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When Everything New Is Well-Forgotten Old: Vygotsky/Luria Insights in the Development of Executive Functions

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Abstract

The concept of “extra-cortical organization of higher mental functions” proposed by Lev Vygotsky and expanded by Alexander Luria extends cultural-historical psychology regarding the interplay of natural and cultural factors in the development of the human mind. Using the example of self-regulation, the authors explore the evolution of this idea from its origins to recent findings on the neuropsychological trajectories of the development of executive functions. Empirical data derived from the Tools of the Mind project are used to discuss the idea of using classroom intervention to study the development of self-regulation in early childhood. © 2011 Wiley Periodicals, Inc.

If one wants to understand the brain's foundations for psychological activity, one must be prepared to study both the brain and the systems of activity in as great detail as contemporary science allows.

Luria, 1979, p. 173

With new data becoming available on the role of executive functions (EFs) in children's development and learning, researchers as well as educators have expressed the need for instructional interventions that would strengthen development of EF in typically developing children and/or prevent possible delays in their development in children with various risk factors. Tools of the Mind (Tools) is a program that has been developed to do just this. In this chapter, we describe the theoretical foundation of Tools and discuss how implementing specific instructional strategies comprising this curriculum impact the development of self-regulation/executive functions in young children. Tools is based on Vygotsky/Luria's views on the development of higher mental functions as well as on the work completed by their students within a cultural-historical paradigm. Insights about how self-regulation develops as well as about the teaching tactics and assessment approach form the basis for all activities so that the practice and learning of self-regulation is embedded in all activities.

A Vygotsky/Luria Approach to Neuropsychology

Although Alexander Luria is often credited with being a founding father of neuropsychology, he had always credited his colleague and mentor Lev Vygotsky with first formulating the principles underlying the relationship between brain and behavior (Luria, 2002). Before beginning the focused discussion of how executive function and self-regulation develop according to Luria, we first discuss the Vygotskian principles that Luria used and on which Tools is based. These principles include:

- Social genesis of higher mental functions
- The systemic structure of higher mental functions
- Dynamic localization and organization of higher mental functions

For Vygotskians, higher mental functions are self-regulated, mediated, and learned mental functions, which makes them central to the discussion of the development of self-regulation. One of the fundamental principles of the cultural-historical paradigm is the assertion that "a child's mental development is not a simple maturing of natural 'instincts,' but that it occurs in the process of objective activity and communication with adults" (Luria, 2002, p. 21). As children master the tools developed in

human history, they learn to make use of external *stimuli-media* or *tools* to organize their own behavior. Unlike an animal's reactions, which are produced by stimuli arising from its external or internal environment, a child's behaviors start being directed by signals that he or she has created. For example, a child can focus his or her attention by the means of labeling objects or can direct his or her problem-solving activities by engaging in external and later internal private speech. Thus, the child's attention or problem solving become mediated by tools that first exist outside the child and later become internalized (Vygotskians use the term "appropriated"), leading to the emergence of higher mental functions that are "complex and self-regulated and are social in origin, mediated in their structure, and conscious and voluntary in their mode of functioning" (Luria, 1980, p. 31).

Vygotsky emphasized the complex and dynamic nature of higher mental functions, pointing out that "In the process of development . . . it is not so much the functions which change . . . not so much their structure . . . but it is *the relations, the connections between the functions* which become changed and modified. New groups develop which were unknown at the preceding stage" (Vygotsky, 1997, p. 30).

Vygotsky referred to these groups as "psychological systems" that comprise mental and physiological processes at the same time. The idea of the unity of mental and physiological states is one of the central ideas underlying the cultural-historical approach, which focuses on the interaction of nature and nurture, and on the natural and cultural factors in the development of the human mind.

In the process of their development, higher mental functions go through a sequence of stages along the continuum from social to individual. Vygotsky illustrated this process using an example of a voluntary action: first, at the inter-mental stage—the initiation and the execution of the action is distributed between two individuals—"I order, you execute." The next stage—the extra-mental stage involves an individual issuing commands to himself or herself and then executing these self-commands. Finally, in the last stage—the intra-mental stage, the voluntary action is formed. Vygotsky associated this last stage with the formation of a new structural-functional system: the concept that later became central in Luria's neuropsychology, "two points in the brain which are excited from outside have the tendency to work in a unified system and turn into an intra-cortical point" (Vygotsky, 1997, p. 106).

The nature of the relationship between different components of the resulting structural-functional system is determined by the nature of social mediation existing primarily in the form of language. For example, as a toddler learns to feed himself or herself with a spoon, his or her concept of a spoon is formed as a result of a combination of experiences: the toddler learns about the function of a spoon as a tool by associating kinesthetic control with food; he or she also develops a generalized image of a spoon

associated with its verbal label. The toddler would hear the adult saying the word “spoon” as he or she starts to use the tool, manipulates the spoon, puts it in his or her mouth, or bangs it on the table. Thus, the resulting concept of spoon is shaped by language as a means of social mediation.

In addition to language being the most universal tool of social mediation, building and restructuring of higher mental functions is mediated by the use of other cultural tools, such as objects, signs, and symbols. In his handbook on neuropsychology Luria wrote that

... these external aids or historically formed devices are *essential elements in the establishment of functional connections between individual parts of the brain*, and that by their aid, areas of the brain which previously were independent *become components of a single functional system* It is this principle of construction of functional systems of the human brain that Vygotsky (1960) called the principle of ‘extra-cortical organization of complex mental functions,’ implying by this somewhat unusual term that all types of human conscious activity are always formed with support of external auxiliary tools or aids. (Luria, 1973, p. 31)

Vygotsky’s idea of systemic structure of higher mental functions was further developed by Luria and applied to cases where in the process of their development, certain components of these functions become impaired. The results of such impairment will have a different impact on the development of the entire system of higher mental functions depending not only on which of the components are affected but also on the time at which this impairment happened. Due to what is described in Vygotsky/Luria approach as dynamic localization and organization of higher mental functions, the relative contribution of each of the components of a higher mental function changes depending on its own maturation and on the nature of the connections established with the other components. As a result, both the nature of the difficulties a person might experience as a result of a specific deficit and the behavioral manifestations of these difficulties will be qualitatively different in an adult than in a growing child. Vygotsky and Luria attributed these differences to the different secondary deficits and the effect of developmental cascade (Karmiloff-Smith, 1998) that may develop following the primary deficit to affect not only existing but also emerging psychological systems, which rely on the participation of the affected component in their development. For example, executive function deficits will affect a child’s ability to engage in complex tasks requiring paying attention and engaging his or her working memory, which in turn will produce reading and writing difficulties. These difficulties, however, will differ qualitatively from the difficulties experienced by a child with a primary deficit related to sensory processes, such as vision or hearing.

Executive Functions as an Example of a Psychological System

The construct of executive functions per se has not been used by Vygotsky or Luria, although the use of the term EF by most current researchers is consistent with the idea of Vygotskian concepts of higher mental functions and the idea of psychological systems (Fernyhough, 2009). In the cultural-historical tradition, the constructs currently associated with EF and self-regulation have been primarily framed in terms of the development of voluntary behaviors and associated with children gaining control of their previously involuntary behaviors by using cultural tools, mostly of a linguistic nature:

. . . voluntary action arises in the process with the child's relationships with the adult and passes through a number of successive stages in its development. Originally taking the form of the fulfillment by the child of the adult's verbal instruction it is gradually—with the development of the child's own speech—transformed into a system of self-regulating acts in which the decisive role is played first by external and subsequently by internal speech, the chief mechanism of voluntary action. (Luria, 1960, p. 139)

Writing about the development of behavior regulation, Luria emphasized that this regulation is socially mediated and involves different mental functions at different stages of development, ideas which are consistent with viewing regulatory capacities as a psychological system. For example, Luria analyzed the changes in the role speech plays in allowing young children to regulate their motor actions. In the beginning, the effects of speech on child behavior are limited to its excitatory function: a toddler gradually becomes able to follow verbal instructions and no longer needs to be guided by more salient visual stimuli. This excitatory aspect of speech remains strong until four to four and a half years. At this age, “As soon as the directive role passes to the semantic aspect of speech and that aspect becomes dominant, external speech becomes superfluous. The directive role is taken over by those inner connections, which lie behind the word, and they now begin to display their selective effect in directing further motor responses of the child” (Luria, 1959, p. 351).

As a result of the further development of the EF system, children gain even greater control of their behaviors as they become able to direct not only their physical behaviors but their cognitive behaviors as well. In an experiment conducted with school-aged children, Luria studied their ability to memorize a set of random words with and without the help of picture cards. Using picture cards allowed children to increase the number of items they were able to recall by 60 percent. In this experiment, picture cards served as cultural tools that enabled children to gain control over

their memory by “replacing their direct application by a complicated cultural application” (Luria, 1994, p. 54).

The functional systems approach to the development of executive functions has important implications for their study in young children. First, it is important to identify whether we are focusing on EFs already forming a higher mental function or on the earlier prerequisites of EFs that have not yet acquired a socially mediated character (Fernyhough, 2009). Second, the study has to take into account the social contexts where EFs develop, and, in particular, the nature of the social mediation involved in their development. Finally, the cultural tools acquired by children need to be examined in relation to their facilitating children’s ability to regulate their behavior.

A Vygotsky/Luria-Based Approach to Instructional Interventions

Vygotsky/Luria views on the systemic structure of higher mental functions have practical implications for designing interventions aimed at strengthening the weakest components of a developing mental function, including EF. In this approach, the intervention focuses on preventing the emergence as well as the developmental progression of primary deficit of EF by engaging children in social interactions that enable them to acquire specific cultural tools. In the area of special education, this approach has been defined as re-mediation: children gain control over their own mental functions, replacing a set of tools that do not work due to the weakness of a certain function with another set better suited for this purpose (Vygotsky, 1993). In the work of post-Vygotskians, a similar approach has been applied not only to special education but also to general education. In the latter case, the emphasis is on designing instruction in such a way that it facilitates children’s acquisition of appropriate cultural tools and thus provides optimal support for the formation of higher mental functions. Knowing how different mental functions are engaged in the process of learning allowed post-Vygotskians to design a number of effective instructional interventions proven to improve children’s academic outcomes and prevent them from developing learning difficulties (Akhutina & Pylaeva, 2008).

The analysis of impairment of psychological functions due to brain damage was, for Vygotskians, “not a primary aim, but only the main method of research involving the interaction of neurobiological and cultural systems” (Kotik-Friedgut, 2006, p. 43). Similarly, instructional interventions founded on the principles of the cultural-historical approach are designed to uncover the relationships between the neurobiological characteristics of a developing child and the “the culture that enabled mind to grow in a manner to recognize and cope with complexities of the world, physical and social alike” (Bruner, 2005, as cited in Kotik-Frietgut, 2006).

Intervening in a developmental process to study how this intervention changes it is the essence of the “experimental-developmental method” proposed by Vygotsky (1978) as the only valid way to study emergent mental processes. In Luria’s (1994) words, by using this method “we are carrying outward whole systems of psychological processes and acquire the possibility of observing objectively how their structure is changed under the influence of inoculating new instruments, and new cultural methods” (p. 55). The tradition of studying mental processes in children by designing specific interventions to promote their development has been continued in the works of many post-Vygotskians and resulted in new insights on child development as well as in new instructional interventions designed to promote this development.

The following description of the Tools of the Mind curriculum will provide an example of an intervention designed to support the development of self-regulation/EF in young children and examine the mechanisms of its development. In keeping with the Vygotskian tradition of the experimental-developmental method, the factors hypothesized to have an impact on developing executive functions are the same factors that are incorporated in the instructional strategies used in the intervention. These factors include (1) specific tools acquired by children, such as external mediators and private speech; (2) specifically designed process of adult-child interaction aimed at social mediation of learning; and (3) children’s engagement in mature make-believe play.

Tools of the Mind

Tools of the Mind is a comprehensive early childhood curriculum for children in preschool and kindergarten that explicitly focuses on the role of self-regulation/executive functions in learning. To date, Tools of the Mind has been implemented in a variety of early childhood settings including public and private preschools, Head Start, Even Start, and half-day and full-day kindergartens in twelve states and fifty districts, serving over 28,000 children.

Tools of the Mind is based on the Vygotskian approach to learning and development that emphasizes the importance of social interactions in developing intentional self-regulated behaviors. This educational philosophy is consistently applied to all components of the curriculum from instructional activities derived from post-Vygotskian research (Elkonin, 1963; Galperin, 1992; Venger, 1988) to the emphasis on structured dramatic make-believe play as the leading activity of kindergarten-aged children (Elkonin, 1978, 2005a, 2005b; Vygotsky, 1967), the systematic use of dynamic assessment (Ivanova, 1976) and scaffolded learning to inform day-to-day teaching, or the approach to school readiness that focuses on the cognitive and social-emotional development that enables children to engage in the learning activities of the primary grades (Davydov, 1988;

Elkonin, 1972). The consistency in the approach allows for the stability of curriculum implementation in different settings, with children of different abilities, and by different staff members working with these children.

Tools is one of the first attempts in the United States to create a comprehensive Vygotskian-based curriculum that could be used in early childhood classrooms. Unlike existing EF interventions, many of which require one-on-one interactions with children (Rueda, Rothbart, & McCandliss, 2005) or are limited to a set of exercises added to a curriculum already implemented by teachers (Domitrovich, Cortes, & Greenberg, 2007), Tools is designed as a systemic intervention addressing multiple facets of self-regulation throughout the day and in varying contexts. It is being accomplished by combining targeted—focal—activities that promote self-regulation with supporting mature make-believe play and by embedding self-regulation promoting activities in instruction designed to build foundational skills in literacy, mathematics, and social-emotional competence.

In addition to the general Vygotskian idea of the importance of children acquiring mental tools—tools of the mind—to develop intentional behaviors, the curriculum and pedagogy of Tools is guided by several specific Vygotskian principles (Bodrova & Leong, 2007):

- Children's self-regulatory abilities originate in social interactions and only later become internalized and independently used by children (Vygotsky, 1978). This embeddedness means that to develop self-regulation, children need to have an opportunity to engage in other-regulation. Other-regulation implies that children act both as subjects of another person's regulatory behaviors and as actors regulating another person's behaviors.
- Play affects a child's self-regulation through shared behaviors that result in internalized higher mental functions, and the development of self-regulation in play becomes possible because of the inherent relations that exist between roles children play and rules they need to follow when playing the roles (Vygotsky, 1967).
- A necessary condition for emergence of self-regulation is children's learning of specific cultural tools that would allow them to eventually use self-regulatory behaviors independently. Among the first such tools children learn is self-talk or "private speech" (Berk, 1992; Vygotsky, 1987). Another kind of tool used by young children is external mediators, that is, objects that assist them in carrying out intentional behaviors (Vygotsky, 1978), as in the use of external mediators in Buddy Reading, described below.
- To be successful in school, the child has to develop general social and cognitive competencies that will allow him or her to become a deliberate, self-regulated learner capable of establishing adequate social relationships with other participants in the teaching and learning process, as well as being able to adopt a specific position of a "student"

characterized by such things as interest in the very process of learning, willingness to play by the school rules, readiness to follow the teacher's directions, etc. (Karpov, 2005).

As a systemic intervention, Tools affects all components of the classroom to enact the principles outlined above. As such, the program is very much distinct from programs that specifically focus on classroom management techniques or activities designed to promote social and emotional competence in children at risk for behavior problems, such as the Incredible Years (Webster-Stratton, Reid, & Stoolmiller, 2008) or the preschool version of Promoting Alternative Thinking skills (PATHS) (Domitrovich et al., 2007). Those programs address social-emotional development as separate from cognitive development, rather than addressing self-regulation within all activities.

In contrast, the hallmark of the Tools of the Mind program is the combination of activities in which cognitive and social-emotional aspects of self-regulation are integrated in activities in which self-regulation, primarily EF, is (a) practiced in symbolic make-believe play and games, (b) a primary focus, and (c) embedded in academic content. These activities exercise self-regulation abilities while also strengthening the acquisition of academic content. They do so by requiring children to (1) monitor and evaluate their own as well as their peers' performance, engaging in prospective and reflective thinking—quintessential manifestations of EF; (2) shift cognitive set, defined as the ability to flexibly maintain competing sets of rules or instructions that challenge working memory and the ability to hold multiple representations of an object or set of objects in mind and to switch between them; and (3) use language to structure their own and others' behavior. Furthermore, the self-regulation promoting activities of Tools of the Mind are embedded in a system of instructional improvement that is clearly linked to assessment. Teachers are trained to use dynamic assessment and to link assessment to instruction that is individualized to meet children's learning styles via scaffolding. The mechanisms of impacting self-regulation/EF through instructional content and pedagogy are described below, using relevant examples from the Tools curriculum.

Social Mediation as a Mechanism of the Development of Self-Regulation/Executive Functions. Two primary forms of social mediation in the Tools of the Mind classroom take place in the form of scaffolding provided by an adult and in the form of mature make-believe play children engage in with their peers. Although the term “scaffolding” has a long history in the West of being associated with Vygotsky's paradigm (Wood, Bruner, & Ross, 1976), it is not a term used either by Vygotsky himself or by the post-Vygotskians. The closest term found in the writings of the post-Vygotskians is “razvivajuschee obuchenije” (developing instruction) (Davydov, 1988), which provides an important link between Vygotsky's

theory of learning and development and its classroom applications. Scaffolding interactions are used in the course of teaching to help a child move from being assisted by an adult in performing a new task to being able to perform this and similar tasks independently (Bodrova & Leong, 2007). These interactions must fall within each individual's Zone of Proximal Development so that they would support the very skills and knowledge that are on the edge of emergence (Vygotsky, 1978). When providing scaffolding, an adult does not make the task easier, but instead makes the child's job easier by giving the child maximum support in the beginning stages, then gradually withdrawing this support as the child's mastery of a new skill increases (Wood et al., 1976). An appropriate support is the one that not only makes it easier for a child to complete a current task or brings to the surface behaviors most mature to date, but plays a role in the child's "construction of mind," influencing the development of mental categories and processes responsible for the child's performance on a variety of tasks. Thus, effective scaffolding should provide only temporary support, needed until these new mental processes and categories are fully developed and can be used by the child without any outside assistance. From this perspective, scaffolding may exist in different formats ranging from teacher-child interactions when they work on a task jointly, to a teacher introducing the child to a strategy or a "tool" the child will be later able to use on his or her own, and to the teacher planning for a specific context or environment where the child will be supported by other children. In Tools of the Mind classrooms, teachers provide scaffolding in a variety of formats and across various contexts not limited to academic tasks; and they introduce children to a variety of "tools" or "auxiliary means" that promote the development of self-regulated behaviors.

One of the primary tools children learn in the Tools of the Mind classrooms is the use of oral language, not only in social interactions but also as a mechanism of self-regulation. For example, to maximize children's expressive language, teachers ask questions that require children to share their answers with other children, instead of waiting to be called upon by a teacher. Unlike well-known "think-pair-share" formats used in many programs, Tools recognizes that young children are not able to separate the "think" part from the "talk" part. Instead, young children "think as they talk" (Berk, 1992; Vygotsky, 1987). Providing specifically designed opportunities for children to talk to each other has multiple benefits: it promotes the development of oral language as a tool for social interactions; it creates the conditions for the emergence of private or "inner" speech that will serve as a mechanism for self-regulation; it promotes social interaction and turn taking; and it provides for growth in knowledge of vocabulary and syntax, that are a foundation of early literacy development.

Another category of tools includes a variety of visual aids that are specifically designed to help children practice their most mature

self-regulated behaviors. These “external mediators” (Bodrova & Leong, 2007) are used primarily in activities where children cannot yet act in a self-regulated way independently or can act in this manner, but for a short time only. Examples of such external mediators include the cards with “lips” and “ears” used in Buddy Reading, the cards with a check and a hand used in the Numerals Game, or the use of “role tags” children wear to indicate the role they are playing. In all these cases, external mediators support self-regulation in two complementary ways: first, children use these mediators to regulate their friends, reminding them of the role they are supposed to be in; and second, children use the mediators as reminders that allow them to better remember their own roles.

Symbolic Play as an Integrative Way to Promote Self-Regulation/Executive Functions. Creating conditions in which children engage in mature make-believe, symbolic play is another feature of Tools of the Mind that promotes self-regulation. Vygotsky theorized that play affects self-regulation through shared behaviors that result in internalized higher mental functions (Vygotsky, 1997). Development of self-regulation in play becomes possible because of the inherent relations that exist between roles children play and rules they need to follow when playing these roles. This relation requires children to practice self-regulation both in its shared and individual forms. In play, the shared form of self-regulation exists as “other-regulation,” as children monitor their play partners’ “playing by the rules” while at the same time following directions issued by other players. By engaging in “other-regulation,” young children gain awareness of the rules of the play situation that they will be later able to apply to their own behavior.

According to the Vygotskian approach, only when make-believe play reaches its “fully developed” or “mature” stage, can it yield self-regulatory benefits (Elkonin, 1978, 2005b). At the same time, Vygotskians emphasize the social and cultural nature of make-believe play, which means that it is shaped by the social context of children’s upbringing. With dramatic changes in the culture of today’s childhood, many children do not get an opportunity to acquire play skills from other children acting as play mentors; thus, they may engage in play that never reaches its mature level. Therefore, in Tools of the Mind classrooms, teachers intentionally promote all of the essential aspects of mature play. These include (a) using toys and props in a symbolic way, (b) developing consistent and extended play scenarios based on the story, (c) taking on and staying in a pretend role for an extended play episode or a series of play episodes, and (d) consistently following the rules that determine what each pretend character can or cannot do.

By kindergarten age, most children can be expected to master the ability to regulate each other and themselves in the context of make-believe play; they become capable of engaging in a different kind of play, namely, games with rules, where they abide by decontextualized and often

arbitrary rules that further promote self-regulation. In reality, many children enter kindergarten not having higher levels of play that have been associated with the development of self-regulation (Berk, Mann, & Ogan, 2006; Elkonin, 1978); they are therefore unprepared to conform their actions to mandatory rules and norms of a classroom. Therefore, teachers in Tools of the Mind kindergarten classrooms have to support play in two ways: (1) by continuing to promote mature and intentional make-believe play as a part of daily activities, and (2) by facilitating children's transition from make-believe play to playing games with rules.

To facilitate children's transition from make-believe play to playing games with rules in kindergarten, Tools of the Mind teachers engage children in learning games with increasingly complex rules. These games are designed to support learning of specific academic content along with other competencies, such as self-regulation or perspective taking, while at the same time engaging children in interactions that are playful and fun. For example, as children play Market Farm, a numerals game activity, one of them plays the role of a grocer and another one of a farmer. The grocer orders food items for the store (for example, eggs and bacon) and writes the number on an order form. The farmer fills the order with manipulatives that represent the food items. Finally, by using a checking sheet, the grocer has to check if the farmer sent the right amount.

Focal Activities to Promote Self-Regulation/Executive Functions.

Activities designed to focus specifically on various components of EF are an essential component of Tools. One example of an activity that focuses primarily on EF is a version of a movement game Freeze, in which children move freely as the music plays, but have to stop and "freeze" mimicking the position of a stick figure held by a teacher the moment the music stops. Although the stick figure is always visible to children, they have to deliberately ignore it while the music is still playing and pay attention to it only after the music stops. As the year progresses, the game becomes more difficult with the stick figures appearing on different colored backgrounds that require children to remember an additional step of which of two figures they are to enact. If there are two figures, one on a pink background and one on a yellow background, the children have to remember to freeze only in the position of the figure with the yellow background if the teacher holds up a yellow card or a pink card with a "no" symbol on it (meaning the "not pink" option). In this activity, children practice inhibitory control as well as learn how to switch from one set of rules to another.

Play Planning is another example of a focal activity. During Play Planning children orally plan and represent on paper what they intend to do during their make-believe play. The primary goal of the activity is to describe intentions prior to enacting them and to follow through with a plan with an additional goal that of supporting children's oral and written language. When engaged in Play Planning children essentially display

such aspects of a classic definition of EF, as the use of information and prior experience to manage behavior prospectively and the coordination of experience with future action (Fuster, 1997). Children also practice monitoring their own actions by reviewing if they “followed the plan.” An additional function of play plans is that—in conjunction with some props corresponding to the child’s initial choice of a role or an activity—they allow children to engage in other-regulation and monitor their friends’ compliance with the rules of play without teacher intervention.

As children move from preschool to kindergarten, Play Plans are gradually replaced by Learning Plans, which also present an example of an activity with its primary focus on self-regulation. The Learning Plans have three functions. First they serve as a simple calendar helping children remember which center to go to, the “must do” activity and work product in that center, and which centers they have not visited yet, thus helping children stay on task when they finish with something in a given center. Second, the Learning Plans serve as a means for children to begin to learn to review their own work by practicing checking that the work is “finished.” (There is a box on the plan to indicate whether the work is finished.) Third, the plans help children reflect on their own learning. At the end of the week, the child, with the teacher’s help, sets a learning goal that is placed at the bottom of the next week’s Learning Plan. Setting the learning goal involves adult scaffolded reflection on one’s own thought processes and promotes early reflective thinking in children, both because the child writes or draws something to remember what the goal is and the child reads the goal prior to starting each activity in the new week. At the end of the week, the teacher has a Learning Conference with each child in which they discuss the effectiveness of the learning strategies, the child’s progress on that week’s learning goal, and next week’s learning goal.

Activities in Which Self-Regulation/Executive Functions Are Embedded in Academic Content. Primarily, Tools of the Mind embeds EF enhancement in academic content in kindergarten with a number of academic-oriented activities implemented in preschool classrooms as well. These activities are designed to both retain the focus on literacy, math, science, and art, while strengthening EF. An example is Buddy Reading, where children engage in hands-on experience “reading” books. Instead of each child reading the book alone, however, children “read” books to each other, which exercises self-regulation in turn taking and requires children to develop the ability to remain in the role of “reader” or “listener” for the entire activity. To support self-regulation in this activity, Tools teachers use visual representations (i.e., mediators) of “lips” and “ears” (“lips read and ears listen”) to help the children to enact the social norms of turn taking and remaining in their given role.

In a similar way, many math activities follow a Numerals Game format in which children alternate roles as “doers” and “checkers” with visual symbols (a picture of a hand, doer, and a picture of a checkmark,

checker) assigned to each role, thus embedding self-regulation and performance monitoring practice into learning math content. In the Numerals Game, the child with the hand, the doer, has a number card and counts out that number of small teddy bears into a cup. The child with the checkmark, the checker, takes the bears and puts them on a checking sheet with the numeral and the corresponding number of dots. If the bears cover the dots with no extra ones showing, the children know that the number is correct. If there are more bears than dots then there were too many counted into the cup. If there are more dots than bears then the children know that there were too few counted.

By taking on doing and checking roles individually rather than simultaneously in activities such as Buddy Reading and Numerals Games, children are able to develop proficiency in performing each of these roles while at the same time increasing their cognitive set-shifting ability. The idea of scaffolding children's learning through such "shared activity" in which one child is the doer and the other the checker (and then switching roles) is based on Vygotsky's principle of children's gradual internalization of mental tools that first exist in a "shared" or "distributed" state (Vygotsky, 1997). By designing cooperative activities around different roles, and thus engaging children in the state of "shared" activity, Tools accomplishes two goals. First, it maximizes children's engagement in the context of large group or small group activities, as children do not wait for the teachers' help but help each other or work as much as they can on their own. Second, by assuming strategically identified roles (such as checker), children learn to monitor and evaluate the actions of their partner, eventually internalizing criteria and actions they will be able to apply to their own work. With respect to the development of self-regulation and EF, such activities build cognitive and social competencies that are hallmarks of self-regulated learning in older children (Schunk, 1999). In addition, these activities provide optimal contexts for children to practice perspective taking and develop insights into a theory of mind that are associated with the development of EF and social-emotional competence (Carlson, Mandell, & Williams, 2004; Hughes & Ensor, 2007).

Evaluation of Tools of the Mind. Over the years Tools of the Mind has been implemented in early childhood classrooms, substantial evidence has accumulated about the effects of this intervention on young children's self-regulation. This evidence base includes anecdotal evidence about the reduction of disciplinary problems and behavior incidents, as well as the number of referrals of children to special education due to their behavioral problems. The evidence also shows the effects of Tools of the Mind on academic achievement—both as measured at the end of the preschool or kindergarten year and as demonstrated several years later when children take standardized tests. Lack of common assessment instruments used across various sites implementing the intervention makes it difficult to provide a numerical measure of its effectiveness, but the data suggests that Tools of

the Mind can improve self-regulation and academic achievement when implemented with fidelity.

The first formal evaluation of the effectiveness of Tools of the Mind was conducted by the National Institute for Early Education Research (NIEER) in a study employing double-randomized experimental design (Barnett et al., 2008). The control group experienced an established, district-created model described as a “balanced literacy curriculum with themes.” The study was conducted in a school district with a high level of poverty and a predominantly non-English-speaking population. Teachers and students were randomly assigned to either treatment or control classrooms. Children (88 Tools and 122 controls, ages three and four) were compared on social behavior, language, and literacy growth. The Tools curriculum was found to improve classroom quality and children’s executive functions, as indicated by lower scores on the problem behavior dimension of the Social Skills Rating Scale (Gresham & Elliot, 1990). In addition, there were gains in language development; however, these effects were smaller and did not reach conventional levels of statistical significance. Teachers trained in Tools scored higher in classroom management, using classroom time productively, and engaged in more appropriate interactions that challenged children to learn at the next level.

A quasi-experimental study (Diamond, Barnett, Thomas, & Munro, 2007) compared Tools to control children on several measures of executive/inhibitory control administered by computer. The sample was built on the one used in the Barnett and colleagues (2008) study reported above, but by the time the executive function study occurred the original control group had former Tools children who were compared with 100 children in the same district that were not in Tools classrooms. At the time of the study, all children attended kindergarten and were an average of five years of age. A stratified randomized sample was used to control for teacher effects. To test EF, children were assessed on the Dots and Flanker tests, which have been used with individuals from age four to adult (Rueda et al., 2004). The results showed that on the test trials requiring minimal EF, children in the Tools and control conditions performed the same. In those conditions that taxed EF, children in Tools did significantly better than controls. Further analyses comparing the child’s scores on the two EF tests and the academic achievement measures collected on the Tools children found that the higher the level of EF, the higher were achievement scores. In addition, the results regarding the EF measures correlated with the teachers ratings of behavior on the Social Skills Rating scale.

Conclusions

Tools of the Mind is currently the subject of a number of randomized design trials. Several more experimental and quasi-experimental studies are in the planning stages. In addition to determining the efficacy of the

curriculum when implemented with children of different ages (preschool and kindergarten) and with different demographic characteristics (for example, with dual language learners), these new studies will investigate the specific mechanisms involved in developing self-regulation and executive functions. We expect to gain new insights into these mechanisms by studying not only individual children, but also by designing and examining specific “systems of activity” where the “extra-cortical” organization of the functional system of executive functions takes place.

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