

CHAPTER 4 INTRODUCTION TO THE spark*EL MODEL

In the previous chapters, executive functions, self-regulation, and their interrelationships were reviewed. Typically, development of self-regulation extends over at least the first two decades of life and requires long periods of time to refine and adapt to changing life circumstances. Current research into self-regulation and executive functions in people with autism showed the challenges they face in translating knowledge into action.

Before going on, we need to look at different approaches for improving self-regulation. Our goal is to find out what works best.

Intervention to improve self-regulation

Interventions for improving self-regulation and executive functioning in children and adults have taken five main forms: (1) computer programs, (2) neurofeedback, (3) physical exercise, (4) mindfulness practices, and (5) curricula and programs. Interestingly, little of the research into these interventions involve people with autism.

Computer programs

Computer programs have been developed to train executive functions. Typically, they focus on just one or two functions at a time.

One area is *working memory*. Both children^{1,2} and adults³ significantly improved their visual working memory after concentrated training with specially-designed computer programs.

There was generalization of training effects from visual to verbal information⁴. Interestingly, there were neurological changes⁵, involving increased activity in the prefrontal and parietal regions of the brain. A meta-analysis⁶ of working memory training with typically developing children found large immediate gains in verbal working memory⁷. The gains were not maintained, however.

Training *inhibitory control* in young children⁸ produced a significant improvement. However, there didn't seem to be any generalization. The researchers suggested this may be due to the children developing strategies that were too specific to the training tasks.

Cognitive flexibility was studied⁹ in three-year-olds. The researchers found that cognitive flexibility was teachable but certain forms of instruction were more effective than others. Simply telling the children the rule for performing a task was significantly less effective than giving them opportunities for practice guided by an adult.

One computer-based study¹⁰ in the field of autism used *Braingame Brian*. It's a computer game that focuses on improving cognitive flexibility and working memory. After 100 hours of training, the eight- to 12-year-old children with high functioning¹¹ autism showed significant gains in working memory only. Cognitive flexibility seemed more resistant to change

Computerized cognitive ('brain') training has become a multi-million-dollar business. One study¹² of over 11,000 participants in online training showed no evidence of gains beyond learning the tasks in the 'brain training'. There was no transfer to activities, 'even when those tasks were cognitively closely related' (p. 775).

Neurofeedback

Neurofeedback helps people focus on and alter their brainwave activity by providing feedback on a computer screen. Use of neurofeedback in adults showed beneficial effects on cognitive flexibility and working memory¹³. Children with high functioning autism who were trained with neurofeedback, showed significant improvements in controlling their attention as well as cognitive flexibility and planning¹⁴. In addition, children showed significant improvements in social interaction, communication skills, and behavior. Follow-up 12 months after the original intervention showed continued significant improvements in selective auditory attention as well as maintenance of executive functions, communication skills and behavioral gains¹⁵. But, there's not yet enough evidence to support use of neurofeedback with autistic children¹⁶.

Physical exercise

The impact of physical exercise on self-regulation has been examined in two basic forms, exercise programs alone, and combined physical and meditation training.

Exercise programs can improve some areas of executive functioning. Children who participated in regular exercise programs showed significant improvement in inhibitory control^{17,18,19}. They also had better selective attention²⁰, focused attention^{21,22}, resistance to distraction²³, and concentration²⁴.

A review²⁵ of research using exercise (e.g., jogging, weight training, bike riding) with children with autism found greatest impact on inhibitory control. Children participating in exercise programs exhibited less aggression, self-stimulation, and self-injury and more attention to task. Vigorous exercise had a more pronounced effect. However, the impact of exercise may be temporary: the children's behavior returned to pre-exercise levels within 40 to 90 minutes.

Physical exercise has been combined with meditative practices, like martial arts and yoga. One study²⁶ into the impact of tae kwon do found significant improvement in physical, cognitive, and affective self-regulation, prosocial behavior, classroom conduct, and mental math. Another study²⁷ looked at the effect of practicing a traditional Chinese Chan-based mind-body exercise, Nei Yang Gong, as compared to progressive muscle relaxation. They found significant increases in inhibitory control both in the laboratory and at home for children in the Chan-based exercise.

Yoga practiced with children with severe forms of autism found gains in a number of areas²⁸. Their imitation of movements, breathing, and vocalizations all improved significantly. Eye contact increased and they modeled their behavior from peers more frequently. In another study, children who practiced yoga for just one month exhibited significantly stronger cognitive flexibility, planning and organization, and behavioral inhibition²⁹. Young adults included yoga showed improvement in inhibitory control and working memory³⁰.

Mindfulness practices

Mindfulness is a type of meditation based in Buddhism which is typically used in a non-secular manner. It teaches a systematic approach to regulating attention to the breath to promote focus on the present moment. The three main facets of mindfulness³¹ consist of (a) awareness and self-monitoring of the present moment, (b) inhibitory control of thoughts (bringing them back to the present

moment if they wander), and (c) acceptance of feelings and emotional state.

Adults practicing mindfulness have repeatedly shown improvements in inhibitory control³². Positive change has also been found in self-monitoring skills³³, and cognitive flexibility³⁴.

Children who receive mindfulness training make gains in behavioral regulation^{35,36}, attentional control³⁷, metacognition³⁸, and overall global executive control³⁹. A meta-analysis found consistent evidence of inhibitory control improvement but variable effects on working memory and cognitive flexibility⁴⁰.

Mindfulness training with autistic children also shows promise. Teens with Asperger syndrome were taught to mindfully shift their attention from negative emotions that triggered aggressive behavior to the neutral soles of their feet⁴¹. After practicing for up to six months, aggressive behavior was reduced to zero. In a follow-up four years later, no episodes of physical aggression were observed among the three participants⁴². Other researchers have found significant reductions in symptoms of depression, anxiety, and rumination in adults with high functioning autism who practiced mindfulness in the short⁴³ and long term⁴⁴. However, other research⁴⁵ obtained non-significant changes in executive functions after seven weeks of mindfulness training in 6- to 10-year-old children with autism.

Curricula/programs

There are a few programs that address executive functions and self-regulation more generally.

The Alert program⁴⁶, also known as *How Does Your Engine Run?*, is an intervention protocol typically used by occupational therapists with children with autism. It's designed to help the children learn to recognize their arousal states and teach them sensory-based self-regulation strategies. This program addresses automatic, stimulus-driven, and largely reactive systems so is considered pre-executive⁴⁷ rather than part of the executive function system. The only juried study of this program in its original form⁴⁸ didn't find significant change in self-regulation associated with participation in it.

*Command & Control Cognitive Training*⁴⁹ is a group executive function training program for children with autism, from 11 years through adults, and their parents. It teaches children within a tech/gaming context to be aware of their executive function command centers and how to control them. After 12 sessions, participants showed small to large positive effects on general executive functioning as well as social responsiveness.

The ECLIPSE model⁵⁰ is described as one that targets self-regulation, executive function, 'attribution retraining', and sensory awareness, aimed at improving social competence. A pilot study⁵¹ with autistic adolescents found some improvement in behavior as well as positive change in shifting attention, inhibitory and emotional control. These promising results did not, however, reach statistical significance.

*Tools of the Mind*⁵² is a curriculum developed to teach academic skills and behavioral and emotional self-regulation to children. *Tools* emphasizes the development of underlying skills such as paying attention, controlling impulses, ignoring distractions, remembering on purpose, logic, symbolic representation, and cognitive flexibility. Activities are incorporated into daily routines and play. Significant gains in inhibitory control, working memory, and cognitive flexibility have been found in children who attended the *Tools* program versus those who were in a traditional preschool⁵³. They also had fewer internalizing and externalizing behaviors compared to controls⁵⁴ and greater growth in receptive and expressive language. To date, this program hasn't been used with children with autism.

*Unstuck and On Target*⁵⁵ (UOT) is a classroom-based executive function intervention approach for promoting cognitive and behavioral flexibility in high-functioning autistic students ages eight to 11. UOT uses a cognitive/behavioral approach that emphasizes self-regulatory scripts, guided practice, and visual/verbal cuing. Children participating in UOT showed significant improvement in their cognitive flexibility⁵⁶. No improvement was found in planning and organization⁵⁷. In a third study, participating children showed significant improvement in cognitive flexibility along with significant change in their ability to compromise, follow rules, and switch from one activity to another⁵⁸. The children also displayed significant change in their abilities to compromise, follow rules, and change from one activity to another. Further tests showed that the children participating in UOT had significantly improved flexibility and planning⁵⁹. At a one-year follow-up⁶⁰, gains made in cognitive flexibility were maintained in the laboratory and at home. Improvements in planning and organization were observable in the laboratory only.

On Target for Life (OTL) is an upward extension of UOT for adolescents with autism. Participants in this cognitive-behavioral intervention program made significant gains in general executive functioning⁶¹ in comparison to participants in social skills training. Children in both groups showed similar improvements in social functioning, anxiety reduction, and behavioral regulation.

Self-regulation Program of Awareness and Resilience in Kids (spark)* was evaluated in two research studies^{62,63}. It was found, after 10 sessions of behavioral self-regulation training, school-aged children with high functioning autism showed significantly reduced behavioral rigidity and greater tolerance for change. There was also significant increase in inhibitory control and affect/emotion recognition. The latter result was unexpected as the focus was solely on body self-regulation. The authors indicated that perhaps by improving the children's self-regulation and self-calming, they became better able to focus attention and to discern important information.

The *Zones of Regulation* program⁶⁴ is designed to teach children to become aware of and control their emotions and impulses, manage their sensory needs, and improve their problem-solving skills. *Zones* is used widely by therapists and teachers but, to date, only one study⁶⁵ is reported. It found that, after 11 weeks of intervention, preschoolers made no significant improvements in their cognitive, communication, motor, social-emotional, or adaptive skills.

Important features of intervention to improve self-regulation

The review above shows that, through intervention, executive functions and self-regulation skills can be taught and enhanced in children and adults. There's some indication that intervention can lead to alterations in brain circuitry. A few studies showed that, by focusing on executive functions, there was flow-through to other areas of development.

A number of important features can be gleaned from the review. Transfer and generalization of learning was limited in some studies. This appeared to be more the case with single-focus approaches - ones that worked on one executive function at a time. Some of the programs that incorporated multiple executive functions seemed to have a broader and more enduring impact. In addition, they were more likely to include interaction with others. Two important meta-analyses^{66,67} highlighted features of programs aimed at improving self-regulated learning⁶⁸ and executive functions. They're summarized below (in grey-shaded areas), followed by ways *spark*EL* deals with them:

Focus should be directly on two or more executive functions at the same time. It isn't necessary to concentrate on just one executive function and may be better to focus on multiples⁶⁹.

Each *spark*EL* lesson places primary focus on two or more executive functions, with secondary attention paid to the others. In

some lessons, all five of the target executive functions are addressed. Fewer executive functions receive primary focus in the early stages of the first unit, Behavioral Self-regulation. By the Cognitive and Emotional Self-regulation units, four and five executive functions are focused on within each lesson.

Cognitive strategies help children engage more fully and independently in learning. Mel Levine, an American pediatrician who championed people with learning differences, proposed an *Essential Cognitive Backpack*⁷⁰. This is a set of skills children need in order to become successful adults. The four main cognitive strategies in the Backpack⁷¹ are: (1) learning how to take in clear and complete verbal and nonverbal information and check to make sure they understand it; (2) learning how to organize activities and projects, make plans, and set priorities; (3) collaborating with others and forming productive working relationships with people of different status; and (4) knowing your own strengths, passions, and weaknesses, and setting appropriate personal goals.

To address these issues, **spark*EL** uses an information processing model to guide lessons in the Cognitive Self-regulation unit. The three main phases of processing in the model include: intake of information, integration, and output or expression. At the intake stage, lessons focus on helping the child learn to work systematically and search for the most relevant information while ignoring distractions. They also learn ways to help themselves hang on to information long enough to figure out what to do. At the Integration phase, the child is taught how to bring together multiple pieces of information to visualize it and check their understanding. At the output stage, the child learns to provide precise descriptions that are clear to other people. These all contribute to the skills needed to be successful learners.

Generalization of skills and strategies must be explicitly taught. Generalization is typically weak in people with autism and variable in different approaches for improving executive functions. It's critical that attention is paid directly to turning knowledge into action in realistic ways that represent everyday life.

spark*EL includes clear and explicit ways of helping children (a) understand the usefulness of the skills and strategies to their everyday life, (b) clearly identify times and places where the skills and strategies should be used, and (c) receive support and encouragement in using them in day-to-day situations. Every skill presented in **spark*EL** is practiced first to help the children understand that they're capable of doing it (for example, walking slowly as well as fast). Then they help to identify (with input from

parents) when and where in their lives the skill would be useful. To aid extension of the skill into everyday life, the children are helped to become more resilient and use the skill even in adverse situations (like, when they get distracted). The final step is to help the children learn how to advocate for themselves. That is, if they're having difficulty using their new skills, they learn many ways to help themselves regain a sense of equilibrium.

Self-calming strategies are important to helping children improve their self-regulation. We know that severe anxiety occurs in 40% of children with autism⁷² but as many as 84% experience at least some symptoms⁷³. Anxiety-related concerns are among the most common problems for school-age children and adolescents with autism⁷⁴. They may be reflected in specific phobias, obsessions and compulsions, social anxiety, separation anxiety and generalized anxiety^{75,76}. Anxiety can cause acute distress, intensify the symptoms of autism, and trigger behavioral difficulties including tantrums, aggression, and self-injury⁷⁷. Anxiety has adverse effects on thinking and learning as well as executive control of attention and inhibitory control⁷⁸. Even mild stress can overwhelm the prefrontal cortex and cause executive dysfunction⁷⁹. Some autistic children, when experiencing negative emotions, engage in disruptive behaviors. They may have tantrums, meltdowns, or lash out at people and objects. Other times, they may be flooded with emotions (like anxiety, excitement, frustration) that interfere with life⁸⁰.

Self-calming, in the form of Turtle Breathing, is an important element of **spark*EL**. It improves self-regulation and reduces destructive anxiety. In the Behavioral Self-regulation unit, beginning mindfulness is introduced as Turtle Breathing. This calming and centering strategy is used throughout the subsequent lessons and activities and is encouraged and supported in everyday life. Turtle Breathing, combined with stress meters for identifying oncoming distress, are ways to reduce the likelihood of meltdowns and other stress reactions. We combine Turtle Breathing and stress meters with 'cooling down' strategies, like visualizing pleasant things and putting worries away.

Metacognitive strategies need to be included. Metacognition involves reflecting on your learning, your understanding, memory, knowledge, planning, and self-monitoring. Metacognitive awareness helps the child become conscious of their thought processes and more engaged and in control of their own learning. Metacognitive strategies teach children to think about their own thinking and behavior. In order to put the 'self' in self-regulation, they must become self-aware. Children who use metacognitive

strategies are more likely to learn efficiently and deeply and generalize what they learn⁸¹.

Throughout **spark*EL**, children are encouraged to reflect on their own actions, thinking, and emotions. The lesson plans outline how to help children think about what they're able to do and what they did so they can note changes and learn to self-monitor. They're prompted to develop vocabulary related to their thinking, attention, understanding, behavior, etc. so they can use self-talk and self-reflection. This transforms the way learning occurs⁸² and children come to understand their motivations and goals.

Increase independence from adult supervision and prompting. As seen in the support needs of children and adults with autism in Chapter 1, specific work needs to be done in this area if true self-regulation and greater autonomy are to be achieved.

Throughout **spark*EL**, children are helped to identify when and where they need to use each skill. Then they're asked to evaluate their own performance ("How did you do?"). This is done deliberately and often in order to promote independence. They're learning that they can evaluate their own performance and don't have to wait for adult input.

Include physical exercise/movement. Movement and exercise are important to engaging children as well as helping improve their self-regulation. But, exercise alone without focus on executive functions will produce little benefit.

Quite naturally the Behavioral Self-regulation unit incorporates physical activity. An important part (and culmination) of this unit's the inclusion of yoga. It allows combining Turtle Breathing with whole body movement and balance. Children with autism typically have sensory-motor difficulties^{83, 84,85}. Simple yoga can help them with self-calming as well as commonly-found problems with sensory systems, balance, and finely-controlled movements⁸⁶.

Practice must extend over multiple sessions, but activities need to vary in complexity, novelty, and variety. The program needs to continuously challenge children's executive functions. More time devoted to practicing is better. Learning self-regulation isn't a 'one shot' issue; it takes time and practice to become self-regulated. Remember, typical development of self-regulation takes at least two decades of neurological development, learning, and refinement. With many autistic children, there'll also be some un-learning that needs to take place in order to move ahead.

Children need some novelty in their learning. By doing the same thing repeatedly, they'll lose interest.

Children also need help to go beyond their current comfort level. This requires support from knowledgeable, caring adults. Social support positively affects prefrontal cortex functioning, attention, and reasoning. Children's feelings of confidence as learners are important to their success.

spark*EL has three main units and a total of 23 lessons. Although lessons may be combined, the structure of **spark*EL** requires multiple opportunities for practice and extension into everyday life. Each lesson describes the level of success/accuracy a child needs before moving to the next lesson. This ensures repeated practice. Activities are also set up so there is some novelty as well as inclusion of each child's favorite topics (affinities). Each lesson can be completed quickly if the child meets criterion for moving on. There is no pre-prescribed amount of repetition.

The program needs to address the negative impact of stress, mood, tiredness, and physical health on executive functions and self-regulation. When children are calm, happy, rested, and feeling well, their prefrontal cortexes function better. They can work and think more flexibly and creatively.

In **spark*EL**, we use the acronym C.A.N. (Calm, Alert, and Nourished) to ensure that children are ready to work on self-regulation skills. We also help children identify those features in themselves so they can make sure their learning is at its best.

The Language of **spark*EL** is incorporated into everything we do. The words and phrases of the Language of **spark*EL** support children emotionally and cognitively in their learning. The adult is placed in the role of a guide and coach who both encourages and challenges each child. There is a great deal of focus on building self-confidence and having a sense of a shared quest.

Any program must be mindful of three main things. It must be:

1. **Developmentally-appropriate.** Ask is an activity or skills is appropriate to the child's age and stage. For example, children do not begin to use eye contact like adults until they're at least 11 years of age⁸⁷. This, among other things, draws into question teaching eye contact to young children.
2. **culturally grounded.** Skills and strategies we teach children need to be appropriate and acceptable to each child's culture.

- 3. autism-sensitive.** People with autism have significant sensory and anxiety issues so we must be careful to respect these and help children become more resilient.

The *spark*EL* model

The **Self-regulation Program for Awareness and Resilience in Kids** – Elementary version (*spark*EL*) is based on *spark**, an evidence-based approach to teaching self-regulation of behavior, cognitive processes, and emotions.

*spark*EL* is intended for children from nine years of age to about 14. It was developed to be integrated into an overall program of development but can be used successfully as a stand-alone intervention or as part of individual or group therapy programs.

*spark*EL* will be of interest to regular and special education teachers, education assistants, occupational therapists, psychologists, speech-language pathologists, and parents.

*spark*EL* is designed to enhance children's self-awareness, awareness of appropriate time and place, resilience, and self-advocacy in relation to self-regulation, attention, and executive functioning. It's theoretically derived from the latest scientific research in the fields of neuroscience, social learning, positive psychology and autism. *spark*EL* was developed and refined through clinical experience with preschool and school-aged children with special needs. The model on which *spark*EL* is based is empirically validated.

The main goal of *spark*EL* is to improve and brighten the future for children with autism and other special needs. We want to move children along the road to improved self-regulation and increased success in learning and day-to-day life. Some of the outcomes of stronger self-regulation will include:

- Willingness to tackle new tasks and unfamiliar situations with confidence.
- Persisting with challenging activities and situations.
- Being able to cooperate, negotiate and collaborate with others, sharing and taking turns.
- Making reasoned choices and decisions.
- Planning and organizing steps toward achieving a goal.
- Finding Resource and solutions without help from others unless necessary.
- Learning by observing others and from past experiences.

- Coping and learning, even in highly stimulating or distracting environments.
- Inhibiting impulses and ignoring distractions.
- Switching easily from one task to another and from one situation to another and coping with change in general.

In **spark*EL**, the major executive functions underlying self-regulation as well as selective, sustained, and shifting attention are explicitly and deliberately highlighted and practiced. In the early stages of development, the adult acts as the child's main regulator by teaching and modeling the skills. With practice, the child will learn to recognize usefulness of the skills and strategies and increasingly assume control over them. Generalization of self-regulation skills is taught through the Awareness of Need, Resilience, and Self-advocacy activities to ensure practice and use in day-to-day settings. Resilience activities help the children increase their tolerance for distraction, disruption, and temptations. Children are also taught to advocate for themselves so that they can promote and maintain their sense of equilibrium.

Main structure of **spark*EL**

spark*EL's three main units are: Behavioral, Cognitive and Emotional Self-regulation, as shown in Figure 5 below.

Each child must start the program with Behavioral Self-regulation so they can work successfully on consciously control their body and attention and calming and centering themselves.

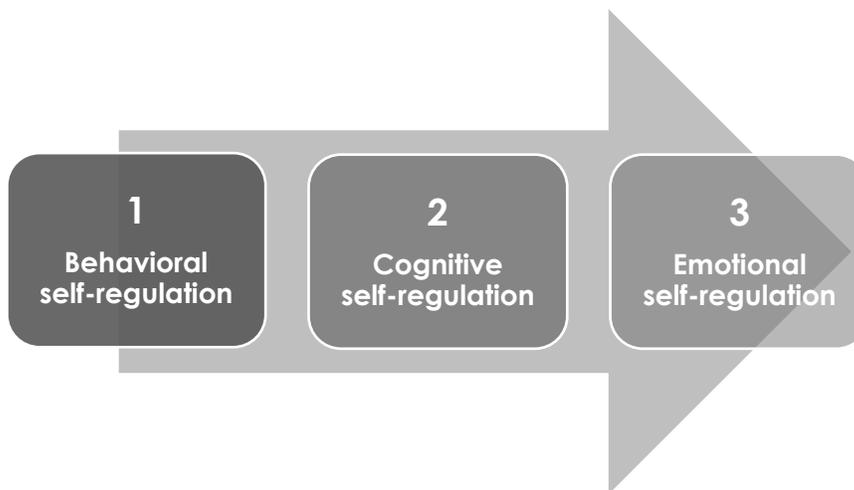


Figure 1. Diagram of the progression across the three main units of **spark*EL**.

Within each unit of **spark*EL**, the children learn skills and strategies that serve as foundations for skills and strategies presented in

subsequent lessons. The child's newly-acquired ability to consciously modulate their body, attention and calmness is integrated into cognitive processing skills within the Cognitive Self-regulation unit which then combine to enable Emotional Self-regulation.

Because of this, it's **critical that all children start with the Behavioral Self-regulation unit**, complete it and then proceed to the Cognitive Self-regulation unit. Once the Cognitive Self-regulation unit is completed, the Emotional Self-regulation unit can begin.

Behavioral Self-regulation

Behavioral Self-regulation is the first area addressed. It involves physical activities that can be directly prompted and shaped. In learning to self-regulate their actions, each child develops an understanding that they can vary how, when, and where they use their body and can do so in flexible, situationally-appropriate ways.

Behavioral Self-regulation skills focus on two main things: breathing to calm and center themselves and whole-body regulation. These are practiced through a series of four different areas of skill development: (1) Awareness of Ability, (2) Awareness of Need, (3) Resilience, and (4) Self-advocacy.

Cognitive Self-regulation

Cognitive Self-regulation refers to the ability to control and adapt how and when the child uses their cognitive Resource. They're **helped** to gather important and relevant information, ignore distractions, check their understanding, and form a response.

Cognitive Self-regulation skills focus on three main areas: (1) complete and accurate intake of information, (2) integration of information with specific emphasis on combining visual and verbal information, and (3) clear and precise expression of knowledge. Each skill is practiced through the same areas of development used in Behavioral Self-regulation: Awareness of Ability, Awareness of Need, Resilience, and Self-advocacy.

Emotional Self-regulation

Emotional Self-regulation involves detecting, interpreting, and responding to emotions, based on both internal and situational information. Controlling or stifling emotions isn't the focus. Instead, children are taught to understand situations and experiences more accurately and then select responses that are more appropriate. We want each child to manage their emotions in flexible, situationally-appropriate ways. For example, we help children learn,

when they become angry, they might walk away or tell an adult rather than hitting or scratching.

Emotional Self-regulation skills focus on three different areas: (1) detection of social clues and gestures, (2) interpretation of clues and gestures, and (3) dealing positively with emotions in themselves. Each of these areas is practiced through three of the same areas of skill development used in the Behavioral and Cognitive Self-regulation units: Awareness of Ability, Awareness of Need, Resilience and Self-advocacy.

Key points in this chapter



Specially-designed programs can improve executive functions and self-regulation.



spark*EL is a comprehensive evidence-based program for improving self-regulation in children with special needs, with specific focus on children with autism.



spark*EL incorporates the main features of the most effective programs for improving executive functions and self-regulation.



spark*EL is comprised of three main units: Behavioral, Cognitive, and Emotional Self-regulation.



The three units of **spark*EL** successively build skills and strategies that form the foundation for each other.

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