Drawing a Dog: Cognitive Underpinnings

Sabrina Panesi (sabrina.panesi@edu.unige.it)
Dipartimento di Scienze della Formazione, corso A.Podestà 2
Genova, Italia

Sergio Rivara (sergio-rivara@hotmail.it)
Dipartimento di Scienze della Formazione, corso A.Podestà 2
Genova, Italia

Sergio Morra (morra@nous.unige.it)
Dipartimento di Scienze della Formazione, corso A.Podestà 2
Genova, Italia

Abstract

This study investigated preschoolers' drawing flexibility, operationalized as their ability to draw a dog that is different from the human figure. The role of working memory (M capacity) and executive function in drawing flexibility was examined. The participants were 123 children, 36-73 months old. Regression analyses showed that both M capacity and executive function predicted development in dog drawing; the dog drawing score correlated with M capacity and executive function even partialling out age, motor coordination, and drawing ability (measured with Goodenough's Draw-a-man test). These results suggest that both M capacity and executive function play an important role in the early development of drawing flexibility.

Keywords: drawing flexibility; working memory capacity; executive function; preschoolers

Introduction

How is the development of drawing ability related to the general development of the cognitive system during childhood? Children's human figure drawing has been studied extensively (e.g., Goodenough, 1926; see also Cox & Parkin, 1986; Freeman, 1980; Lange-Küttner, Kerzmann & Heckhausen, 2002). During an early stage of drawing development, children typically use a single shape to represent both head and trunk and often include only a single pair of limbs. By the time children finish preschool, they begin to differentiate the head from the trunk and to depict both arms and legs (Willcock, Imuta & Hayne, 2011). In the pre-school years drawing skill develops markedly; some studies investigated the cognitive mechanisms which permit the development of representational drawing, specifying the role of developing graphic and cognitive skills (Freeman, 1980; Freeman & Adi-Japha, 2008; Jolley, 2008; Riggs, Jolley & Simpson, 2013). However, only a few studies focused on the relationships between the general development of the human cognitive system and drawing development, suggesting a role of working memory capacity (Dennis, 1992; Morra, 2008a, 2008b) and inhibitory control (Riggs et al., 2013) in children's drawing development.

Although human figure drawing was widely investigated, fewer studies investigated the development of drawing animal figures (e.g., Lurçat, 1985). Silk and Thomas (1986) suggested that young children (three to six years old) may acquire the graphic scheme for a dog by differentiation from the human figure; Golomb (1992) provided converging evidence from young children's drawings of other animals. Consistent with Silk and Thomas's view, both Reith (1988) and Morra (2005) found that school children's drawings of a kangaroo are highly affected by their habitual scheme for the human figure.

Children's ability to modify their habitual drawing schemes is often referred to as "drawing flexibility". This term is related to the more general concept of flexibility as an ability not to follow in a rigid way an established routine or scheme. If drawing schemes for animals are initially differentiated from the human figure scheme, then explaining children's creation of new schemes to draw animals can be regarded an important achievement in the field of drawing flexibility.

Explaining drawing flexibility is a controversial matter, however. An early account was proposed by Karmiloff-Smith (1990), in the context of her Representational Redescription theory. Karmiloff-Smith (1990) suggested that preschoolers are constrained by procedural rigidity, i.e., they do not have access to their drawing procedures and therefore they are not able to interrupt a habitual drawing procedure to make a novel drawing. Subsequent research (Berti & Freeman, 1997; Spensley & Taylor, 1999; Spensley, 2001; Barlow, Jolley, White & Galbraith, 2003), however, reported evidence that falsified Karmiloff-Smith's account, because preschoolers seem to have access to their drawing procedures. In particular, these studies showed that young children (a) can insert novel items midway through a drawing procedure, and (b) are able to produce a flexible drawing if the instructions and materials make it clear to them what type of modification is required. Karmiloff-Smith (1999), in a reply to Spensley and Taylor (1999), acknowledged that young children's drawing procedures are not so rigid as she initially hypothesized.

A different account of drawing flexibility was proposed by Morra (2005, 2008a), in the framework of neo-Piagetian theory (e.g., Pascual-Leone & Johnson, 2005). This approach maintains that working memory growth has a central role in cognitive development, and in particular, its capacity can set an upper limit to drawing performance. In this theoretical framework, attentional capacity (or M capacity) is considered as the core of working memory; the term “M capacity” indicates the maximum number of schemes that a person can simultaneously activate with central attentional resources (Pascual-Leone, 1987).

Morra (2005) hypothesized that working memory is essential in drawing flexibility, because the child must keep in mind, in addition to a habitual scheme, its feature(s) that must be modified and the graphic devices that could represent those modifications. Specifically, Morra (2005) examined the role of M capacity in drawing flexibility, with children in the age range from kindergarten to grade 3. Two experiments concerned drawing a human figure in movement, and a third experiment required creating a novel scheme for drawing an unfamiliar animal (a kangaroo). The results showed that, in this age range, working memory capacity was highly relevant both to modify the human figure scheme to represent specific movements, and to differentiate a kangaroo from the human figure.

A third relevant view was proposed by Barlow et al. (2003), who suggested that young children are probably rigid in encoding information that would lead to cognitive overload if dealt with consciously, but a quantitative increase in general information processing ability could enable the child to make a qualitative change in the way of coping with that information. More particularly, they suggested that executive function development may aid the development of drawing flexibility (in line with the views on executive function development proposed by Zelazo & Frye, 1997). In line with this view, Riggs et al. (2013) showed a role of one executive function (i.e., inhibition) in drawing development.

This study has the general goal of investigating drawing flexibility in young children’s ability to draw a dog that is different from the human figure. More particularly, the first goal of this study is to create a scoring system for the dog drawing task adequate for preschoolers. The second goal is to examine the role of M capacity and executive function in early drawing flexibility.

Our second goal, however, poses a problem of choice of models and measures for executive functions. Miyake, Friedman, Emerson, Witzki, Howerter & Wager (2000) found that, in adults, inhibition, working memory updating, and attention shifting are correlated but distinguishable processes. Im-Bolter, Johnson & Pascual-Leone (2006) proposed that M capacity and inhibition are general resources, whereas shifting and updating are executive abilities that partly rely on M capacity and inhibition. This model, however, was tested on school children. The structure of executive functions in preschoolers is widely debated, and it is still unclear at which age inhibition can be distinguished from broadly understood executive control (Wiebe, Scheffield, Nelson, Clark, Chevalier & Epsy, 2011; Miller, Giesbrecht, Muller, McInerney & Kerns, 2012; Usai, Viterbori, Traverso & De Franchis, 2013).Therefore, we used three working memory tests, widely used in neo-Piagetian research as measures of M capacity, and a battery of four executive function tests (two of which tap inhibition, one updating, and one shifting), leaving to preliminary analyses the decision on whether inhibition as a basic, general resource can be measured separately. Finally, we also used a motor coordination test as a control measure.

Method

Participants

The participants were 123 children, from 36 to 73 months old (M = 53.1 months, SD = 9.6 months). There were 58 girls and 65 boys, recruited in pre-schools in Genova and Rapallo (Italy). Parents provided informed consent for participation.

Materials and Procedure

Drawing tasks

Goodenough’s Draw-A-Man (Goodenough, 1926; Harris, 1963). The experimenter gave the child a white A4 sheet and a pencil, and invited the child to draw a man. Instructions and scores were given according to the manual.

Dog Drawing Task. The experimenter gave the child a white A4 sheet and a pencil, and invited the child to draw a dog. The details of scoring are presented below.

Motor coordination

TPV- subtest coordination eye-hand (Hammill, Pearson, & Voress, 1994). This task assesses motor coordination. The experimenter invited the child to trace with the pencil a standard set of routes.

Working memory tests

Mr. Cucumber test (Case, 1985). The outline of an extraterrestrial figure, to which colored stickers had been attached, was displayed for 5 sec per item. There were three items at each level from 1 to 8 stickers. The child must then show, on an outline without colored stickers, the positions of the stickers. The test was discontinued when a child failed all three items at a level. One point was given for each consecutive level on which a subject got at least two items correct, and one-third of a point for each correct item above that level.

Backward Word Span (Morra, 1994). The child was required to repeat lists of words backward. There were three lists at each level from 2 to 7 words. The test was discontinued when a child failed all three lists at one level. One point was given for each consecutive level on which a subject got at least two items correct (including level 1 which cannot exist, because it is not possible to reverse the order of a list made of a single word, and therefore is granted as correct by default), and one-third of a point for each correct item above that level.

Direction Following Task (DFT, Cunning, 2003; Pascual-Leone & Johnson, 2005). This task requires children to follow oral directions of increasing complexity. We modified it for preschoolers, using tokens of different shapes (bike and boat), colors (white, yellow, green, blue and red) and size (large and small), to be placed in boxes of different color and size. We only presented items in the form “put X in Y” (i.e., the three simplest levels of complexity of the test). There were five items at each level. The scoring rules for the Italian version of the test were followed (see Morra, Camba, Calvini & Bracco, 2013).

Executive function tasks

Day/Night Stroop (Gerstadt, Hong, & Diamond, 1994). This task assesses the ability to inhibit a prepotent verbal response and to activate an alternative verbal response. Children were instructed that in this game they had to say “night” to a white card with a yellow sun drawing, and “day” to a black card with a moon and stars on it. There were 16 test trials; accuracy was scored (range 0-16).

Bear/Dragon (Reed, Pien, & Rothbarth, 1984). This task assesses the ability to inhibit or activate a motor response following a rule, in a way similar to a go-no-go task. The experimenter introduced children to a “nice” bear puppet and a “naughty” dragon puppet, and explained that in this game they had to do what the bear told them to do (e.g., touch your nose) but not to do what the dragon said. There were 10 test trials, with bear and dragon commands in alternating order. The no-go trials were scored as follows: 0 points for performing the movement commanded by the dragon; 1 point for a partial movement or response; 2 points for performing a different movement from that commanded by the dragon; 3 points for no movement at all. The possible scores for the no-go trials range from 0 to 15.

Dimensional Change Card Sort (DCCS, Zelazo, 2006). This is a complex response inhibition task. The DCCS creates a prepotent response during the pre-switch phase that must later be inhibited. The child was shown a deck of cards that varied on two dimensions – shape (rabbit versus boat) and color (red versus blue). During the pre-switch phase, the child must sort the card according to shape dimension. In the post-switch phase, the child was asked to sort the card according to color dimension. In the third sorting phase (border phase), the experimenter explained that if there was a black border on a card, then the child must sort according to shape, and if there was not, according to colour. There were 6 trials in the pre-switch phase, 6 in the post-switch phase, and 12 in the border phase. The pre-switch and post-switch phases were scored 1 point if at least 5 responses out of 6 are correct, and the border phase was scored 1 point if at least 9 out of 12 are correct.[1]

[1] Binary scores for each phase were used, instead of the number of correct responses, because this strict scoring criterion is less vulnerable to the child’s random placing of cards in either box.

Puppets Updating Task. This is a novel task designed for this study; it assesses the constant monitoring and rapid addition or deletion of working memory contents. On each item, the child was shown three, four or five puppets that the experimenter placed sequentially in a cardboard house; then, the child must recall the last two puppets placed in the house. There were 9 items, each of which was scored 1 point if the child recalled correctly one puppet, and 2 points if the child recalled two puppets (possible range of scores, 0-18).

Scoring of the Dog Drawing

For the dog drawing task, a list of 13 features was prepared. This scoring was devised so that drawing flexibility could be scored as independently as possible from general drawing development; i.e., only features in which the dog drawing was different from that of a person were considered. These features are listed in Table 1. One point was awarded for each feature (except feature 4 that was scored 1 point in case 4a and half point in case 4b). Figure 1 presents an example of scoring.

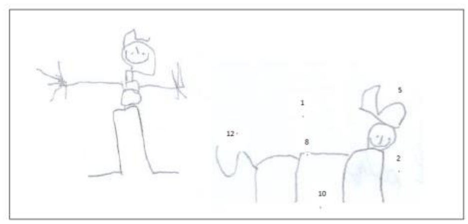

Figure 1: Example of drawing, by a 57-month-old child. Numbers refer to the features listed in Table 1.

Table 1: Features considered in scoring and their proportion of occurrence

Feature	Proportion
1. Whole dog's figure length > height	.43
2. Head connected to body along the horizontal axis	.47
3. Pointed or elongated face	.16
4a. Face details (nose at the end of the head)	.05
4b. Face details (cat/bunny face; or mouth farther than eyes from the trunk)	.06
5. Pointed or hanging ears	.28
6. Whiskers	.01
7. Tongue extending out of mouth	.03
8. Trunk length > height	.45
9. Hair on body/legs	.09
10. Four vertical legs	.17
11. Paws (with animal shape)	.05
12. Tail	.40
13. Dog objects (collar, leash, or muzzle)	.02

Results

All dog drawings were scored by a second rater. Table 2 presents the reliability (proportion of inter-rater agreement and Cohen's kappa) of each single feature scored in the dog drawing task. The proportion of inter-rater agreement on each single feature ranged .89 to 1 (mdn = .97); Cohen's *Kappa* ranged .49 to 1 (mdn = .87), and all of them were significant with $p<.001$. Cronbach's *alpha* was .77, and the correlation between the total scores given by the two raters was r(121) = .96, $p<.001$. Thus, all reliability indexes were good.

Table 2: Inter-rater reliability

	proportion of inter-rater agreement	Cohen's *Kappa*	*p* of Cohen's *Kappa*
1. Whole dog's figure length > height	.89	.79	<.001
2. Head connected to body along horizontal axis	.94	.87	<.001
3. Pointed or elongated face	.97	.88	<.001
4. Face details		.58	<.001
4a. Face details (nose at the end of the head)	.98		
4b. Face details (cat/bunny face; or mouth farther than eyes from the trunk)	.95		
5. Pointed or hanging ears	.93	.82	<.001
6. Whiskers	1	1	<.001
7. Tongue extending out of mouth	.99	.89	<.001
8. Trunk length>height	.97	.93	<.001
9. Hair on body/legs	.96	.72	<.001
10. Four vertical legs	.98	.91	<.001
11. Paws	.98	.79	<.001
12. Tail	.95	.90	<.001
13. Dog's objects (collar, leash, or muzzle)	.98	.49	<.001

Table 3 shows the descriptive statistics.[2] A factor analysis of the working memory and executive function tests (with principal axis extraction and varimax rotation) found two factors. The Backward Word Span, DFT, and Mr.Cucumber Test loaded higher on the first factor (.93, .49, and .47, respectively), while the Bear/Dragon, the Day/Night Stroop, and the Puppets Updating loaded higher on the second factor (.65, .63, and .63, respectively). The DCCS did not load highly on any factor, probably because of lack of variance in this sample. Therefore, we defined an M Capacity variable as the mean of the first three tests, and an executive function variable as a weighted mean of the z scores in the latter three tests. Note that M capacity is conceived as a general, attentional resource at the core of working memory capacity, and therefore the finding of a factor that loads both verbal and visuo-spatial tasks is fully consistent with the theoretical assumptions.

[2] A few children did not perform all tasks; N=123 in the analyses that only consider the drawing task, whereas in correlation and regression analyses we only considered the children who contributed all relevant data points.

Table 3: Descriptive Statistics

	N	Mean	Std. Dev.	Min	Max
Drawing Tasks					
Goodenough's Draw-A-Man	123	9.87	6.29	0	28
Dog Drawing Task	123	2.64	2.46	0	7
Motor coordination					
Tpv - subtest eye-hand coordination	122	113.5	32.98	28	172
M capacity tests					
Mr. Cucumber Test	120	1.59	.79	0	4
Backward Word Span	120	1.66	.74	1	3.66
Direction Following Task	122	1.54	1.06	0	3.5
Executive Function Tasks					
Night/Day Stroop	122	10.48	4.48	0	16
Bear/Dragon no go	120	9.01	6.47	0	15
DCCS	120	2	.43	1	3
Puppets Updating	120	11.63	3.08	2	18

The dog drawing scores increased with age, r(121) = .77, $p<.001$. The correlation between working memory capacity and the dog drawing score was highly significant, r(117) =.73, $p<.001$, also with age partialled out, r(116) = .33, $p<.001$. The correlation between executive function and the dog drawing score was also highly significant, r(114) = .65, $p<.001$, also with age partialled out, r(113) = .29, $p = .002$. The dog drawing also correlated with the Goodenough Draw-a-man test r(121) = .69, $p<.001$, also with age partialled out, r(120) = .26, $p = .002$, and with motor coordination r(120) = .53, $p<.001$, but this correlation didn't resist partialling out age.

A stepwise regression analysis of the dog drawing scores, with M capacity, executive function, motor coordination, and the draw-a-man scores as predictors, yielded significant results for M capacity (*Beta* = .40, $p<.001$), Draw-a-man (*Beta* = .31, $p<.001$), and executive function (*Beta* = .18, $p<.03$), thus accounting for 62.8% variance overall.

Another regression analysis was run, in which age was entered first, accounting for 60.0% of the dog drawing scores; M capacity, executive function, motor coordination, and the draw-a-man scores were entered subsequently, with a stepwise method. This analysis showed that both M capacity and executive function contributed significantly to the dog drawing scores, accounting together for another 5.8% variance above and beyond age. In the final equation, the significant predictors were age (*Beta* = .46, $p<.001$), M capacity (*Beta* = .26, *p*<.01), and executive function (*Beta* = .17, *p*<.04).

Finally, when age, motor coordination, and the Goodenough Draw-a-man were all partialled out, the dog drawing scores still correlated significantly with both M capacity, r(109) = .30, *p*<.001, and executive function, r(109) = .26, *p*<.01.

Discussion

This study investigated preschoolers' ability to draw a dog that is different from the human figure. This ability can be regarded as an early form of drawing flexibility. To measure drawing flexibility independently of general drawing development, we created a scoring system for the dog drawing that only includes features that differentiate the dog from the human figure. All the reliability indexes of this scale were very good. Children's ability to differentiate the animal graphic scheme from the human increased linearly with age.

The role of M capacity and executive function in early drawing flexibility was examined. Evidence for a role of M capacity in drawing flexibility at an older age was reported by Morra (2005). A role of executive function was suggested by Barlow et al. (2003) as a possible explanation of their results, which were inconsistent with the predictions from Karmiloff-Smith (1990). In this study, regression analyses showed that both M capacity and executive function predicted the dog drawing score, M capacity being the best predictor. Also drawing ability (as measured by Goodenough's Draw-a-man test) was another predictor of the dog drawing scale; however, when age was entered first in the regression analysis, the Goodenough score disappeared from the equation, and only M capacity and executive function accounted for a significant proportion of variance beyond that accounted for by age. Finally, both M capacity and executive function correlated significantly with the dog drawing scale even when age, motor coordination, and human figure drawing were partialled out. These findings strongly support the views of both Barlow et al. (2003; see also Riggs et al., 2013) and Morra (2005, 2008).

It seems interesting to note that both M capacity and executive function accounted for a specific, significant proportion of variance in the dog drawing scale; the contribution of one of them could not be explained away by the other. This suggests that the process of creating a graphic scheme for the dog involves, in addition to a scheme for the human figure (Silk & Thomas, 1986), also these two general-purpose components of the child's cognitive system. M capacity is likely to be involved because the child needs to activate, in addition to the habitual graphic scheme for the human figure, also representations of relevant features of dogs, and operative schemes to create or modify graphic marks that could represent these features (Morra, 2005). Executive functions are likely to be involved because, while drawing, the child must inhibit the habitual way of drawing of the human figure, and monitor the ongoing process to optimize changes in the habitual scheme (Barlow et al., 2003). Therefore, working memory and executive functions are likely to work in synergy when the child is engaged in differentiating a new graphic scheme.

References

Barlow, C. M., Jolley, R. P., White, D. G., & Galbraith, D. (2003). Rigidity in children's drawings and its relation with representational change. *Journal of Experimental Child Psychology, 86*, 124-152.

Berti, A., & Freeman, N. (1997). Representational change in resources for pictorial innovation: A three-component analysis. *Cognitive Development, 12*, 501-522.

Case, R. (1985). *Intellectual development: Birth to adulthood.* Orlando: Academic Press.

Cox, M. V., & Parkin, C. E. (1986). Young children's human figure drawing: cross-sectional and longitudinal studies. *Educational Psychology, 6*, 275-287.

Cunning, S. A. (2003). *The direction-following task: Assessing mental capacity in the linguistic domain*. Unpublished doctoral dissertation. Toronto: York University.

Dennis, S. (1992). Stage and structure in the development of children's spatial representations. In R. Case (Ed.), *The mind's staircase* (pp. 229-245). Hillsdale, NJ: Erlbaum.

Freeman, N. (1980). *Strategies of representation in young children.* London: Academic Press.

Freeman, N. H., & Adi-Japha, E. (2008). Pictorial intention, action and interpretation. In C. Lange-Küttner, & A. Vinter (Eds.), *Drawing and the Non-Verbal Mind: A Life-Span Perspective* (pp. 104-120). Cambridge: University Press.

Gerstadt, C., Hong, I., & Diamond, A. (1994). The relationship between cognition and action: performance of children 3 1/2-7 years old on a Stroop-like day-night test. *Cognition, 53*, 129-153.

Golomb, C. (1992). *The child's creation of a pictorial world.* Berkeley, CA: Universitiy of California Press.

Goodenough, F. (1926). *Measurement of intelligence by drawings.* Chicago: World Book.

Hammill, D. D., Pearson, N. A., & Voress, J. K. (1994). *Test TPV - Percezione visiva e integrazione visuo-motoria.* Trento: Erickson.

Harris, D. B. (1963). *Children's drawings as measures of intellectual maturity.* New York: Harcourt, Brace & World.

Jolley, R. (2008). Children's understanding of the dual nature of pictures. In C. Lange-Küttner, & A. Vinter (Eds.), *Drawing and the Non-Verbal Mind: A Life-Span Perspective* (pp. 86-105). Cambridge: University Press.

Karmiloff-Smith, A. (1990). Constraints on representational change: Evidence from children's drawing. *Cognition, 34*, 57-83.
Lange-Küttner C., Kerzmann A. & Heckhausen J. (2002). The emergence of visually realistic contour in the drawing of the human figure. *British Journal of Developmental Psychology, 20,* 439-463.
Lurçat, L. (1985). Réalisme et modèle interne: à propos du dessin d'enfant. [On realism and internal models in children’s drawings] *Bullettin de Psychologie, 38*, 231-241.
Miyake, A., Friedman, N., Emerson, M., Witzki, A., Howerter, A., & Wager, T. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variabile analysis. *Cognitive Psychology, 41*, 49-100.
Miller, M. R., Giesbrecht, G. F., Muller, U., McInerney, R. J., & Kerns, K. A. (2012). A latent variable approach to determining the structure of executive function in preschool children. *Journal of cognition and development*, 395-423.
Morra, S. (1994). Issues in Working Memory Measurement: Testing for M Capacity. *The International Society for the Study of Behavioral Development, 17,* 143-159.
Morra, S. (2005). Cognitive aspects og change in drawings: A neo-Piagetian theoretical account. *British Journal of Developmental Psychology, 23*, 317-341.
Morra, S. (2008a). Memory components and control processes in children's drawing. In C. Milbrath, & H. M. Trautner (Eds.), *Children's understanding and production of pictures, drawing and art* (pp. 53-86). Göttingen (D): Hogrefe & Huber.
Morra, S. (2008b). Spatial structures in children's drawings: how do they develop? In C. Lange-Küttner, & A. Vinter (Eds.), *Drawing and the Non-Verbal Mind: A Life-Span Perspective* (pp. 159-194). Cambridge (UK): Cambridge University Press.
Morra, S., Camba, R., Calvini, G., & Bracco, F. (2013). Italians do it better? M-capacity measurement and cross-linguistic differences in the direction following task (DFT). *Journal of Applied Psycholinguistics, 13*, 9-24.
Pascual-Leone, J. (1987). Organismic Processes for neo-Piagetian theories: A dialectical causal account of cognitive development. *International Journal of Psychology, 22,* 531-570.
Pascual-Leone, J., & Johnson, J. (2005). A dialectical constructivist view of developmental intelligence. In O. Wilhelm, & R. Engle (Eds.), *Handbook of understanding and masuring intelligence* (p. 177-201). Thousand Oaks, CA: Sage.
Reed, M., Pien, D., & Rothbart, M. (1984). Inhibitory self-control in preschool children. *Merrill-Palmer Quartlerly, 30*, 131-147.
Reith, E. (1988). The development of use of contour lines in children's drawing of figurative and non-figurative three dimensional models. *Archives de Psychologie, 56,* 83-103.
Riggs, K., Jolley, R. P., & Simpson, A. (2013). The role of inhibitory control in the development of human figure drawing in young children. *Journal of Experimental Child Psychology, 114*, 537–542.
Silk, A. M., & Thomas, G. V. (1986). Development and differentiation in children's figure drawings. *British Journal of Psychology, 77*, 399-410.
Spensley, F., & Taylor, J. (1999). The development of cognitive flexibility: evidence from children's drawing. *Human Development, 42*, 300-324.
Usai, M. C., Viterbori, P., Traverso, L., & De Franchis, V. (2013). Latent structure of executive function in five-and six-year-old children: a longitudinal study. *European Journal of Developmental Psychology*, 1-16.
Wiebe, S., Scheffield, T., Nelson, J. M., Clark, C. A., Chevalier, N., & Espy, K. (2011). The structure of executive function in 3-year-olds. *Journal of Experimental Child Psychology,* 436-452.
Willcock, E., Imuta, K., & Hayne, H. (2011). Children's human figure drawing do not measure intellectual ability. *Journal of Experimental Child Psychology, 110,* 444-452.
Zelazo, P. D. (2006). The dimansional change card sort (DCCS): A method of assessing executive function in children. *Nature Protocols, 1*, 297-301.
Zelazo, P. D., & Frye, D. (1997). Cognitive complexity and control: A theory of the development of deliberate reasoning and intentional action. In M. I. Stamenov (Ed.), *Language structure, discourse and the access to consciousness* (p. 113-153). Amsterdam: John Benjamins Publishing Company.