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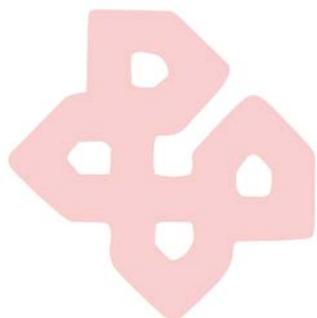
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THE EMERGENCE AND EARLY DEVELOPMENT OF SELF-REGULATION IN YOUNG CHILDREN

*Emergencia y desarrollo temprano de la autorregulación en niños
preescolares*



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Abstract:

It is amply recognised in the literature that metacognitive and self-regulatory abilities are of fundamental significance for children's general and academic development, and also, that these abilities are highly teachable. When do these skills emerge and how do they develop are questions still open to debate, and therefore, subject to new evidence accumulated in the field. In this paper we aim to provide a general overview of the significant advances in the last decade of research regarding the development of self-regulation in children from birth to six years of age. We review evidence suggesting that these abilities begin their development right from infancy and through the preschool years. In the first two sections we address the early emergence of executive functioning and cognitive control, and early emotional and social regulation. The final section deals with a significant and newly emerging area of research, concerned with early communicative and symbolic tools and the key role they play in the emergence of self-regulatory abilities in young children. We discuss the theoretical, methodological and educational significance of this body of research.

Key words: childhood education, learning self-regulation, emotion self-regulation abilities, self-regulatory abilities in pre-school children.

Resumen:

Es ampliamente reconocido en la literatura que las habilidades metacognitivas y de autorregulación son de fundamental importancia para el desarrollo general y académico de los niños, y que son altamente enseñables. Cuándo y cómo comienzan a desarrollarse estas habilidades son preguntas aún abiertas a debate, y por lo tanto, sujetas a la nueva evidencia acumulada en este campo de investigación. En este artículo nos proponemos desarrollar una mirada general de los avances significativos durante la última década en la investigación sobre el desarrollo de la autorregulación desde el nacimiento hasta los seis años de edad. Revisamos evidencia que sugiere que estas habilidades comienzan a desarrollarse desde el la infancia misma y a lo largo de los años preescolares. En las primeras dos secciones abordamos la emergencia temprana del funcionamiento ejecutivo y el control cognitivo, y la regulación social y emocional. En la sección final tratamos un área significativa de emergencia reciente, relacionada con las herramientas comunicativas y simbólicas y el rol clave que juegan en la emergencia de las habilidades de autorregulación en niños pequeños. Discutimos las implicancias teóricas, metodológicas y educacionales de este campo de investigación.

Palabras clave: educación infantil, autorregulación del aprendizaje, habilidades de autorregulación emocional, habilidades de autorregulación temprana.

1. Introduction: historical review

The early emergence and development of self-regulation in young children is a research topic currently attracting considerable and rapidly growing attention. There are a number of clear and compelling reasons for this. To begin with, it has been established for some time that metacognitive abilities, the cognitive and arguably central component of self-regulation, make a major contribution to learning (Wang, Haertel & Walberg, 1990) and do so independently of traditionally measured IQ (Veenman & Spaans, 2005). More recently, research with young children has shown that early developing executive functioning and self-regulatory abilities in pre-school children predict 'positive adaptation to school' (Blair & Diamond, 2008) and the development of early academic abilities (Blair & Razza, 2007). Early emotion regulation abilities, specifically, have been implicated in young children's capacity to follow instructions, focus attention and co-operate with teachers and peers (Rubin et al., 1999).

At the same time, a growing number of studies have demonstrated that metacognitive and self-regulatory abilities are learnt and are highly teachable. Dignath, Buettner & Langfeldt (2008) recently provided a meta-analysis of a range of studies across the primary school age-range, for example, and revealed impressive effect sizes for interventions teaching self-regulation strategies to children in this age-range. A systematic review of recent studies of parental influence on self-regulation among pre-schoolers and primary aged children has identified a number of characteristic parenting dimensions and behaviours which have been consistently found to be related to metacognitive and motivational aspects of self-regulated learning (Pino-Pasternak & Whitebread, 2010).

A number of research traditions have contributed to our developing understandings concerning self-regulation. These include the socio-cultural, originally Russian, school of developmental studies prominently influenced by the writings of Lev Vygotsky (1978), which has emphasised the social origins of 'higher mental processes' involved in self-regulation. The information-processing, cognitive school, mostly located in the United States, was influenced by the early work of Flavell (1979) who first coined the term 'metacognition' and Ann Brown (1987) who developed an influential early model of metacognition distinguishing metacognitive knowledge from metacognitive awareness and control. More recently, work focused upon motivational and affective aspects of self regulation, both in Europe (Boekaerts, Pintrich &

Zeidner, 2000) and in the United States (Baumeister & Vohs, 2004), has located metacognition (i.e. the regulation of cognition) within the much broader conception of self-regulation, incorporating all aspects of development. At the same time, research emerging from clinical and neuroscience traditions concerned with processes of brain development and early executive functioning has shown that, even in very young children, emergent regulatory processes can be detected which appear likely to be fundamental to later metacognitive and self-regulatory developments (Fernandez-Duque et al., 2000).

This level of interest and research activity in relation to self-regulatory developments in pre-school children and even infants is, however, a relatively recent development. The established orthodoxy within metacognition research has been that metacognitive skills emerge around the age of 8 to 10 years (Veenman, Van Hout-Wolters, & Afflerbach, 2006) and are necessarily preceded by other cognitive abilities such as the development of theory of mind (Wellman, 1985). However, this position has been challenged by recent research on both methodological and theoretical grounds. As regards methodology, it is increasingly recognised that research relying on self-report or verbally-based experimental methodologies may significantly underestimate the metacognitive and self-regulated performance of young children (Van Hout-Wolters, 2000; Whitebread et al., 2005; Winne & Perry, 2000). Recent studies, adopting a range of more age-appropriate methodologies, have identified and begun to analyse metacognitive and self-regulatory behaviours in much younger children.

At the theoretical level, the key development has been the recognition of the role of implicit, non-conscious processes in metacognitive development, particularly in its early emergence in young children. In much of the early metacognition literature, following the early influential work of Flavell (1979), the assumption has been that metacognitive knowledge is declarative and that metacognitive processes are available to conscious awareness. However, work in other areas of cognition (e.g. memory) and related to consciousness itself, has indicated that implicit, unconscious processes are likely to make a significant contribution to metacognitive development (e.g.: see Reder 1996). Certainly, extensive study of the relations between explicit metacognitive knowledge and performance, particularly in the area of memory, shows that while they increase with age, they are never especially strong (Schneider & Bjorklund 1998). Siegler (1996), in his important work relating to children's development of cognitive strategies, has also concluded that the metacognitive processes involved in strategy selection, certainly in children, are predominantly of an implicit nature and unavailable to conscious awareness. Fitzsimmons & Bargh (2004) have provided a comprehensive review of work related to the non-conscious self-regulation of cognition, emotion and behaviour.

Bronson (2000) provided a very useful, comprehensive review of research concerned with the early development of cognitive, emotional, motivational and social aspects of self-regulation in children, particularly in relation to educational contexts, up to the end of primary, or elementary schooling. In this paper, our intention is to acknowledge the work reviewed by Bronson, and established knowledge by the date of her book, but to focus principally upon research in the last decade which has significantly advanced our understandings in this area. The first two sections deal with areas addressed by Bronson (2000), namely the early emergence of executive functioning and cognitive control, and early emotional and social regulation. The final section deals with a significant and newly emerging area of research, concerned with early communicative and symbolic tools and the key role they play in the emergence of self-regulatory abilities in young children.

2. Executive functioning and cognitive control

Table 1 is adapted from a similar table put together by Martha Bronson (2000) and lists the key points established concerning young children's development of cognitive self-regulation by the turn of the last century.

Table 1. *Early development of cognitive self-regulation (adapted from Bronson, 2000)*

From 0 to 12 months old	<ul style="list-style-type: none"> Focuses attention on specific others, objects, and own activities (reaching, grasping, manipulating objects) Notices regularities and novelties in the social and physical environment Begins to participate and predict sequences Begins to initiate behaviour sequences with people and objects Notices effects of own actions
From 12 to 36 month old	<ul style="list-style-type: none"> Wants predictable routines and resists change Can choose among a limited number of alternatives Goal directed behaviour Begins to notice and correct errors in goal directed activities Uses an increasing number of strategies to reach goals Shows cognitive organization by matching, sorting, and classifying
From 3 to 6 years old	<ul style="list-style-type: none"> Can engage in a wider range of cognitive activities More able to carry out multi-step activities More able to control attention and resist distraction Can learn to use more advanced problem solving strategies More able to choose tasks appropriate for own level of skill

As indicated above, however, over the last decade there has been considerable renewed interest in this area, and some very significant developments in methodology and theory have been achieved. Following on from Fernandez-Duque et al.'s (2000) insights concerning the relations between executive functioning and cognitive control, much of the renewed research interest has concerned the identification, measurement and theoretical modelling of early executive function development across the entire preschool age range. Garon, Bryson & Smith (2008) have provided an extensive review of research in this area. In the 3-6 age range, the model of metacognition originally developed by Nelson & Narens (1990), incorporating the complimentary processes of metacognitive monitoring and control, has been widely adopted, and evidence has been accrued of young children's much more advanced abilities in these areas than was previously recognised.

The processes of executive functioning and cognitive control have been extensively linked to the pre-frontal cortex, which is known to be the slowest developing brain region, showing profound developmental changes right through to adulthood. Within the first five or six years of life, however, there are crucial developments in basic cognitive functioning which have widespread implications for later development. An extensive range of basic cognitive processes have been proposed as 'executive functions', but in an influential integrative review of the most up-to-date research Garon, Bryson & Smith (2008) have concluded that the key processes appear to be those related to attention (focusing on relevant rather than irrelevant information), working memory (holding information in mind while updating or manipulating it), inhibitory control (stopping an initial, proponent, automatic or perceptually attractive response and replacing it by another) and cognitive flexibility (often referred to as 'set shifting', or the ability to adapt from one mental set, or task rules, to a different set). As they further review, an increasingly ingenious set of tasks has been developed over recent years in the attempt to validly and reliably measure children's abilities in relation to each of these processes. Carlson (2005) helpfully carried out a meta-analysis of the results for 24 such tasks which had been tested on 602 preschool children (118 two-year-olds, 207 three-year-olds, 194 four-year-olds and 83 five and six year olds) and produced a developmental

progression of tasks which could typically be successfully addressed by children in each age group.

Various theoretical models have been advanced as to how the various executive functions are inter-related, and how the relationships between them develop during the preschool period. Thus, Jones, Rothbart & Posner (2003) showed that, in children within this age group, the processes of attention focusing and cognitive flexibility could sometimes be negatively correlated i.e. children who showed ability in one of these were less likely to be good at the other. However, in a study of 228 3-year-olds, using a battery of executive function tasks related to working memory and inhibitory control, Wiebe et al. (2011) concluded, on the basis of a confirmatory factor analysis, that at this age executive function appeared to be best described by a single factor i.e. as a unitary, domain-general process. Marcovitch & Zelazo (2009), on the other hand, based on studies of children's performance on A-not-B tasks (where a child has to search for a hidden object which has been visibly hidden at location A, then visibly moved and hidden at location B) have proposed what they have termed a 'hierarchical competing systems' model, whereby performance on any particular task is determined by the competing influences of developmentally invariant habits of mind and the increasingly influential conscious representational systems being developed within the mind of the young child. Garon, Bryson & Smith (2008), in a view which might essentially be coherent with this model, conclude that development in executive functioning, particularly in the later preschool years, is a consequence of developments in attention, and integration of component executive functions.

What does clearly emerge, however, is that early simple forms of each of the key executive functions can be seen in very young children, and that there are clear developments during the preschool period arising from improvements in voluntary control i.e. increasing self-regulation. Thus, as Garon, Bryson & Smith (2008) review, the ability to select and focus attention upon a stimulus is present from early infancy. This ability is initially strongly dependent on environmental factors such as novelty, but becomes increasingly under voluntary control from the end of the first year. During the preschool years, the ability to sustain attention for longer periods develops and becomes less dependent upon context. As regards working memory, the ability to hold a representation of an object or event in mind during a period of time develops before 6 months of age. Improvements in holding both auditory and visual information in memory occur throughout the preschool period, but these appear to be largely attributable to improved functioning of the central executive system within working memory, which co-ordinates and regulates the performance of the various basic stores, rather than simple growth of store capacity. A similar pattern emerges with inhibitory control, with simple forms being easily identified during the first year, but considerable improvements in control throughout the preschool period, for example on 'delay of gratification' tasks, and 'Stroop' tasks requiring children to ignore a highly perceptually salient feature of a stimulus and instead respond to a less salient feature. The status of cognitive flexibility or 'set shifting' as a separate executive function is less clear, as many of the tasks and abilities involved here seem to be also dependent upon working memory and inhibitory control processes. Perhaps partly as a consequence of this, the ability to re-focus attention, or deal with conflicting information, or shift from one mental set to another, appears to emerge later during the preschool years. However, once again, developments in this area are clearly coherent with a self-regulation model.

The development of these fundamental executive function processes into clearly metacognitive or self-regulatory behaviours and abilities amongst children in the 3-6 age range has been firmly established during the last decade. A team led by one of the present

authors (Whitebread et al., 2005, 2007, 2009), for example, has carried out observational studies of children in the naturalistic contexts of their preschool classrooms, mostly engaging in playful, self-initiated individual and small group collaborative activities. In this type of context, these observations have revealed extensive self-regulatory behaviours in this age group, including examples of both the complimentary processes of monitoring and control, as defined by Nelson & Narens (1990). Monitoring behaviours observed in preschool children included self-commentary, reviewing progress and keeping track, rating effort and level of difficulty, checking behaviours and detecting errors, evaluating strategies used, rating the quality of performance, and evaluating when a task was complete. Control behaviours included changing strategies as a result of previous monitoring, applying a previously learnt strategy to a new situation, repeating a strategy in order to check the accuracy of the outcome, using a non-verbal gesture to support cognitive activity, and various types of planning activities.

In very young children, however, these abilities are very context dependent. As Efklides (2006) has noted, a variety of cues are used when individuals make judgements about their learning or the difficulty of a task, and novice learners in particular are prone to attend to more salient but less relevant cues. So, for example, if a task looks superficially familiar, this might override an analysis of the mnemonic demands of the task and lead to an over-optimistic judgment. Certainly, it is well documented that young children are extremely prone to over-optimistic judgements about what they will remember. The evidence from experimental studies reviewed by Schneider and Lockl (2002) indicates that, in comparison to preschool children, older children can more accurately predict future performance; are more accurate when they are asked to estimate if they are ready to recall a series of items, and can more accurately tell if they would be able to recognise the names of items they are not able to retrieve spontaneously. However, the same researchers have acknowledged that cognitive monitoring is highly dependent on the format and content of the tasks and that preschool children can engage in monitoring when the tasks are ecologically valid and meaningful to them. In a recent replication of Istomina's (1975) classic study of young children's memory performance in different contexts, Mistry, Rogoff and Herman (2001) found that 4 year olds showed evidence of awareness of forgetting and simple memory strategies in a scenario involving shopping for a tea party which they were unable to show in a purely experimental memory task.

3. Socio-emotional development of self-regulation

The socio-emotional aspect of self-regulation refers, in general terms, to the ability to control and modulate emotional expressions (positive or negative) and interacting with others in increasingly more complex ways in accordance with social rules. It also refers to the ability to adapt to emotionally challenging situations, to inhibit behaviors perceived as inappropriate in a given context and to privilege behaviors that are perceived as the socially expected, even when they do not correspond to the individual's first response or may not be pleasant to undertake. Table 2 is again adapted from Bronson (2000), with some additions from the significant earlier work of Kopp (1982) and indicates what was established in this area by the turn of the century. Since 2000, research in this field has proliferated considerably, but especially in the period from birth to 3 years of age, within which new evidence has challenged assumptions sustained for decades about the late onset of some aspects of socio-emotional self-regulation. For this reason, in this section we will focus on the infancy (birth to 1 year) and toddlerhood (1 to 3 year) periods.

Table 2. *Early development of social-emotional regulation (adapted from Bronson, 2000 and Kopp, 1982)*

From 0 to 12 months old	Regulation of arousal and sleep/wake cycles Responsive interaction with others Attempts to influence others Begins to anticipate and participate in simple routines Responsiveness to emotional expressions of others
From 12 to 36 months old	Increasing voluntary control and voluntary self-regulation Growing ability to comply with external requests and awareness of situational demands Increasing assertiveness and desire for independent action Increasing awareness of others and the feeling of others (empathy) Some spontaneous helping, sharing and comforting behaviours Increasing awareness of social rules and sanctions Increasing ability to inhibit prohibited activities and delay upon request
From 3 to 6 years old	More capable of controlling emotions, abiding by rules, and refraining from forbidden behaviours More capable of using language to regulate own behaviour and influence others More interest in peers and peer acceptance, so more apt to regulate self in relation to peers Can learn more effective interaction strategies Can engage in dramatic play with roles and rules Begins to talk about mental states of self and others Better understanding how others may feel Can engage deliberate helping, sharing, and comforting behaviours Internalizing standards of behaviour Developing more stable prosocial (or antisocial) attitudes and behaviours

a) Socio-emotional self-regulation in Infancy

The first 3-4 months of life are characterized by the infant's dependency on caregivers to modulate her emotional states and to adapt to new changing circumstances in the environment. The organization of routines related to daily care and caregivers' responsiveness to the babies' cues (e.g. discomfort, distress, crying) facilitate the development of anticipation to events and the formation of sleep-awake patterns. This supports the ability to modulate emotional responses in increasingly effective ways, to be less likely to suffer emotional distress and to be easier to soothe and comfort. The acquisition of sleep-awake patterns helps infants to maintain emotional balance between shifts of states from alertness, to drowsiness and sleep, and vice versa. This has been recently associated with temperament and later self-regulatory abilities (Peirano, Algarín, & Uauy, 2003; Scher, 2005; Spruyt et al., 2008).

Trevarthen's research shows that infants' movements during face to face interaction, even days after birth, are organized and sensitive to the emotional expressions of the adult (e.g. Trevarthen, 2011; Trevarthen & Aitken, 2001). The rapid growth of perceptive skills and repeated face to face 'plays' and 'conversations' assist the infant to attend for longer periods of time, in a more responsive and synchronized ways. The well-known 'social smile' first appears at this stage and becomes more regular as a response to caregivers efforts during communicative exchanges. Infants are especially sensitive and they have a clear preference for the particular way in which adults spontaneously talk to them, referred to as 'infant directed speech', or 'motherese', along with exaggerated facial expressions of emotions. In sum, face to face interactions between caregivers and babies are a fundamental source of learning and early regulation.

In the first few months encounters between infants and their surroundings are based on applying and exercising innate reflexes, for example turning her head towards something that touches her cheek and sucking, or grasping objects nearby. By about the 4th or 5th month, however - at the point where some researchers set the capacity to differentiate

between the self, the world and others - the ability to interact with objects and others qualitatively changes. From this age infants realize that their actions have an effect in the real world, and they attempt to repeat over and over interesting events. They begin to reach for and accept objects that others show and offer to them. During interactions with others, they start initiating play and anticipating the others' responses, coming to participate in back and forth patterns of interaction which Trevarthen has referred to as 'proto-conversations'. Lewis & Granic (2010) refer to this phase as 'Interpersonal Expectancy' emphasizing the emotional effect of expecting a certain response from others. At this stage it is more likely that the break of a playful interaction will cause distress, making this phase a vulnerable period for the infant.

In the 5 to 8 month period, babies keep improving their ability to act upon objects, and they engage in increasingly more conventionalized games with others, such as 'peek a boo'.

The following stage, from 8 to 12 months, is particularly rich in essential developmental milestones for socio-emotional aspect of self-regulation. In this phase infants first show the ability for social referencing, using cues from adults in order to decide how to act in situations that they perceive as frightening, for example. Studies that have used the 'visual cliff' procedure show that babies assess the situation, direct a gaze at the adults' face and according to their interpretation of the adults' negative or positive emotional expression, they decide whether to keep crawling or not towards the cliff (Feinman, 1992; Tamis-LeMonda et al., 2008). The cognitive accomplishment of understanding the permanency of objects and people first emerges in this period and it has a great impact on socio-emotional development. Now the baby understands that parents do not disappear when they are not visible, and tries to look for them. In this stage infants are considerably more sensitive to the whereabouts of caregivers and they can experience emotional distress at separation.

b) Socio-emotional self-regulation in Toddlerhood

The following phase, from 12 to 18 months, is also distinguished by great advances in the socio-emotional realm. The ability to walk gives a whole new perspective on the world and, more importantly, on the self, as an autonomous and independent being. This gives toddlers great opportunities to explore, search for people for interaction, and to learn about new aspects of their culture. Their first words expand their possibilities for social interaction beyond that achieved through preverbal communication. They can establish interaction with a greater degree of agreements with others, they can comment on events or states of the world, and tell other people what to do in a more elaborated way.

One aspect in which new research has changed previous assumptions in early development is the recent evidence on false belief understanding, or the ability to assume that other people can hold beliefs that may not correspond to reality, which can consequently mislead their behaviour. For example, a child that stealthily ate the last cookie in a box and laughs when observing her sister reaching into the box can understand that the latter was holding the false belief that there were still some cookies left in the box. Standard tasks measuring this skill typically use characters and specified scripts to recreate situations in which the understanding of false beliefs is necessary to respond correctly to the experimenter's questions. However, in tasks like this, not only the understanding of false beliefs is compulsory to respond accurately, but also complex computational and verbal skills

(see Bloom & German, 2000). Onishi & Baillargeon, (2005) for example, using only non verbal tasks, demonstrated that children as young as 15 months old appeal to mental states, such as beliefs, to explain the behaviour of others.

The phase between the 17 and 22 months is referred to by Lewis & Granic (2010) as that of 'social negotiation' because the understanding of others' goals and intentions, in contrast with the set of one's own goals, and the progressively more advanced communicative skills, allows children the possibility to refuse to act according to others' expectations and challenge their plans. The word "no!" can become one of the favourites in the vocabulary of young children, and the fixed determination to carry out their own goals "now", with poor understanding of temporal notions like "later", has given this stage and part of the following the reputation as the 'terrible twos'. Reactions of caregivers to these negatives from the child and the constant negotiations can give rise to a state of anxiety and emotional vulnerability in the child.

From 22 to 28 months, children continue to improve their communicative and symbolic skills. Increasing vocabulary helps them to gain better understandings with others, to express and to cope with their own emotions. They are more able to cooperate with others apart from their caregivers, and this can help them to reduce the anxiety caused by separation. An important emotional challenge in the next stage, from 28 to 36 months, is the new ability to feel jealousy. Understanding that their caregivers can assist other people to achieve their needs, or express positive emotions towards them, can lead the child to react aggressively. From around 30 months onwards, individual differences become more salient. In general, children from this age know more about their own emotions and others' and they are better able to communicate about them and control them according to the context.

Research on inhibitory and effortful control or the ability to suppress dominant behaviors, and perform a subdominant response (Kochanska, et al., 2008; Kochanska, Coy, & Murray, 2001; Rothbart & Rueda, 2005; Rothbart, et al., 2011; Rueda, et al., 2005), uses tasks such as 'Do's and Don'ts' and 'Go/NoGo', delay of gratification, and so on. In these situations, children typically show that they are increasingly able to voluntarily control their behaviour and comply with other's demands.

Perhaps one of the most important advances in the recent years in this field is the increase of our understanding on the biological mechanisms that underlie these developments. Kochanska et al. (2009) studied longitudinally a sample of children from 15 to 22 months. They measured attachment (*secure vs. insecure*) and the polymorphism of alleles of the serotonin transporter gene (5-HTTLPR, *short or short/long vs. long*). Individuals that are either homozygous for the short allele (*short*) or heterozygous (*short/long*) have been found to be associated with poorer inhibitory capabilities. They also used a number of self-regulation tasks with children at 25, 38, and 52 months of age. Interestingly, they found that children that had the shorter type of allele, and insecure attachment, performed significantly worse than those with the longer allele on the self-regulation tasks. However, they did not find any significant difference for children with the shorter allele, but with secure attachment. They concluded that children with that certain type of allele were 'at risk' of developing poorer self-regulatory skills, but that secure attachment served as a protective factor.

As a consequence of this accumulating evidence of increasing voluntary control of emotional and social regulation during infancy and toddlerhood, Rothbart et al. (2011) have hypothesized that, between the 1st and the 3rd years of life, there is a shift from the neural

networks associated with the regulation of emotion, from the attention orienting system, involving the parietal area of the brain, to the executive attention system in the prefrontal cortex.

4. The development of early cognitive tools: self-directed and social communicative signs, symbol and gestures

At the time of publication of Bronson’s (2000) review of early self-regulation, the area of communicative and self-directed tools, in comparison to the other areas we have discussed, was relatively under-researched. However, there have been considerable and very exciting developments in this area in the last decade, the key points of which are addressed in this section. Table 3 summarises the main milestones in gesture and language development from infancy to childhood, as established by major reviews in the area (Bates & Dick, 2002; Capone & McGregor, 2004). The role of these verbal and non-verbal and communicative signs in the early development of self-regulation is now increasingly recognized.

Table 3. *Gesture and language development (adapted from Bates & Dick, 2002; Capone & McGregor, 2004)*

6 -8 months	Canonical babbling Rhythmic hand movements
8-10 months	Deictic gestures (like pointing) Recognition of some familiar words Gestural routines (like those carried out with songs)
10 - 13 months	Comprehension and production of gestures like showing, giving, pointing and ritualized requests Other pre-linguistic behaviours include eye contact, joint attention and turn-taking Asking for the help of others to achieve own goals
12-13 months	Representational gestures, iconic and arbitrary (iconic gestures are those with some similarity to what they represent, and arbitrary are those gestures that keep no similarity to what they represent, and usually conventionalized, like waving bye bye, or thumbs up) First words emerge Gestures for recognizing the functions of objects or “play schemes” (a type of gesture where children perform very briefly the function of a known object, using a hairbrush to brush their hair, or drinking from a cup) Gesture serves a complementary function to spoken language
14-17 months	Gesture or vocal preference for communication Spoken word preference Gestures- words combinations
18-24 months	Significant increase in words produced and vocabulary 50 words by 20 months; 300 words by 24 months Transition to empty-handed play schemes
2-5 years	Grammaticization (learning to transform words according to grammatical rules, for example, declining verbs) Speech-gesture integration Beat gestures emerge, they can accompany longer utterances (rhythmic gesture accompanying language used for example to give emphasis in one point of a sentence) Gesture scaffolds spoken expression and comprehension
School age	Gesture scaffolds expression and comprehension Mismatched gesture-spoken language combinations in relation to tasks can provide information about children’s knowledge that is not yet declarative Gesture aids in the transition to concept acquisition

Researchers in pursuit of understanding the development of self-regulation in young children have commonly used children's speech during play as a window to their cognitive processes. It is common to observe 3 - 4 year old children playing together, greatly engaged in their activity, and talking aloud at the same time in a parallel display of self-commentaries or monologues rather than a genuine social dialogue or discussion. Vygotsky (1978) revolutionized the way in which developmental psychologists conceive the relationship between language and thought by reinterpreting the function of this kind of self-talk that children produce accompanying their actions. Piaget had previously referred to this phenomenon as 'egocentric speech' in his writings about infantile play (Piaget, 1923). While for Piaget this kind of self-directed speech represented an example of children's egocentric thought and lacked cognitive relevance for development, for Vygotsky this phenomenon was seen as a fundamental milestone in human development.

From Vygotsky's point of view, children talk to themselves during play, or when facing challenging situations, because it helps them to guide their actions and cognitive processes. For instance, a child playing with a jigsaw puzzle can whisper to herself something like *"Where are the corners?"* while searching for a piece or *"This one doesn't fit here"* when trying to fit a piece on the board. This ability to use a conventional semiotic tool, such as language, to intentionally control one's own thoughts and behaviours represents the emergence of what Vygotsky referred to as 'Higher Psychological Functions'. In his words:

"the most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development, converge" (Vygotsky, 1978, p. 24)

According to Vygotsky's sociocultural account, higher psychological functions are a product of social interaction and not merely a result of maturation or a construction through the child's experience alone. His 'law of double formation' states that higher psychological functions always appear twice, first in an 'intermental level', in interaction with other persons through communicative semiotic means, and only afterwards, as a product of internalization, in an 'intramental level', when the child regulates her own thoughts and actions through the use semiotic tools learnt beforehand in communicative contexts. Thus, caregivers play a fundamental role in the development of children's cognition and self-regulation. They first have the full responsibility over the task regulating children's actions through language and other tools, for example, in the case of the jigsaw puzzle, they might say *"Why don't you search for the corners first?"* or *"Check if that one fits there"* when *pointing* at an empty slot on the board. Adults progressively allow children to take over the control of the task as they gain mastery. After children have come to understand and use signs and language in these communicative encounters, they may also learn to use these 'tools' with a self-regulatory purpose, to control their own cognitive processes. Children first talk to themselves aloud, as in private speech, and progressively internalize language until it becomes internalised, silent thought.

During the past decade, empirical studies on private speech have proliferated remarkably, across different age groups, tasks and contexts (Winsler, Fernyhough, & Montero, 2009). This work has established that private speech is linked to improved performance on specific tasks (Fernyhough & Fradley, 2005); that it is more frequent as a function of the level of difficulty of the task (de Dios & Montero, 2006); and that the content of private speech is related to parents/teachers input during previous instruction of a similar task (Berk & Spuhl, 1995; Diaz & Berk, 1992). Interestingly, in a pretend play context, young children that first

played with a parent and were observed playing with the same toys alone afterwards, not only repeated the same actions previously carried out with the adult, but also developed new creative symbolic scenarios to a greater extent than children who did not play with an adult beforehand (Nielsen & Christie, 2008).

In addition to the recognition given to spoken language as a tool for self-regulation in this recent research, however, researchers interested on the use of non verbal communication have also demonstrated that non-verbal signs and symbols and language are not two separate systems, but a unified one (e.g. (Goldin-Meadow, 2005, 2006). A number of studies have now demonstrated that gestures can also serve a cognitive function. This is reflected, for example, in children's language-gesture mismatches when trying to explain recently acquired concepts (Garber & Goldin-Meadow, 2002; Pine, Lufkin, & Messer, 2004) or in the spontaneous production of gestures when solving tasks that involve the use of spatial information (Chu & Kita, 2008), among other teaching-learning contexts (see Roth, 2001 for a review).

For the purposes of the argument that we are developing in this paper, this evidence is important for two reasons. First, as we argued earlier, it is increasingly recognised that non-conscious, non-verbal behaviours are a significant part of children's and adults' metacognitive processes. Second, in investigating the developmental pathways of self-regulation in children before language and in the threshold of language acquisition it is the *only* window that we have available. Furthermore, although studies on cognitive self-regulation in children before the age of 2 years are scarce, recent research suggests that preverbal children might be able to use gestures and pre-linguistic vocalisations as a tool for self-regulation.

Rodríguez & Palacios (2007) have coined the term 'private gestures' to refer to this phenomenon to build a parallelism with the literature on private speech. In their study, they reported a case study in which a child was observed longitudinally from 12 to 18 months in interaction with her mother and one object (consisting of stacking rings around a vertical post). Arising from these observations the use of two types of private gestures -intentional signs directed towards the self in the face of a difficulty in the conventional use of an object- were described: private pointing gestures and private ostensive gestures. The girl in this study was repeatedly deploying pointing gestures towards the vertical post while holding a ring in her hand *before* her attempt to place it on the post, as if she was reminding to herself "the ring goes here". She did this in a way that did not seem to be directed towards the adults around her, but she remained focused on her own activity instead. 'Ostensive' gestures refer to signs that use an object itself as the referent to communicate something about it, such as in a showing or giving gesture. Rodríguez & Palacios described situations in which the girl used private ostensive signs with the ring when, during the course of her action, she would stop and show the ring to herself for several seconds and rotate it in her hand, as if she was trying to understand the shape of the object and the position in which it should be placed around the post. The key issues about these kinds of behaviours for Rodríguez & Palacios are that there is a pause in the course of the action, and that the child uses communicative signs that were learnt previously in a social context, but in a reflexive way -towards herself- in order to regulate her own goal directed conventional action with the object. The signs were not produced in order to affect the behaviour of others, or to affect reality in an immediate way, but as if their intention was to change something at the level of the mental representations that the girl held about the object and its use. She was being the producer and the interpreter of her own signs, which indicates reflection and some form of consciousness at the preverbal stage.

In a recent study, Basilio & Rodríguez (2011) reported observations from a longitudinal study showing other types of private gestures and vocalizations. They described a 'private use' of an instrument, when a 15 months old girl at the beginning of the session was using a hammer toy as if she was trying to remember what the instrument was for. Similar situations have been described in the literature of language acquisition, referred to as 'object recognition gestures' (Bates & Dick, 2002; Capirci, et al., 2005; Iverson, 2010). This type of gestures consists of spontaneous uses of objects related to their function but not in a practical way (e.g. moving a hair brush towards the head, an empty spoon to the mouth, blowing an unlit candle, etc.). When they are not meant to engage anyone else in a communicative way, but are just produced in a solitary way, these gestures may serve a self-proto-declarative function, as in telling oneself, "I know what this is for".

Some gestures are conventional, such as waving 'bye bye', pointing gestures, or thumbs up, are produced and taught spontaneously by caregivers and vary across cultures. Some researchers have investigated the cognitive impact of specifically instructing young children in the use of symbolic signs taken from Sign Language. Claire Vallotton (2008, 2011), for example, has observed young children in a nursery setting that actively used a set of symbolic gestures on a daily bases and also promoted its use at home. She produced evidence that the children could use these gestures in order to understand and regulate their emotions. For example, a young child could be soothed more easily, when a parent was leaving, by using the gestures for "mummy" and "later", or a child could comment about a classmate crying using gestures for "cry" and "bottle". In addition, Vallotton & Ayoub (2009, 2011) have provided evidence, from a large sample of children, showing that early vocabulary repertoire (including gestures) at 14 months of age predicted later self-regulation at 24 and 36 months. As Winsler (2009) pointed out in his recent review of the literature on private speech:

"these finding [about the studies on private gestures] show that self-regulation and the use of signs for one's own purposes appear, at least in some forms, preverbally, earlier than previously thought. Clearly, this is an area of research that will likely blossom in the years to come." (Winsler et al., 2009, p. 10).

5. Conclusions and Implications

We began this paper by acknowledging the evidence, now well-established, that metacognitive and self-regulatory abilities are of fundamental significance for children's general and academic development and that these abilities are teachable. We have attempted to provide a general overview of the considerable advances in the last decade suggesting that these abilities begin their development right from infancy and through the preschool years. We would like to conclude by making a few brief points indicating the theoretical, methodological and educational significance of this body of research.

As regards theory, it is clear that a fuller understanding of metacognitive and self-regulatory abilities and development will be furthered by studies at a wide range of levels of analysis, including physiological, psychological/functional and social levels, and by continued research which investigates the relationships and influences between processes at these levels. We have reviewed work in which this has begun to happen (for example, the mediating effects of attachment on gene-expression related to inhibition) but much more of this kind of research is required. Of educational relevance, of course, are studies investigating the impact of social mediation on the development of skills and dispositions relevant to self-regulation. Diamond et al.'s (2007) analysis of the impact of the 'Tools of the Mind' kindergarten

programme on executive functions is a good example of this kind of work. In fact, what work has been carried out of this kind has mostly focused on the home parental environment. Recent research has shown, for example, that the sensitivity and responsivity of parental interactions with infants may play a significant role in facilitating the organization of the infant's psychological system necessary for achieving self-regulation. During the last decade a number of similar studies have stressed the mediational effect of certain features of parental interactions during infancy on later executive functioning and cognitive development (Bernier, Carlson & Whipple, 2010; Landry, et al., 2002; Landry, Smith, & Swank, 2006).

Methodologically, it is clear that we need more observational studies of children in naturalistic contexts, or undertaking playful tasks which are developmentally appropriate. It is clear that many of the tasks developed to investigate executive functioning and self-regulation experimentally are remote from young children's everyday experience and likely to provide results which under-estimate young children's real abilities. There is also little that can be learnt of direct educational relevance from these types of executive functioning studies. We also need to develop more extensive and soundly researched observational frameworks and instruments in relation to the development of self-regulation in young children. One of the present authors has developed a research coding framework and an instrument for use by teachers of 3-6 year olds (Whitebread et al., 2009), but there is nothing of this type for younger age-groups, and this instrument is of a rather general nature. Observational instruments directed at more specific aspects of self-regulatory development would be advantageous.

It is now very well established that there are clear and fundamental implications of the kind of research reviewed here for education. Metacognitive and self-regulatory abilities, under-pinned by efficient executive functioning, have a major impact on children's general and academic development. It is also evident that adult intervention and social mediation can have significant influence of this development, and that there are marked individual differences in the skill and sensitivity with which adults are able to fill this role. This is clear from the now reasonably developed work with parents and preschool children (Pino Pasternak & Whitebread, 2010) and has also been demonstrated in a smaller number of studies with slightly older children in educational contexts. Ornstein, Grammer & Coffman (2010), for example, have recently reported a study concerned with what they term teachers' 'Mnemonic Style'. Echoing other research on the impact of child-parent dialogue which involves 'mentalising' words and reference to mental processes on children's developing metacognitive abilities, this study of Year 1 teachers demonstrated similar effects at work in the educational arena. Children in mathematics classes with teachers who explicitly modelled and discussed mnemonic strategies showed significantly improved memory skills and memories for mathematical information and this effect was still significant three years later when the children were in Year 4.

While there is still much to be investigated, it is clear that we are already in a position to provide some guidance of educational relevance which would improve the effectiveness of educational provision for young children. One of the present authors, for example, has written extensively concerning pedagogical principles to support and nurture self regulation in children in the first few years of schooling (Whitebread, 2007). It is hoped that the present paper will make a contribution to the dissemination of research which can inform the efforts of teachers to most effectively mediate the learning of young children and help them develop into independent, metacognitively skilled and self-regulating learners.

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