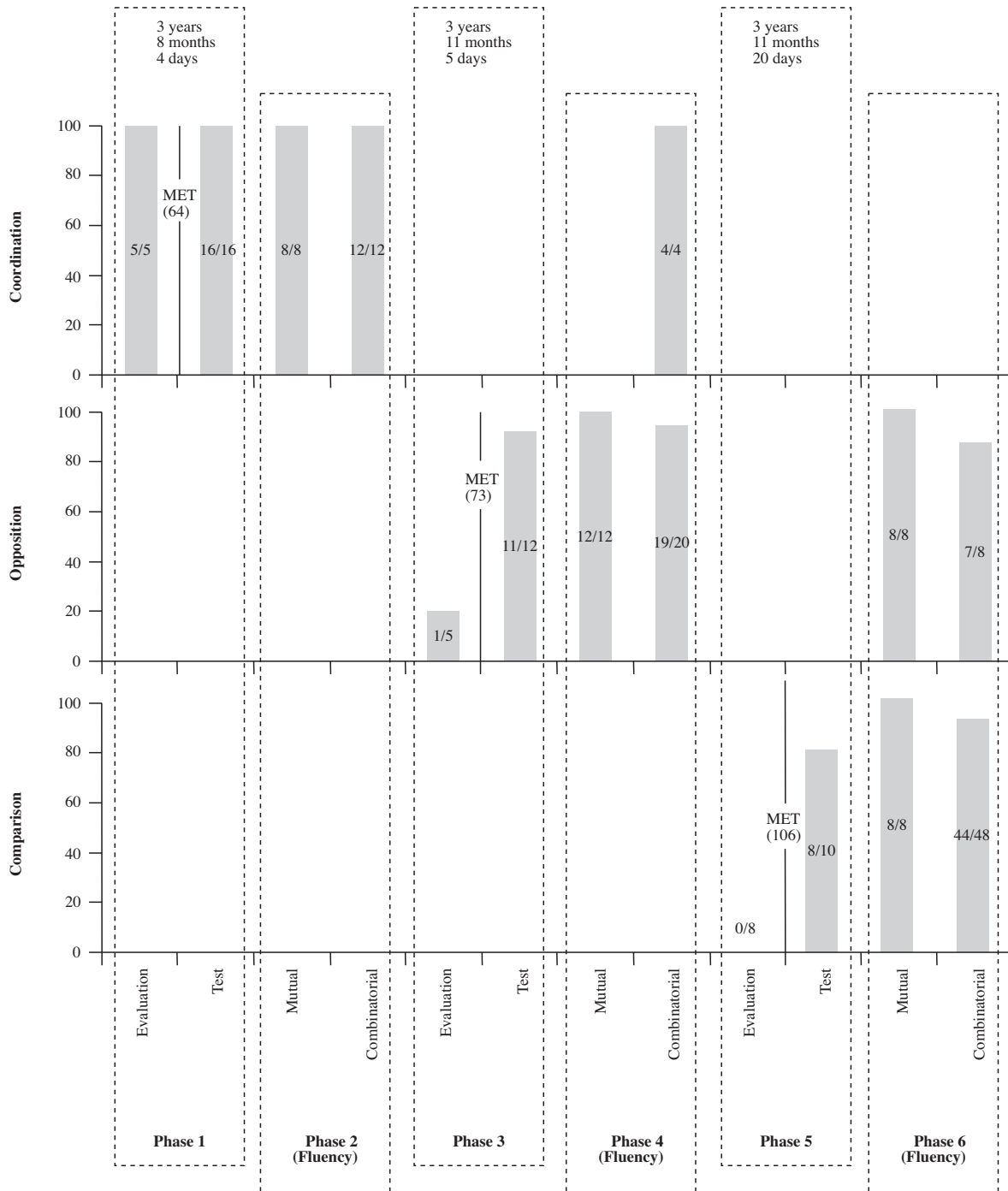


Figure 3. Percentage of correct responses per phase. The numbers separated by bars (e.g., 5/5) indicate the number of correct trials of the total number of trials. The numbers in parenthesis refer to the number of trials involved in the multiple exemplar training. The terms evaluation and test have been used to differentiate if there was previous training (test) or not (evaluation), but are functionally the same

might be related in different ways. Although these tasks were topographically different from the ones used in the previous phase, they were functionally equivalent because they all involved deriving relations through coordination. Eight stories were used with a total of 8 mutual and 12 combinatorial relations. CR responded correctly to all 20 trials (see Figure 3). The extract of one story with four questions is described below (not all stories had the same structure):

There was a teacher who played with his students in the following way: When the teacher drew a square (A1) on the blackboard, the children raised their hands (B1). What did the teacher draw on the board in order for the children to raise their hands? (...) When the children raised their hands (B1), a violin sounded (C1). What did the children do to make the violin sound? (...) What did the teacher draw on the board in order to make a violin sound? If the teacher drew a square on the board, what could be heard? (...).

Phase 3. Evaluation and training of relational framing according to OPPOSITION. This phase began when CR was 3 years, 11 months, and 5 days old, and was conducted intensively for a period of 150 minutes, with several 10-15 minute breaks.

An evaluation including five mutual entailment trials with arbitrary relations was conducted first to explore CR's abilities in relational framing through opposition (e.g., "is the opposite of"). Three identical boxes were used, the dimension evaluated was sweet vs. salty, and the expression used as opposition relational cue was "is the opposite of." In a typical trial, the experimenter presented two boxes on the computer screen, one on the left (A) and the other one on the right (B). She said: "There are sweet things in box number 1 (A), and in box number 2 (B), there are things that are the opposite of the things of box 1. What are the things in box 2 like?" CR only responded correctly to one trial.

In view of the fact that this repertoire was absent, a MET with nonarbitrary opposite relations was conducted. This training consisted of 60 trials with three dimensions and seven sets of stimuli (see Table 1). Transformation of functions through mutual entailment was trained first. The first trial of a dimension was presented twice. For instance, with the first set of stimuli (potatoes), while touching the first potato (A), the child was told that it was cold and the second potato (B) *is the opposite* of first one (i.e., hot), and he touched this stimulus too. In the next trial, stimulus A was presented again, and without touching B, CR was asked what B was like if it *is the opposite* of A. The remaining trials for this dimension (i.e., hot-cold) were presented once, and CR was asked to touch the first stimulus and then to describe the second one that was in an opposite relation. This stage ended when CR responded correctly to 8 consecutive trials.

Subsequently, CR was exposed to a similar training with three stimuli for training mutual and combinatorial entailment. First, the experimenter presented the A-B relations as before (e.g., "This potato [A] is cold and is the opposite of this one [B]. What is this potato like [B]"?). When CR responded correctly, the B-C relations were introduced (e.g., "This potato [B] is hot and is the opposite of this one [C]. What is this potato like [C]"?). Finally, the experimenter presented the three stimuli together and evaluated the corresponding transformation of functions (e.g., "This potato [A] is cold and is the opposite of this one [B], and this one [B] is the opposite of this other one [C]. What is this potato like [C]"?).

When CR made a mistake, he was allowed to touch the stimulus to obtain feedback and was asked again. This stage finished when CR responded correctly 8 consecutive trials (with the set containing cotton balls, see Table 1; overall, CR responded correctly to 37 of the 47 training trials).

Afterwards, a MET of mutual and combinatorial relations was conducted with arbitrary relations (13 trials in total). This training was similar to the previous one, but the trials were presented on the computer screen and involved two dimensions (full/empty, sweet/salty) and three sets of stimuli (see Table 1) and ended when CR responded correctly to 8 consecutive trials. Lastly, CR was exposed to a test of arbitrary mutual and combinatorial relations consisting of 12 trials (8 mutual and 4 combinatorial relations) with two sets of stimuli (see Table 1). CR passed the test by responding correctly to 11 of the 12 trials (see Figure 3).

Phase 4. Promoting fluency and flexibility in relational framing according to OPPOSITION and COORDINATION. Similar to Phase 2, fourteen stories that led to 36 trials involving both mutual and combinatorial relations were used in daily interactions. CR responded correctly to 95% of the trials with opposite relations and to 100% of the trials with coordination (see Figure 3). An illustrative story is presented below:

With identical toy cars but with different colors, a red car (A) (on the right side), a blue car (B) (at the center), and a yellow car (C) (on the left side), CR was told: "*This car (pointing to the red car) is a fast car and is the opposite of this other car (pointing to the yellow car), and the yellow car is the opposite of the blue car (left). What is the blue car like? What about the red and blue cars? (...) Are they the same or the opposite? (...)*"

Phase 5. Evaluation and training of relational framing according to COMPARISON. This phase began when CR was 3 years, 11 months and 20 days old, and was conducted in a single session that lasted 3 hours and included 114 trials and several 10-15-minute breaks.

Table 1
Stimuli used in Phase 3

	Dimensions	Stimuli
Evaluation arbitrary opposite relations	Sweet-Salty	Drawings of boxes
		Potatoes
	Hot-Cold	Glasses of water
		Porcelain containers
Training nonarbitrary opposite relations		Boiled eggs
	Dry-Wet	Sponges
		Kitchen napkins
Training arbitrary opposite relations	Hard-Soft	Cotton balls
		Drawings of colored glasses
	Full-Empty	Drawings of boxes
Test arbitrary opposite relations	Sweet-Salty	Surprise gift boxes
		Drawings of glasses
		Drawings of boxes

An evaluation including eight trials with arbitrary relations was conducted first to explore CR's abilities in relational framing through comparison relational cues (e.g., "more than," "less than"). Table 2 shows that three sets of stimuli were used. An illustrative trial was as follows: Three round tokens of the same size but of different colors were used as coins. CR was told: "With the blue token, we can buy more presents than with yellow token (A>B), but with the yellow token we can buy more presents than with the red token (B>C). With which token can we buy more presents? With which token can we buy fewer presents? If you want go to the shop and buy a lot of presents, which token would you choose? With the blue token, can we buy more or fewer presents than with the others? With the red token, can we buy more or fewer presents than with the others?" CR responded incorrectly to all trials.

Once it was shown that this repertoire was absent, a MET with nonarbitrary mutual and combinatorial relations was conducted (85 trials) with other sets of stimuli. Two dimensions (volume and size) and seven sets of stimuli were used (see Table 2). A typical trial proceeded as follows: Two towers (A>B) with a different number of pieces of wood were presented and CR was asked: "Which of them has more pieces? Which has fewer?" Progressively, the differences between the towers were minimized throughout 3 trials while the same questions were asked. Later, a third tower (A>B>C) was presented and CR was asked for the combinatorial relations (A>C and C<A): "Which tower has the most pieces? Which has the least? Does this tower have more or fewer pieces than the others? If you want the tower with the most pieces, which tower would you choose?" If CR responded incorrectly, he was allowed to count the pieces of the tower. Afterwards, the trial was repeated.

When CR produced 15 correct consecutive responses, a MET with arbitrary relations (21 trials) commenced with four dimensions and six series of stimuli (see Table 2). A typical trial proceeded as

follows: Cards identical in size but different in color were used. CR was told: "Here we have two cards: you can buy less ice cream with the red card than with the black card. With which card can we buy less ice cream? With which can we buy more? Now, pay close attention, we have these two cards, we can buy less ice cream with the black card than with the yellow one. So, tell me, which card can we use to buy less ice cream? Which can we use to buy more ice cream?" If the child responded correctly, he was told: "Now we have all three cards. With the red card (A) we can buy less ice cream than with the black card (B), but with this one (B) we can buy less ice cream than with the yellow card (C): if you want to buy a lot of ice cream, which card would you choose? Now, take the card that buys the least amount of ice cream. Now, with the red card, could we buy more or less ice cream? And with the yellow card, could we buy more or less ice cream? Is the red card the one we could use to buy the most ice cream or the least ice cream? And is the yellow card the one that can be used to buy the most ice cream or the least ice cream?" If the child made a mistake, the relation "If A is ... and A is more/less than B, then B is..." was trained explicitly. Next, the trial was repeated. If he made the same mistake, the nonarbitrary trials were repeated.

Figure 3 shows that, after this intensive training, CR responded correctly to 8 of the 10 trials of the test with arbitrary relations involving the same sets used in the previous evaluation of this repertoire.

Phase 6. Promoting fluency and flexibility in relational framing according to COMPARISON and OPPOSITION. Twenty-four new stories involving 56 comparison and 16 opposition trials were presented on a day-to-day interactions basis. He responded correctly to 92.9% of comparison and 93.8% of opposition trials (see Figure 3). An example of story with comparative relations is presented below:

"Let's imagine that we have 3 towels: one green, one yellow, and one black. The green towel is smaller than the yellow one, but the yellow one is smaller than the black one. If you want to have the biggest towel, which towel would you choose? And if you want to have the smallest towel for your little brother, which would you choose?"

Post-intervention assessment. This evaluation was conducted in two sessions at the end of the study when CR was 4 years and 11 days old.

Data analyses

CR's direct scores on the MSCA at pre-intervention were interpreted according to the scales for 3 years and 4 months to 3 years and 9 months when he was 3 years and 7 months old. Direct scores at post-intervention were interpreted according to the scales for 3 years and 10 months to 4 years and 3 months when he was 4 years old. Ninety percent confidence intervals were obtained from the MSCA manual.

The integrity of the protocol administration (Phases 1, 3, and 5) was measured by means of inter-observer agreement (agreement among two independent observers divided by the sum of agreement and disagreement, multiplied by 100). Both observers claimed 100% agreement in evaluation, training, and tests regarding the correct presentation of the trials, identification of CR's responses, and adequate feedback provision.

Table 2
Stimuli used in Phase 5

	Dimensions	Stimuli	
Evaluation arbitrary comparative relations	Value	Tokens	
	Quantity	Boxes	
	Value	Meaningless symbols	
Training nonarbitrary comparative relations	Size	Wooden blocks	
		Bottles	
		Paint brushes	
			Stickers
	Quantity	Containers	
		Transparent boxes	
		Glasses of water	
Training arbitrary comparative relations	Speed	Toy cars	
	Value	Cards	
	Bounce	Balls	
	Quantity	Drawings of bags	
Drawings of rubbish bins			
Opaque containers			
Test arbitrary comparative relations	Value	Tokens	
	Quantity	Boxes	
	Value	Meaningless symbols	

Results

Figure 4 shows that, at pre-intervention, CR obtained average levels adjusted to the norm in all areas (*T* scores between 40 and 59) and in the *General Cognitive Index* (GCI = 106, 90% CI [99, 113], percentile 65, and a direct score of 80). At post-intervention, CR showed increases in the scores on all areas, especially in the verbal one where he obtained a *T* score of 49 at pre-intervention (90% CI [44, 54]) and of 66 at post-intervention (90% CI [61, 71]). As shown in Figure 4, CR obtained a very high level in the GCI, scoring 131 points (90% CI [124, 138], percentile 97, and a direct score of 140).

Discussion

CR entered in the study performing at average levels in the MSCA. After the implementation of the training protocol, he showed improvements in all areas of the MSCA. These changes were especially relevant in the verbal area and in the GCI, the intelligence quotient of the MSCA, in which CR showed a 25-point increase (from 106 to 131). Anecdotal reports by CR’s teacher and family were consistent with the improvement found in the MSCA (e.g., CR performed better at school, showed better verbal understanding than his schoolmates, etc.).

As in previous studies with normal developing children (e.g., Barnes-Holmes et al., 2004; Berens & Hayes, 2009), METs were effective in establishing relational framing in accordance with opposition and comparison. In this study, however, both relational frames were trained with the same participant, and the number of sessions necessary to establish them was reduced. As suggested in Luciano et al. (2009), this might be due to the incorporation of diverse stimuli with different functions in addition to the initial

training in nonarbitrary relations, as conducted in previous studies. This might quickly facilitate the abstraction of the relational cues. More specifically, this study adds empirical information in regard to the efficacy of RFT-based trainings to improve IQ in normally developing children. A novelty of the current study was the incorporation of daily natural interactions to promote fluency and flexibility in relational framing as indicated in Luciano et al. (2009).

However, the current study has all the limitations of *N* = 1 designs. In addition, some other limitations are noteworthy. First, the experimenter was CR’s mother. This made the protocol implementation less intrusive and facilitated the day-to-day interactions to promote fluency and flexibility in relational framing, but her behavior could be more strongly affected by the expectations of the experimenter. For instance, it could be that the mother inadvertently provided some cues that would have facilitated CR’s responses both during the training and tests. Second, the training protocol used was formed of coordination, opposition, and comparison framing. Further studies should study the effect of a protocol training including relational framing according to relations such as distinction, hierarchy, spatial, causality, and deictic. Third, this study lacked of a control participant that would allow controlling for the child interactions that occurred throughout the five months of training.

In conclusion, the current case study provides promising evidence of the effect of an RFT-based training in improving the linguistic and cognitive abilities categorized within the construct of intelligence. In this sense, this type of studies might change the way most psychologists conceive intelligence as a relatively stable construct across lifetime (Cassidy et al., 2010). However, better controlled studies are required to analyze the potential of these RFT-based trainings.

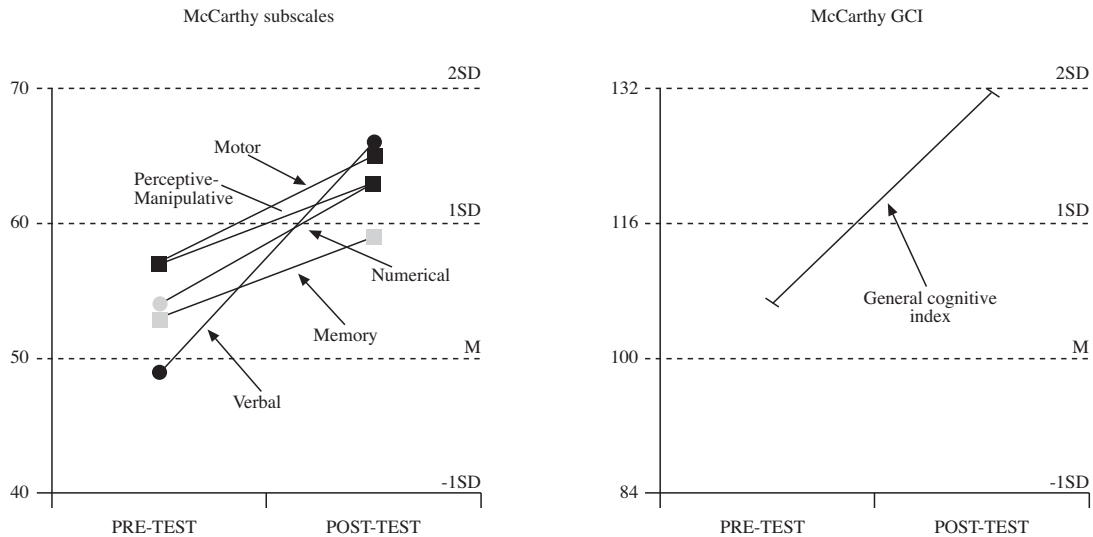


Figure 4. Pre-post differences in McCarthy’s Scales with *M* referring to normative mean scores and *SD* to the standard deviations

References

- Barnes-Holmes, Y., Barnes-Holmes, D., & Smeets, P.M. (2004). Establishing relational responding in accordance with opposite as generalized operant behaviour in young children. *International Journal of Psychology and Psychological Therapy*, 4, 559-586.
- Berens, N.M., & Hayes, S.C. (2007). Arbitrarily applicable comparative relations: Experimental evidence for a relational operant. *Journal of Applied Behavior Analysis*, 40, 45-71.
- Cassidy, S., Roche, B., & Hayes, S.C. (2011). A relational frame training intervention to raise Intelligence Quotients: A pilot study. *The Psychological Record*, 61, 173-198.
- Cassidy, S., Roche, B., & O'Hara, D. (2010). Relational Frame Theory and human intelligence. *European Journal of Behavior Analysis*, 11, 37-51.
- Hayes, S.C., Barnes-Holmes, D., & Roche, B. (Eds.) (2001). *Relational frame theory. A post-Skinnerian account of human language and cognition*. New York: Kluwer Academic.
- Kaplan, R.M., & Sacuzzo, D.P. (2012). *Psychological testing: Principles, applications, and issues*. Belmont, CA: Wadsworth Inc Fulfillment.
- Luciano, C., Gómez-Becerra, I., & Rodríguez-Valverde, M. (2007). The role of multiple-exemplar training and naming in establishing derived equivalence in an infant. *Journal of the Experimental Analysis of Behavior*, 87, 349-365.
- Luciano, C., Valdivia-Salas, S., Berens, N.S., Rodríguez-Valverde, M., Mañas, I., & Ruiz, F.J. (2009). Acquiring the earliest relational operants. Coordination, difference, opposition, comparison, and hierarchy. In R.A. Rehfeldt & Y. Barnes-Holmes (Eds.), *Derived relational responding. Applications for learners with autism and other developmental disabilities* (pp. 149-170). Oakland, CA: New Harbinger.
- McCarthy, D. (1988). *Escalas McCarthy de aptitudes y psicomotricidad para niños* (3rd ed.). Madrid: TEA.
- Ruiz, F.J., & Luciano, C. (2011). Cross-domain analogies as relating derived relations among two separate relational networks. *Journal of the Experimental Analysis of Behavior*, 95, 369-385.
- Ruiz, F.J., Suárez, J.J., & López, J.C. (2012). Tratamiento de un caso de autismo a través de entrenamiento en comportamiento relacional derivado [Treatment of case of autism through training in derived relational responding]. In R. Quevedo-Blasco & V.J. Quevedo-Blasco (Eds.), *Avances en Psicología Clínica* (pp. 609-612). Granada: Asociación Española de Psicología Conductual.