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Individual differences in cognitive and affective flexibility in children, adolescents and young adults

PHD THESIS ABSTRACT

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CHAPTER 1.

Cognitive and affective flexibility. Conceptual Clarifications

Introduction and motivation

Cognitive flexibility (CF) enables us to swiftly adjust our thoughts and actions according to current goals and opportunities. This is crucial for effective problem solving, creativity, and outside-the-box thinking. In school settings, children deploy such skills in various activities such as identifying multiple ways to reach a certain solution to a Maths problem, or when alternating between grammar rules of different languages. Cognitive flexibility is an essential component of the umbrella term of “executive functions” (Miyake et al., 2000) along with memory updating (the ability to manipulate and act on information held in mind) and inhibition (suppressing distracting information or inappropriate responses). These executive skills are considered responsible for the conscious control of thought, emotion, and action (Kloo, Perner, Aichhorn, & Schmidhuber, 2010).

Within this general executive domain, a method of dichotomizing *between "hot" and "cool" aspects of executive functioning* has been recently proposed (Zelazo & Muller, 2002; Zelazo, Qu, & Muller, 2005; Zelazo, Qu, & Kesek, 2010; for a review see Zelazo & Carlson, 2012). This distinction was anchored, in part, to evidence suggesting that cognitive aspects of executive functions are usually associated with the lateral prefrontal cortex while the relatively “hot” affective aspects of EF are usually associated with the orbitofrontal cortex and other medial regions (Happaney, Zelazo, & Stuss, 2004; Zelazo & Muller, 2002). Generally, it is considered that purely cognitive ”cool” aspects of executive functions rely on bottom-up processing and are elicited during abstract problem solving, in non-emotional contexts. By contrast, ”hot” aspects of executive functions are best captured when looking at top-down control processes present in motivationally and emotionally significant contexts (Qu & Zelazo, 2007; Zelazo & Muller, 2002). However, most of the studies looking at ”hot” executive functions have studied the impact of motivation on these core functions and have not directly addressed the impact of emotional stimuli.

A large body of research has focused exclusively on investigating such “cool” aspects of flexibility (e.g., Anderson, 2002; Best & Miller, 2010; Cragg & Nation, 2009; Kiesel et al., 2010; Zelazo, Craik, & Booth, 2004). However, when children or adults deal with emotionally complex situations, such as reinterpreting a negative situation after receiving a bad grade to find a motivating role in order to work harder for the next exam, they make use of affective flexibility (AF). AF refers to “the ability to flexibly attend to, and disengage from, emotional material” (p. 381, Genet & Siemer, 2011). However, to date, relatively little effort has been paid to examining such “hot” emotional cognitive control (Peterson & Welsh, 2014) especially during development.

Greater flexibility in processing emotional material has been associated with superior emotion regulation skills and academic achievement in early school age children (Wilson et al., 2007), resilience to negative life events and stress in adults (Genet, Malooly, & Siemer, 2013). Also, AF predicts lower levels of anxiety and depression (De Lissnyder et al., 2012; Johnson, 2009a) in adults. Despite such significant contributions of “hot” aspects of flexibility across the lifespan, we still lack a comprehensive componential account of this ability (Ionescu, 2012). A recent surge of interest in studying flexibility over emotional material has been motivated by recent findings reporting an association between inflexibility in processing negative information in psychopathology such as depression and anxiety (De Raedt, Koster, & Joorman, 2010). Deficits in AF have been documented to predict greater use of rumination (Genet et al., 2013) and less use of reappraisal in adults (Malooly, Genet, & Siemer, 2013). These studies attempted to uncover the underlying mechanisms of affective symptoms by suggesting that inflexibility over emotional material could act as a vulnerability factor for the onset and maintenance of different forms of psychopathology. Tackling AF in the context of affectively salient target or distracter stimuli has great relevance for a better understanding of cognitive control deficits in clinical populations.

1.1. Cognitive flexibility and affective flexibility: Some conceptual clarifications

Across studies, the multiple and diverse definitions of CF in terms of its underlying processes (see Table 1.1.) are bound to the experimental tasks used (Peterson & Welsh, 2014), offering a fragmented picture of its developmental trajectory. However, most of the studies focused on AF have defined it as a subset of cognitive flexibility which involves the ability to alternate between emotional and non-emotional rules when processing emotional faces (see Table 1.2). In this chapter, our aim was to provide a comprehensive and integrative analysis of cognitive and AF by considering these constructs across a variety of behavioral paradigms employing emotionally salient, as well as affectively neutral stimuli. So far, most researchers approached flexibility as *a specific cognitive ability* (by referring to it as shifting) while a small number of studies conceptualize it as *a property of different cognitive processes* (Blaye & Bonthoux, 2001; Plunkett, 2006) or *of the cognitive system* (Deák, 2003; Ionescu, 2012). In our own view, cognitive flexibility represents a separate cognitive control function together with working memory and inhibition processes.

Also, a frequent approach was to assess shifting in relation to two other executive functions from the seminal model proposed by Miyake and collaborators (2000): updating and inhibition. Shifting is however one of the most complex executive functions, building on the other two core executive functions (Huizinga, Dolan, & van der Molen, 2006) and emerging later in development (Davidson, Amso, Anderson, & Diamond, 2006; Diamond, 2013; Garon et al., 2008). From a developmental perspective, working memory and inhibition are considered prerequisites for successful shifting (Best & Miller, 2010). Though it may depend upon adequate working memory and inhibition skills, shifting is more than the simple combination or coordination of these two executive skills (Chevalier et al., 2012; Diamond, 2013).

In everyday interactions, CF represents a complex ability which in addition to set-shifting relies heavily upon attention, inhibition, and working memory processes (Dajani & Uddin, 2015), plus inductive or deductive reasoning (Jacques & Zelazo, 2005), and problem solving skills (Yerys et al., 2012). Throughout this thesis we define "affective flexibility" *as the executive function which allows us to successfully alternate between different tasks or goals and also to flexibly process different emotions as a function of changing relevant environmental cues.*

Table 1.1. Definitions of cognitive flexibility

Authors	Year	Definition
Eslinger & Grattan	1993	"FLEXIBILITY commonly refers to the ability to shift avenues of thought and action in order to perceive, process and respond to situations in different ways."
Deák	2003	"cognitive flexibility: that is, the ability to select task appropriate responses, then shift responses appropriately when task demands or task context changes"
Jacques & Zelazo	2005	"the ability to take multiple perspectives simultaneously on a single object or event"
Diamond	2006	“Cognitive flexibility, that is, the ability to flexibly switch perspectives, focus of attention, or response mappings”
Chevalier & Blaye	2009	"the ability to adaptively select among multiple representations of an object, multiple strategies, or multiple task sets the one that best fits the features of a given situation, as well as the ability to switch among such representations as a function of changing relevant cues in the environment"
Geurts et al.	2009	"Cognitive flexibility is the process of adapting thoughts and behavior in response to situational demands."
Dennis & Vander Wall	2010	"the ability to switch cognitive sets to adapt to changing environmental stimuli appears to be the core component for most operational definitions of cognitive flexibility"
Cragg & Chevalier	2012	"the ability to flexibly shift between different tasks commonly termed set-shifting or cognitive flexibility"
Peters & Crone	2014	"Cognitive flexibility is defined as the ability to adapt behavior to changing environmental demands."
Diamond	2013	"changing perspectives or approaches to a problem, flexibly adjusting to new demands, rules, or priorities (as in switching between tasks)"
Dick	2014	"Cognitive flexibility describes the ability to begin solving a problem in one way and to then shift to solving the same problem in a different way."
Mahy & Munakata	2015	"Children's ability to overcome habitual or prepotent behavior, like blurting out what they are thinking, and to switch flexibly to new ways of thinking or behaving, such as waiting their turn."
Piquet et al.	2016	“Cognitive switching processes which subserve the ability to alternate between different cognitive states, and imply not only generating a new mental set but also inhibiting the previous mental set”

Table 1.2. Definitions of affective flexibility

Authors	Year	Definition
Genet & Siemer	2011	"flexible affective processing which we define as the specific ability to switch back and forth between processing the affective versus non-affective qualities of affective information."
Malooly et al.	2013	"Affective flexibility is a subset of cognitive flexibility that involves the more specific ability to switch between emotion-focused and nonemotional cognitive sets."
Genet et al.	2013	"ability to flexibly switch between the processing of affective and non-affective properties of positive and negative material."
Aboulafia-Brakha et al.	2016	"Attending to and disengaging from emotional material in a flexible manner is termed affective flexibility."

1.2. Cognitive flexibility. Methodological aspects

We will first focus on the investigations targeting cognitive aspects of flexibility, as many of the tasks that address AF have been derived and adapted from them. A wide array of tasks has been generated to tap into CF and this has resulted in different developmental trajectories. Two categories of tasks can be extracted: 1) inductive vs. deductive tasks and 2) instructive vs. adaptive flexibility tasks.

In *deductive tasks*, children are required to sort stimuli based on explicit instructions, thus being provided with the sorting rules before each trial. One such example is the Dimensional Change Card Sorting Test (see Doebel & Zelazo, 2015 for a recent meta-analysis), in which children are instructed to flexibly switch from sorting cards according to an initial rule (e.g., shape) to sorting them according to a new rule (e.g., color). Such tasks require individuals to make deductive inferences on each trial based on explicit instructions reminded before each sorting trial. In contrast, during *inductive tasks*, children have to discover by themselves the appropriate rules and to apply them when needed. For instance, during the Flexible Item Selection Task (FIST), children are presented with three or more cards and are instructed to find a pair of items that "go together in one way", and then to select a pair of items "that go together, but in another way" (Jacques & Zelazo, 2001; Qu, Finestone, Qin, & Reena, 2013; Dick, 2012, 2014). Inductive and deductive tasks most likely tap into different underlying processes of flexibility.

The other distinction is between *instructed flexibility* in which participants are proactively instructed to alternate between two or more task rules, and *adaptive flexibility*, captured using paradigms in which participants need to flexibly adjust their responses based on the feedback they receive. The most widely used type of instructed flexibility tasks is the *task-switching paradigm*, in which a cue is presented prior to or concurrently with the trial stimulus, informing participants about the rule that needs to be applied. When participants switch from one rule to the other their responses are substantially slower and more inaccurate compared to performing the same task repeatedly, a phenomenon called "switch cost" (Monsell, 2003). A prototypical example of an adaptive flexibility task is the Wisconsin Change Card Sorting Task (WCST) in which participants have to keep sorting cards according to a rule, and then to switch to sorting them according to a different rule as they receive a feedback that their responses are no longer correct and they need to identify the new rule.

It is clear that a degree of overlap is present between these two main categories of flexibility tasks. Deductive tasks are similar to instructive flexibility tasks because participants are provided before each trial with the necessary information to solve the task. However, instructive flexibility tasks are more complex as they require participants to proceed in a trial and error manner in order to discover the new rule, as opposed to the deductive tasks in which the rules can be inferred based on the available clues presented. Also, inductive tasks are very similar to adaptive flexibility tasks given that they both rely on inductive inferences as participants have to generate by themselves the sorting criteria in a trial-by-trial manner. Nonetheless, these tasks differ as a function of feedback and number of rule shifts required. However, during both these tasks categories participants have to overcome their tendency to approach each problem in a unique way, therefore exhibiting flexibility in response to changing task demands (Jacques & Zelazo, 2005).

1.3. Understanding cognitive and affective flexibility: A proposed componential account

Due to increased interest in flexibility over emotional material, this ability has been studied with numerous tasks, mostly adapted after classical CF tasks to include emotional stimuli such as facial expressions or emotional words. We want to propose a componential account, which describes three main levels, each corresponding to various tasks employed to assess AF. This integrative analysis will provide us with a straightforward way of understanding the similarities, as well as the differences between different forms of flexibility also reflected in assessments procedures used in this line of research. We describe our componential account of flexibility which includes three levels of flexibility: elementary flexibility, shifting flexibility and generative flexibility.

Elementary flexibility refers to the basic ability to alternate only once between different behaviours, tasks or emotions according to different environmental cues. For instance, when children find two different uses for a given object (e.g., a chair used as a climbing tool) as they make use of the ability to alternate between two different perspectives towards that object. Elementary flexibility over emotional material is best captured by deductive tasks which incorporate a reduced number of switching trials and involve alternating between two simple rules. Such an example is the Emotional-Dimensional Change Card Sorting Test (Qu & Zelazo, 2007) in which participants are required to sort cards depicting happy and sad faces of a male and a female. The task basically requires only one shift, as children have to alternate only once between these two sorting criteria (from emotion to gender or vice versa). Knowing this rule in advance decreases the influence of other cognitive processes (such as working memory) in addition to flexibility (Yerys et al., 2012). The disadvantage is that this elementary form of flexibility may lack ecological validity (Burgess et al., 2006), given that in real life scenarios flexibility relies heavily on updating and inhibition, as well as on inductive reasoning. Such elementary AF tasks are mostly used with preschoolers (e.g., Qu & Zelazo, 2007; Visu-Petra et al., 2014) offering preliminary insights into the building blocks of AF

Shifting flexibility refers to the ability to frequently alternate between different behaviours, tasks or emotions in order to select the best response as a function of contextual cues. For instance, when children switch back and forth between two different tasks such as solving a given homework and talking to a colleague in a class. Shifting flexibility, involves the coordination of multiple executive demands and is best examined through deductive tasks such as the task-switching paradigm (Monsell, 2003). Over recent years, a number of studies have examined the influence of emotion on flexibility in adulthood by means of different versions of a task-switching paradigm (e.g., Genet et al., 2013; Johnson 2009a, 2009b; Malooly et al., 2013) while a small number of studies have looked at this association during development (but see de Vries & Geurts, 2012 for an exception).

The task switching paradigm has proven to be a very valuable and a pure measure for investigating shifting flexibility. The tasks, however, can differ in terms of the predictability or random trial sequence of the task. For example, a distinction can be made between the alternating-runs variant of the task switching paradigm, in which participants are instructed to switch after every second trial and this structure is predictable all throughout the task (e.g., AABB format), and the cue-based switching paradigm, in which a switch is unpredictably indicated by a cue (e.g., a word, a picture or a symbol). Given that our everyday activities constantly include unpredictable events that interrupt the task at hand, rarely preceded by a warning (de Vries & Geurts, 2012), the latter type of paradigm is considered to best capture flexibility (Andreadis & Quinlan, 2010). An example of such a task-switching paradigm is the Gender/Emotion switch task (de Vries & Geurts, 2012) in which participants are presented with emotional facial stimuli and they have to judge each stimulus according to two dimensions. An unpredictable cue preceding each stimulus informs participants the relevant type of rule that they need to apply: the non-emotional rule (gender: male or female) or the emotional rule (emotional valence: happy or angry). In this task, switching from one type of task set to another (alternating from sorting by gender to sorting by emotion) requires the explicit representation of a higher-order rule for selecting among different ways of approaching the problem, so that participants are required to consider each sorting rule before each trial (Bunge & Zelazo, 2006).

The highest form of AF, *generative flexibility*, refers to the ability to successfully alternate in a successive manner between different behaviours, tasks or emotions as well as the ability to select or actively generate the best choice especially when the contextual environmental cues are missing. For instance, the ability to generate a positive interpretation to an ongoing negative situation and to do this a couple of times (during a long conflict). This generative form is best captured by inductive tasks which in addition to cognitive flexibility tap into participant's ability to infer new rules. During such tasks, participants have to generate the sorting rules by themselves and switch between three to four rules in order to solve the task. This form of flexibility also includes a higher number of switching trials which are presented in an unpredictable manner. An example is the emotional version of the Flexible Item Selection Task (EM-FIST; Mărcuș et al., 2015) used with children or the emotional version of the Wisconsin Card Sorting Test (WCST) mostly used with adults. During the emotional version of the FIST, participants are presented with four emotional stimuli on a trial-by-trial basis, and are required to find two matching pairs of stimuli. On each given trial, participants are instructed to use inductive reasoning in order to generate two sorting criteria from the total of three existing possibilities (e.g., identity, emotion and size). To successfully solve the task, participants have to flexibly shift between attending to and ignoring the emotional aspect of the stimuli.

In our view, this task taps best into generative AF as it requires participants to infer the sorting rules on a trial by trial basis. Furthermore, the number of rules is increased as compared to most task-switching paradigms which include the need to alternate between two rules. Also, participants are required to shift their attention in a trial-by-trial manner, while most task-switching paradigms have the requirement of including a number of repetition trials before each switching trial, so that participants are not supposed to make the switch on every trial (e.g., De Vries & Geurts, 2012) or include an equal proportion of both switching and repetition trials (e.g., Reeck & Egner, 2014). Generative flexibility taps into individuals' ability to shift between sorting rules in an autonomous manner which resembles our unpredictable daily life.

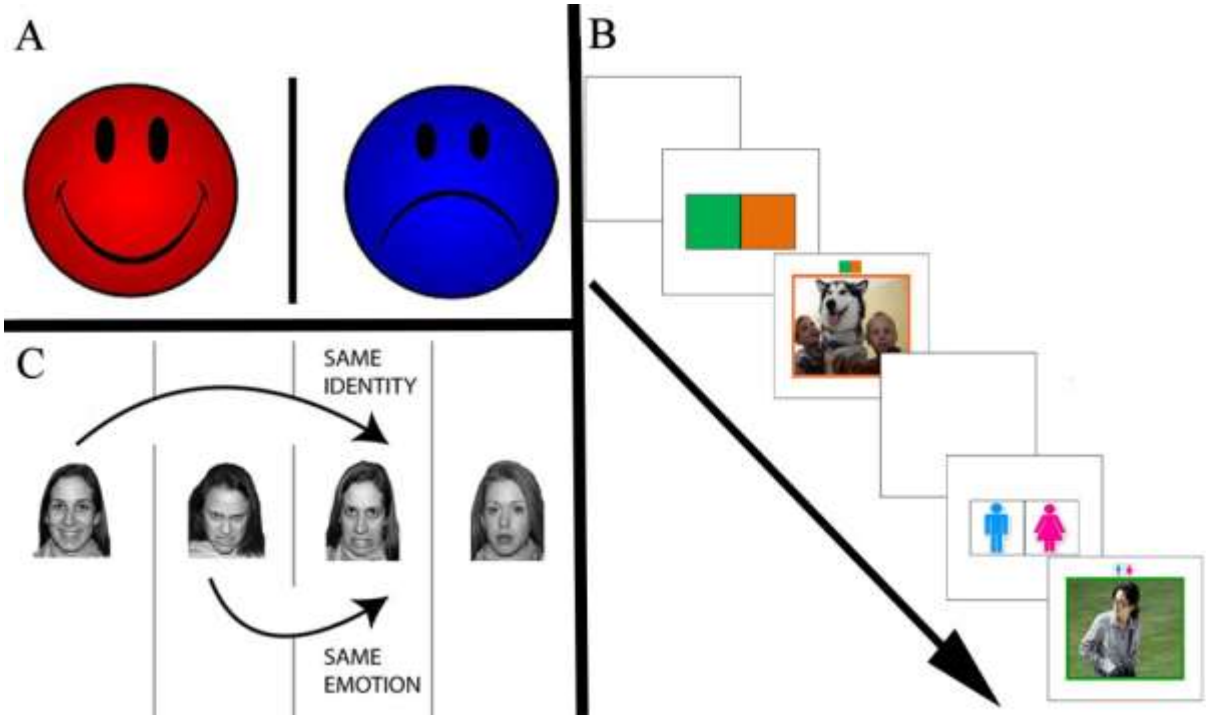

Figure 1.1. A depiction of three different levels of flexibility as measured with different task methodologies. A: The emotional DCCS task measures elementary flexibility and requires participants to judge these two stimuli according to the emotional rule and the non-emotional rule the task includes only one rule shift. B: The emotional task-switching paradigm which is a reflection of shifting flexibility. During this task, participants know in advance the relevant rules and are required to alternate between an emotional rule and a non-emotional rule in a trial by trial basis. C: The Emotional FIST which measures generative flexibility requires participants to find two pairs of items that match according to two different rules. In this case, the rules are not provided and participants need to generate by themselves two rules on each trial.

1.4. Developmental trajectory

There is a substantial body of research regarding shifting flexibility in adults (see reviews in Monsell, 2003; Kiesel et al., 2010), yet little is known about the developmental trajectory of this form of flexibility, particularly beyond the preschool years (Cragg & Nation, 2009). Beyond the intensive development of shifting skills during the preschool period (Deák, Ray, & Pick, 2004; Kloo, Perner, Kerschhuber, Darbernig, & Aichhorn, 2008), there is a protracted improvement in shifting ability until adolescence (e.g., Davidson et al., 2006; Huizinga et al., 2006). Fine-grained developmental studies targeting mid-childhood pointed to significant improvements in the ability to alternate between rules during this interval (Davidson et al. 2006; Huizinga et al.,2006) and an increased ability to resist interference from an irrelevant task (Cragg & Nation, 2009). Also, Huizinga et al. (2006) documented superior shifting skills in 15 year olds compared to 7- and 11-year-olds. Further support comes from Davidson et al. (2006), who examined various aspects of executive functioning in 4- to 13-year-olds and confirmed that shifting ability was substantially superior in older children, albeit not fully matching adult levels by age 13. These above-mentioned studies have investigated shifting flexibility during middle childhood and adolescence by using mostly tasks which included non-affective stimuli. As a result, we still lack an understanding of the development trajectory of AF during these crucial years.

1.5. Thesis overview

The studies included in the current thesis build upon these conceptual clarifications and the componential approach presented in this chapter. The second chapter represents a review and aims to answer questions regarding the role played by emotion in different forms of AF across development. Also, the second chapter stresses out the need of carrying additional investigations to capture the critical conditions under which emotional valence has an influence on the ability to flexibly adapt to a permanently changing environment especially during middle childhood and adolescence. In the third and fourth chapter we present five experiments aiming to fill in this gap and are focused on two main research directions: investigating shifting flexibility in children and adolescents (Chapter 4) and generative flexibility in preschoolers, preadolescents and adults (Chapter 5).

Firstly, we wanted to examine the ***effects exerted by emotion*** on AF performance.

Secondly, we aimed to explore the ***contribution of the other two key executive functions*** - affective inhibition and working memory processes to AF performance.

Thirdly, we aimed to investigate the ***role of individual differences*** in ***age, gender and internalizing symptoms*** (especially anxiety) in both CF and AF performance.

Lastly, we wanted to investigate the relation between CF and AF and explore if these two constructs are related.

This thesis aims to contribute to the understanding of both CF and AF throughout development by examining the influence of different emotions on different forms of affective flexibility, and by investigating possible underlying mechanisms (e.g., anxiety symptoms) for this influence.

CHAPTER 2.

Literature Review: Emotion-cognition interactions and flexibility in children and adults

2.1. Introduction

Emotion is considered a "double edged sword" as it can either impair or facilitate our cognitive performance, depending on contextual and personal circumstances (Dolcos & Denkova, 2015; for review see Cromheeke & Mueller, 2014). For instance, depending on the relevance that emotion plays when performing a given task, it could exert a facilitative or a detrimental effect upon performance. During task relevant, or *direct* effects, participants need to judge the valence of the emotional stimuli in order to complete the task (emotion serves as target of attention). By contrast, task-irrelevant, or *indirect*, effects of emotion are visible when participants are required to focus on the non-emotional features of the stimuli (emotion serves as a background context or as a distractor). We begin our review by presenting the main theories regarding the effects of emotions on cognitive control performance. Next, we examine the direct and indirect effects of emotions on AF in relation to individual differences in emotion regulation and different forms of psychopathology.

2.2. The role of emotions in cognitive and affective flexibility. Theoretical accounts

The broader *"dual competition" model* proposed by Pessoa (2009) explains how an affective significant stimulus can influence the competition for cognitive and emotional resources. One way in which the stimuli can exert their influence is via a "stimulus-driven" path. This is directly relevant for our current paper, because AF tasks use emotional stimuli which consist mostly in images depicting emotional expressions, but also in affective scenes and emotional words. The model describes the influence of emotional stimuli as being diverse and dependent on several factors. One of the factors is the extent to which the emotional stimulus is relevant or not for the task at hand. Due to their prioritization at the neural level, emotional stimuli usually gather the available limited resources, thereby enhancing performance when they are *directly task-relevant*. In contrast, when emotional stimuli are *task-irrelevant*, the necessary resources for successful performance could be depleted by their preferential processing, which does not directly serve the task at hand. Another important factor is the *level of threat* posed by the emotional stimuli. Stimuli lower in threat are somewhat ambiguous, hence attention will be directed towards them for supplementary clarification, and if they are task-relevant, performance will be enhanced. If they are task-irrelevant, they will not require too many resources necessary for disruption of the ongoing task. On the other hand, when the threat level of the stimuli is high, they can draw resources that are important for other mechanisms, hence significantly impairing performance. This deleterious effect is not expected from the positive stimuli, due to their proclivity to draw attention.

According to the *Attentional control theory of anxiety* (Eysenck et al., 2007; Eysenck & Derakshan, 2011; Berggren & Derakshan, 2013) high anxious individuals should exhibit a deficit in cognitive flexibility ability, particularly in disengaging attention from emotional stimuli. When presented with an angry face or any given negative information, an anxious individual may take longer to disengage attention away from this content, compared to a non-anxious individual. Importantly, the ACT theory suggests that the effect of anxiety on cognitive flexibility is most striking when task demands are high and when participants are presented with threat-related distracting stimuli. When presented with external (threatening task-irrelevant distractors) or internal threatening stimuli (worrisome thoughts) participants allocate their attentional resources to detecting the source of threat at the cost of diminished performance. In particular, task-irrelevant threatening stimuli will draw the available resources away from goal-oriented attention, which will result in performance impairments (mostly in terms of reaction times). Even though it is clear that flexibility is reduced in individuals with high levels of anxiety, it is less clear whether this inflexibility represents an antecedent or a consequence of anxiety (Kashdan & Rottenberg, 2010).

A more specific account regarding the effects of emotional stimuli in the context of the task-switching paradigm has been put forward by Reeck & Egner (2014). According to their *affective task dominance hypothesis*, emotional stimuli have a privileged access to cognitive resources, and they tend to disrupt our ongoing cognitive performance (Reeck & Egner, 2011). More specifically, when an ambivalent stimulus affords two possible responses, one based on the stimulus emotional features, and the other based on its non-emotional features, the emotional rule will exert more influence on behavior. Consequently, the following predictions regarding performance are made: participants will respond slower when switching from the non-emotional rule to the emotional rule and will respond faster when switching from the emotional rule to the non-emotional rule. This effect has been referred to "counterintuitive asymmetric switch cost" and it appears because the dominant emotional task rule requires greater inhibition.

We will now separately address the two ways in which AF has been measured across studies. We will begin by reviewing tasks in which emotion is task relevant and thus participants are required to attend to the emotional characteristics of the emotional stimuli (direct effects). Next, we will move on to tasks in which emotion is task-irrelevant, participants being instructed to focus on the non-emotional features of the emotional stimuli (indirect effects).

2.3. Direct effects of emotion

In our everyday life, we rarely encounter emotional information that is irrelevant to our activities. For instance, during social interactions, clues about one's own emotional states are relevant for a specific conversation (Aker & Landro, 2014) and help individuals to flexibly alternate between different communication styles in order to select the appropriate. This is why many studies have focused on AF while presenting participants with task-relevant emotional facial stimuli which are considered ecological and socially relevant stimuli.

2.3.1. Direct effects of emotion: cognitive vs. affective flexibility

Some studies directly contrasted cognitive and AF tasks in children (Qu & Zelazo, 2007, Study 1) and adults (Aker & Landrø, 2014). For instance, Qu and Zelazo (2007, Study 1) compared cognitive and AF in 3- to 4-year old children. They used the standard DCCS (alternating between the color and the shape rule or vice-versa) and an emotional version of the DCCS in which participants only have to switch once during the entire task between applying an emotional rule (to sort the stimulus according to valence: happy or angry) and a non-emotional rule (to sort the stimulus according to gender: female or male). A major finding of this study was that children's accuracy was higher in the emotional DCCS compared to the standard version of the same task, a facilitation effect reported for the first time. The authors argued that the use of positive stimuli that may have induced a transient, mild positive mood (e.g., Wild et al., 2001), which has been shown to enhance cognitive flexibility (e.g., Dreisbach & Goschke, 2004; Isen & Daubman, 1984; Isen, Niedenthal, & Cantor, 1992; Nadler, Rabi, & Minda, 2010). In another study with young adults, Aker and Landrø (2014) designed the Emotional Picture Sorting Task (EPST) which resembled the WCST paradigm except it presented participants with emotional stimuli. They used both the newly developed EPST and the neutral WCST paradigm to directly compare CF and AF. Findings using these two generative flexibility measures indicated that the emotional task was more difficult as compared to the neutral task. The authors suggested that the specific effect of emotional pictures on performance could be explained by specific impairments in processing emotional faces present in clinical populations which were not measured in this study. For instance, such impairments are present in depressed individuals who tend to have decreased recognition of happy faces and misattribution of neutral faces (Kohler, Hoffman, Eastman, Healey, & Moberg, 2011), in high-anxious individuals (Pessoa, 2009) or in those who have an attentional bias taking the form of a deficit in the ability to disengage emotional information.

2.3.2. Interactions between flexibility, emotion, emotion regulation

Experiencing strong negative emotions may be incompatible with flexibly attaining one's goals. Therefore, people may often choose to decrease the intensity of their emotional responses by using different emotion-regulation strategies (Malooly et al., 2013). Looking at a very elementary level of flexibility in preschoolers, researchers used the Children's Attention Shifting Task (Wilson, Derryberry, & Kroeker, 2007). This elementary flexibility task was used to investigate the relation between emotion, attention processes and emotion regulation. Findings indicated that children's ability to successfully shift attention away from angry facial expressions (reaction times for shifting attention away from angry to happy facial expressions) predicted their academic achievement and superior emotion regulation skills (Wilson et al., 2007). In adults, Johnson (2009b) looked at the relation between emotion regulation and shifting flexibility using the Attentional Control Capacity for Emotion task (ACCE) and a similar neutral flexibility task. Findings indicated that participants with poor emotion regulation abilities, as measured by the shorter time taken to solve a stressful anagram task, presented a deficit when switching from an emotional rule to a non-emotional rule (Johnson, 2009b). According to the author, these findings suggest that participants with poor emotion regulation abilities exhibit a deficit in the ability to disengage attention from emotional representations.

Finally, Malooly and collaborators (2013) investigated the link between AF and emotion regulation using a shifting flexibility measure. Overall, greater AF predicted the ability to use reappraisal in order to decrease negative emotions in response to a sad film clip. The use of reappraisal was predicted by 1) superior flexibility toward the neutral aspects of negative pictures and 2) greater flexibility toward the emotional aspects of positive pictures. Taken together, these findings imply that it is not only the capacity to shift away from the negative features of a stimulus, but also the capacity to shift toward the positive interpretation of a stimulus that predicts effective use of reappraisal in order to decrease one's negative emotions.

2.3.3. Direct effects of emotions and vulnerability to internalizing symptoms

Research on emotion and CF has contributed significantly to the understanding of psychopathology, including internalizing symptoms specific to anxiety and depression. Recent studies have shown that CF deficits during the preschool years predict greater anxiety/depression severity after 3.5/ 5.5 years (Kertz, Belden, Tillman, & Luby, 2015). These findings provide support for the hypotheses that cognitive control deficits taking the form of inflexibility represent a crucial vulnerability factor for developing affective symptoms (e.g., Disner et al., 2011). In what follows, we will separately review studies looking at AF deficits in individuals experiencing symptoms of anxiety and/or depression.

Direct effects of emotions and anxiety symptoms

Different emotional versions of the task-switching paradigm are able to capture the effects of anxiety upon the ability to deploy attention to different emotions. Individuals experiencing anxiety often engage the environment with a rigidity reflected by their reduced and stereotyped repertory of cognitive and behavioural responses (Kashdan & Rottenberg, 2010). This inflexibility can take the form of intrusive worrisome thoughts, considered the primary source of anxiety, which could be explained by a deficient ability to deploy attention away from emotional thought content (Sarason, 1986; Sibrava & Borkovec, 2006). Johnson (2009a) used a shifting flexibility measure and found that participants with higher levels of anxiety and worry exhibited a flexibility deficit by taking longer to switch from an emotional to a non-emotional rule (Johnson 2009a, Study 1). These results provide partial support for the Attentional Control Theory predictions by showing that individuals high in trait anxiety exhibited a generalized flexibility impairment.

A modified version of the Attentional Capacity Control for Emotion encompassing emotional valence was used during both pre- and post-test assessments in order to verify the efficacy of an attention training technique consisting in auditory attentional exercises (sounds included a clock, church bells, bird song, insects, traffic and running water.) on PTSD (Callinan, Johnson, & Wells, 2014). Findings revealed that the ability to shift back and forth between emotional and non-emotional rules was improved in the experimental group. Interestingly, only the experimental group exhibited a reduction in switch costs for positive stimuli (switching from an emotional rule to a non-emotional rule while happy faces are presented) between the two time points. The authors explain these findings by indicating that the participants in the experimental group used a strategy of focusing on positive stimuli (happy faces), while the control group did not appear to show this response of prioritizing positive stimuli (Callinan et al., 2014).

Direct effects of emotions and depression symptoms

To investigate the link between CF and depression symptoms and rumination, De Lissnyder et al. (2012) developed a task that measured the ability to switch between internal emotional or non-emotional representations in working memory. During the Internal Shift Task, a measure of cognitive control, participants need to perform a mental count based on emotional features of a face (to count the number of negative and neutral faces) in one block or on non-emotional features of a face (count the number of males and females) in a separate block. This cognitive control task measures shifting AF as well as working memory at the same time. Findings indicate that 1) there was no difference in cognitive control measured by general switching performance when comparing dysphorics to non-dysphorics and 2) high ruminators showed impaired cognitive control, reflected in a larger switch cost, compared to low ruminators when presented with emotional material. In a second study Koster et al., (2013) using the same task procedure, reported similar findings by showing that rumination was related to internal switching impairments in the context of emotional information.

To analyze the link between both cognitive and AF and resilience, as well as the use of rumination, a shifting flexibility measure was developed with emotional words (Genet and Simer, 2011) and emotional faces (Genet et al., 2013; Malooly et al., 2013). In addition to the use of a shifting AF measure, this research line also included measures of CF. In the Genet and

Siemer`s study (2011) a version of the task-switching paradigm with emotional verbal stimuli was used to investigate its relation to trait resilience. During this task, participants were presented simultaneously with a word and a cue during each trial. The cue signalled if the participant had to apply the emotional rule (valence: positive or negative) or the non-emotional rule (part of the speech: adjective or noun). Findings revealed that CF and AF were both good predictors of trait resilience. With respect to rumination, in a subsequent study, using emotional faces instead of words (see task described in the Malooly et al., 2013 study presented in the Interactions between flexibility, emotion, emotion regulation section), Genet and collaborators (2013) showed that affective inflexibility in processing negative information was associated with increased use of rumination in daily life. In contrast, affective inflexibility in processing the emotional meaning of positive material was related to decreased use of rumination. The authors suggest that these deficits in the ability to shift away from negative stimuli and inhibit emotionally positive aspects of stimuli can be a protective factor against the tendency to ruminate. Therefore, elevated levels of rumination are explained by deficits in the ability to shift attention away from negative emotional material and also by an enhanced ability to shift attention away from positive emotional content. Furthermore, an intriguing finding of this study was that affective (and not cognitive) flexibility proved to be a predictor for the use of rumination in daily life (Genet et al., 2013).

De Lissnyder et al. (2010) used a different task, namely the Affective Shift Task to examine if depressive symptoms and rumination are related to impairments in executive control. Looking at individual differences in depression, AF impairments were only found in a small group of participants with moderate to severe depression who exhibited slower responses when switching from an emotional to a non-emotional rule (De Lissnyder et al., 2010). Interestingly, AF impairments were strongly predicted by depressive rumination. In terms of the specific effects of different emotions, no valence specific effects were observed, which is in line with previous research indicating the presence of flexibility impairments in the context of cognitive flexibility (Davis & Nolen-Hoeksema, 2000; Whitmer & Banich, 2007). In a recent study using this task it was found that both shifting and updating impairments in response to negative material had an indirect effect on depression severity through a negative interpretation bias. No evidence was found for direct effects of deficient cognitive control over emotional material on depressive symptoms (Everaert, Grahek, & Koster, 2016). These findings indicate that a specific cognitive control deficit remains of crucial importance given its influence on interlinked cognitive biases that are related to depression (Everaert et al., 2014).

All of these above-mentioned findings pinpoint to the presence of a more general AF impairment found in depressed individuals. On the one hand some studies investigate depression symptoms as predictor for AF impairments while some other studies look at the predictive role of AF impairments for the onset of depression symptoms. These studies provide us with an integrated understanding of the cognitive foundations of depressive symptoms.

2.3.4. Emotion, flexibility and developmental disorders

Studies indicate a link between CF impairments and a wide range of disorders, such as autism spectrum disorder (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009; Yerys et al., 2012). However, most of these studies looked at cognitive flexibility and did not include emotional stimuli. An ecological approach of assessing a higher level form of AF by using a task-switching paradigm was adopted by de Vries and Geurts (2012). In their study, they used a simplified version of the task-switching paradigm in which participants were presented with faces and they had to apply either the emotional rule (to judge the emotional expression of the face presented: happy or angry) or the non-emotional rule (to judge the gender of the face presented: male or female). In order to diminish the working memory load, this task presented a cue before the stimulus onset and it also remained on the screen when the stimulus appeared. Using this task in a sample of 8- to 12- year olds with autistic spectrum disorder, findings revealed the absence of a general flexibility impairment in this group compared to the control group. However, within the autistic spectrum disorder group participants showed higher switch costs when switching from an emotional rule to a non-emotional rule (de Vries & Geurts, 2012). These findings suggest that children with autistic spectrum disorder find it harder to disengage from applying an emotional rule in which they are required to judge the type of emotions presented as compared to the gender rule in which the same emotions had to be ignored.

Regarding the specific effect of emotional valence, using the Children's Attention Shifting (which has been described in the Interactions between flexibility, emotion, emotion regulation sub-section) it was found that early grade school children with social and conduct problems exhibited difficulty shifting attention away from angry, but not from happy or neutral facial expressions as compared to a typical developing group (Wilson, 2003). These findings suggest that the ability to shift attention between different emotional expressions plays an important role in children's social and conduct problems towards peers.

2.3. Indirect effects of emotion on flexibility

Compared to the other two executive functions, inhibition and working memory, which has received increased interest by recent studies investigating the impact of emotions when they act as task-irrelevant, there seem to be fewer studies looking at the indirect effects of emotion on AF performance. We will now turn to the influence of emotion on AF by looking at the effects of emotion when it acts as a distracter, being thus presented in the background, and not being directly relevant for solving the task at hand.

2.3.1. Indirect effects of emotion in healthy individuals

We will first begin by discussing studies taping into an elementary level of AF and moving on to more complex versions. In their study with preschoolers described before (see section Direct effects of emotion: cognitive vs. affective flexibility), Qu and Zelazo (2007) assessed elementary flexibility using a modified version of the DCCS in order to analyze the effects of each emotional valence. Results indicated that participants had a significantly better performance on the happy version compared to the other versions of the task. A similar approach was adopted by Wong, Jacques, and Zelazo (2008) to assess generative flexibility in preschoolers (3 to 5 years old). An emotional card version of the FIST presenting task-irrelevant emotional information was contrasted with a standard version of the FIST. In the EM-FIST, four facial stimuli expressing the same emotion were presented on each trial. Participants had to select two pairs of stimuli that match according to two different non-emotional rules (gender or hair color) while the emotional expression of the face was irrelevant to pair classification. The emotional task was more difficult than the standard FIST but only angry and neutral faces, and not for the happy ones. A possibility is that similar to the study conducted by Qu and Zelazo (2007) the mere presence of positive emotional stimuli may have induced a transient, mildly positive mood, which served to increase children's AF.

Furthermore, researchers argue that emotional stimuli are more emotionally evocative; gaining an easy access to the affective processing networks (Malooly et al., 2013). Pictures depicting fearful items are thought to be prioritized (Pessoa, 2009). We are evolutionary wired to detect and avoid spiders (e.g., Blanchette, 2006) and as a result, one would expect a disrupted performance when they appear as irrelevant stimuli in an AF task. In the Paulitsky et al., (2008) study, a higher level form of AF was captured given that participants were presented with a spider and a digit on each trial and had to apply two non-emotional rules: the texture rule (judge if the spider had a smooth or hairy texture) or the number rule (judge if the digit was odd or even). Participants with high levels of spider phobia, easily shifted to the texture rule, and disengaged harder from it (Paulitsky et al., 2008). A possible explanation for this effect could be that the resources are drawn towards the highly threatening aspects of the stimuli. Indeed, bias towards spider stimuli enhances performance when they have to be attended to, in order to succeed in the task (Lipp & Derakshan, 2005).

Another category of studies used task irrelevant emotional stimuli that change their valence across trials. One such study used a voluntary task-switching procedure in which participants had to switch between non-emotional rules at their own free will while they were instructed to select each rule in an approximately equal number of times (Demanet, Liefooghe, & Verbruggen, 2011). Participants responded faster when repeating a rule, albeit it took longer to switch, if a high arousal picture preceded the target. High arousal stimuli may act as high-threatening stimuli, attracting resources necessary for other processes. These findings are in line with the ”dual competition model” which entails that performance will be impaired when the high arousal stimuli are task-irrelevant (Pessoa, 2009). Moreover, findings show that participants had a better general performance, as measured by reaction times, associated with the presentation of positive pictures. The absence of an effect of positive stimuli on cognitive flexibility per se was surprising given that the previous literature highlights the facilitating effect of positive information on cognitive flexibility.

2.3.2. Indirect effects of emotion and depression symptoms

One of the tasks used with adults is the Emotional Card Sorting Task (ECST; Deveney & Deldin, 2006) which is very similar to the Wisconsin Card Sorting Task and is considered to assess generative AF. This card task version uses emotional verbal stimuli (e.g., “agony”) and participants respond to the perceptual characteristics of the words (the color of the ink, the font used, and number of times the word appeared) and had to ignore the emotional valence (positive, negative or neutral). Emotion was kept constant and thus three versions were created which varied as a function of the emotion presented. Findings revealed that participants with major depressive disorder tended to make more errors when the valence of the words was negative. In contrast, the control group showed inflexibility only in the happy version of the task. Given that the negative and positive valence was always present, it’s difficult to discern which effect is more demanding, the engagement or the disengagement effect. We can only conclude that, from the perspective of the “dual competition” model, the resources were preferentially allocated to the emotional aspects of the stimuli.

2.4. Summary: Affective flexibility - an integrative approach

In this review, our first aim was to revise studies that look at the direct and indirect effects of different emotions on AF performance. Departing from our componential account (presented in the first Chapter) we separately described studies investigating the direct as well as indirect effects of emotions upon these three levels of flexibility. The studies that directly contrasted cognitive and AF tasks in children (Qu & Zelazo, 2007; Wong et al., 2008) and adults

(Aker & Landrø, 2014) reveal a complex picture. Reflecting upon these findings, two conclusions can be drawn. First, the facilitating effect of positive stimuli emerges in preschoolers given that the presentation of these stimuli is associated with an increased performance when emotion is irrelevant and perhaps also when emotion acts as task-relevant. Second, the comparison between cognitive and AF reveals a different pattern of findings indicating that the "dominance" effect of AF is only present in generative forms of flexibility and not in the case of shifting flexibility, regardless of the effect of emotion. More specifically, when we look at shifting flexibility, the cognitive measure seems to imply a similar or higher level of difficulty as compared to an affective measure in preschoolers. However, when we look at generative flexibility, the cognitive flexibility measure is associated with a lower level of difficulty as compared to an AF measure.

Several studies have looked at the link between shifting flexibility when emotion is relevant and emotion regulation. Some authors argue that cognitive reappraisal requires the interpretation of emotion-evoking situations and thus should be closely related to the ability to flexibly shift among different rules (Malooly et al., 2013). Findings also indicate that children's ability to successfully shift attention away from angry facial expressions predicted superior emotion regulation skills (Wilson et al., 2007). Findings also show that adults with poor emotion regulation abilities exhibit a deficit when switching from an emotional rule to a non-emotional rule. Furthermore, findings reveal that the shifting AF measure (and not the equivalent neutral flexibility task) predicted emotion regulation in adults (Johnson, 2009b). These results are in line with Malooly et al. (2013) showing that greater shifting flexibility predicts the ability to use reappraisal in order to decrease emotions in response to a sad film clip in adults.

Studies have considered the link between depression symptoms and AF. Impairments in AF were only found in participants with moderate to severe depression who took longer when switching from an emotional to a non-emotional rule (De Lissnyder et al., 2010). Looking at the effect of emotion when it acts as task irrelevant, findings reveal that participants with major depressive disorder tended to make more errors during a generative flexibility task only when presented with negative information (Deveney & Deldin, 2006). Furthermore, studies with mood disorder patients show that these patients make more efforts when switching between rules and suggest the presence of a depletion of cognitive resources (Piquet et al., 2016). Evidence for an indirect effect comes from studies showing that both shifting flexibility and updating impairments in response to negative material had an effect on depression severity through negative interpretation bias (Everaert, Grahek, & Koster, 2016). At a first glance, the "dual model" competition (Pessoa, 2009) can partially account for this asymmetric effect of emotional stimuli, meaning the emotional stimuli act as a facilitator if they represent a way of supporting performance, otherwise they hinder performance. However, these studies mark AF as another executive function that is impaired when dealing with emotional information in the context of mood disorders (Joorman & Gotlib, 2008), but also as a possible tool to detect those at risk for developing mood disorders. No age differences were found in adult studies, which indicate a stability of executive functions after the adolescent years. This makes the studies investigating AF ability in children valuable, as they may provide us with a better understanding of the dynamics of flexibility while processing emotion information as underlying processes of emotional disorders. However, there is a gap in the developmental literature regarding the relation between anxiety/depression and cognitive as well as AF given that most of the existing studies revised here have focused on adult samples. So far, studies have only looked at the relation between AF and autism as well as conduct behaviours across development. Findings reveal that young children with social and conduct problems exhibited difficulty shifting attention away from angry, but not from happy or neutral facial expressions (Wilson, 2003) and that 8- to 12- year olds with autistic spectrum disorder showed higher switch costs when switching from an emotional rule to a non-emotional rule (de Vries & Geurts, 2012). These findings suggest that atypical children encounter specific difficulties in AF but they don’t inform us regarding the effects of anxiety/depression upon flexibility during childhood or adolescence. The next chapter addresses these issues by investigating in detail the relation between internalizing symptoms (with a focus on anxiety) and AF in children and adolescents.

CHAPTER 3.

Relating affective flexibility with internalizing symptoms and affective executive functioning during middle childhood and adolescence

3.1. Introduction

The ever-changing environment requires us to flexibly adjust our thoughts, actions and emotions to daily life requirements. This flexibility is supported by complex cognitive control processes which allow us to produce meaningful, goal-directed behavior and to adapt this behavior according to situational demands (e.g., Botvinick, Braver, Barch, Cater & Cohen, 2001). The current study focuses on shifting AF. Flexibility is the opposite of rigidity as it allows us to process affective material in a flexible manner, such as emotional words or pictures, by allowing us to switch back and forth between processing the affective and non-affective aspects of these stimuli (Genet & Siemer, 2011).

3.1.1. The role of inhibition and working memory in predicting cognitive flexibility

Several scholars argued for the need of investigating specific executive functions that contribute to the developmental path of cognitive flexibility from childhood into adolescence (Many & Munakata, 2015). So far, there are fewer studies that have analyzed the role played by both inhibition and working memory processes to CF performance beyond the preschool years. An ingenious study investigated whether inhibition and working memory predicted CF in preschoolers in terms of its two underlying components (Chevalier et al., 2012). Results indicated that working memory and inhibition were important predictors for the goal-representation component (i.e., to monitor for the necessity to switch and to select the relevant task rule) of CF ability, while no relation was found between working memory, inhibition and the switch implementation component (i.e., actual switch to the newly relevant task-rule when needed). These findings were replicated in an older sample of 5-14 year-old children by showing that working memory and inhibition processes explained variance in CF in general and its underlying goal representation component in particular (Brocki & Tilman, 2014). A recent study showed that working memory and inhibition were related to different aspects of cognitive flexibility in preschoolers (2-4 years old). Findings indicated that CF in the presence of distraction developed tremendously between 2-3 years, and was associated with superior inhibitory control. Furthermore, cognitive flexibility in the presence of conflict improved rapidly between the ages of 3-3.5 years, and was associated with better working memory (Blakey, Visser, & Carroll, 2016).

Although the existing literature pinpoints to the central role played by inhibition and working memory in CF performance, the degree to which the same relation is valid when children process emotional content is debatable. So far, it is unclear if affective aspects of inhibition and working memory are related to AF during middle childhood and adolescence. The current study was designed to address this question and explore the contribution of affective inhibition and working memory to AF during development

3.1.2. The impact of individual differences in internalizing symptoms on flexibility

Research on dispositional factors that generate individual differences in flexibility across the lifespan is very limited. In adults, individual differences in *anxiety* have been shown to impact cognitive and AF. The Attentional Control Theory (ACT; Eysenck, Derakshan, Santos, & Calvo, 2007) proposes that higher levels of anxiety primarily impair attentional control, which leads to performance decrements in executive functions such as inhibition or flexibility (Derakshan & Eysenck, 2009). Several studies on adult populations corroborate the predictions of the ACT (Ansari, Derakshan, & Richards, 2008; Derakshan, Smyth, & Eysenck, 2009). Depressive symptoms have also been linked to performance impairments in adult populations (i.e., more perseverative errors) on generative flexibility tasks such as the Wisconsin Card Sorting Test (see Rogers et al., 2004, for a review). Given the high comorbidity of anxiety and depression symptoms especially in childhood and adolescence (Lonigan, Carey, & Finch, 1994), the use of a composite index of internalizing symptoms might be best suited for this developmental period. Early internalizing problems have been linked to impaired flexibility when alternating between rules in a clinical versus a non-clinical sample of boys aged 9-11 (Emerson, Mollet, & Harrison, 2005). On the other hand, in a preschool non-clinical sample, high-anxious (HA) girls displayed better flexibility performance than low-anxious (LA) girls, but displayed longer response times (Ţincaș, Dragoş, Ionescu, & Benga, 2007).

In the developmental population, the role of attentional control as a moderator for the relationship between internalizing symptoms and AF has been under-investigated. In adults, skilled control of voluntary attention may allow anxious people to limit the impact of threatening information (Derryberry & Reed, 2002). Across development, attentional control may have an important function in buffering negative emotions by helping children reduce their emotional reactivity when confronted with stressful or challenging events (Perez-Edgar & Fox, 2007).

3.2. Study 1: Relating affective flexibility with internalizing symptoms during middle childhood[1]

The main theoretical and empirical goal of our first study was to *relate individual differences in internalizing symptoms* (anxiety and depression) *age and gender* to children's ability to deploy attention towards and away from emotional stimuli during mid-childhood. To be able to assess shifting AF during mid-childhood, an initial methodological aim was to adapt the *Attentional Control Capacity for Emotion* (ACCE) task used by Johnson (2009a; 2009b) in a study with adults. The use of this shifting flexibility task in a younger sample could yield important insights into the development of internally-directed emotional attentional control during this period. *From a developmental point of view*, we expected that with age, performance on this task would become faster and more accurate. We also explored *the presence of gender differences* in the ACCE task. According to the predictions of the Attentional Control Theory (ACT, Eysenck et al., 2007) *individual differences in internalizing symptoms* (especially in trait anxiety) were expected to have a greater detrimental effect on processing efficiency (measured by response times) than on performance effectiveness (measured by accuracy). Furthermore, as

[1] [1] The first study described in this chapter has been already published in the Journal *Anxiety, stress and coping*: Mocan, Visu-Petra, & Stanciu (2014) doi:10.1080/10615806.2014.888419.

the adverse effects of trait anxiety were thought to be exacerbated by an increase in central executive demands, we speculated that performance on switching trials would suffer more interference from internalizing symptoms than performance on repetition trials.

Secondly, we aimed to investigate *the effects of stimulus valence*, we maintained the demand for participants to alternate between emotional and non-emotional rules, while the switch itself became sensitive to the emotional valence of the stimuli (as compared to the always neutral switches in the previously mentioned study).

Thirdly, we wanted to check whether the *potentially negative effect of internalizing symptoms on AF performance was moderated by self-perceived attentional control capacity*.

Finally, we wanted *to explore the effect of externally-directed performance feedback*, compared to a non-feedback condition, and relate this effect to individual differences in internalizing symptoms.

3.2.1. Method

Participants

A sample of 108 primary school children (54 girls) aged between 7 and 11 years (*M* = 9.23 years, *SD* = 1.16) were recruited from a local Romanian school. The children came from families which varied widely in household earnings and maternal education levels (45% of mothers had completed at least an undergraduate degree, and an additional 31% had graduated from high-school).

Procedure

Written consent was obtained from parents, and children gave their verbal assent to take part in the study. The children who were old enough to read and write (n = 86) completed two self-report questionnaires measuring attentional control (ACS-C) and internalizing symptoms (RCADS) and all parents filled in the parental report version of the same scale (RCADS-P). Following this, all children were administered the computerized experimental task individually under the guidance of the experimenter, completing the feedback and non-feedback conditions in counterbalanced order (in two distinct sessions which took place a few days apart).

Materials

The Revised Child Anxiety and Depression Scale (RCADS; Chorpita, Yim, Moffitt, Umemoto, & Francis, 2000; translated to Romanian by Ţincaș, Cheie, Mocan, Benga, & Visu-Petra, in preparation) is a 47-item self-report scale adapted from the Spence Children's Anxiety Scale (SCAS; Spence, 1997, 1998). RCADS is used for measuring the frequency of occurrence of different anxiety (37 items) and depression symptoms (10 items).

The Attentional Control Capacity for Emotion (ACCE) task, adapted from Johnson (2009a), represents a shifting AF task as it measures an individual’s ability to shift attention between emotional and neutral rules. In the current study, children had to apply two types of rules on a compound stimulus that consisted of faces located within geometrical shapes (see Figure 3.1). A cue presented either 200 ms (short CSI) or 1500 ms (long CSI) before stimulus onset indicated whether the participants had to apply the neutral or the emotional rule. Following stimulus presentation, participants had to press one of three keys (1, 2, or 3) according to whether they thought this was a happy, neutral, or angry face (emotion rule), or a circle, triangle, or square (shape rule).

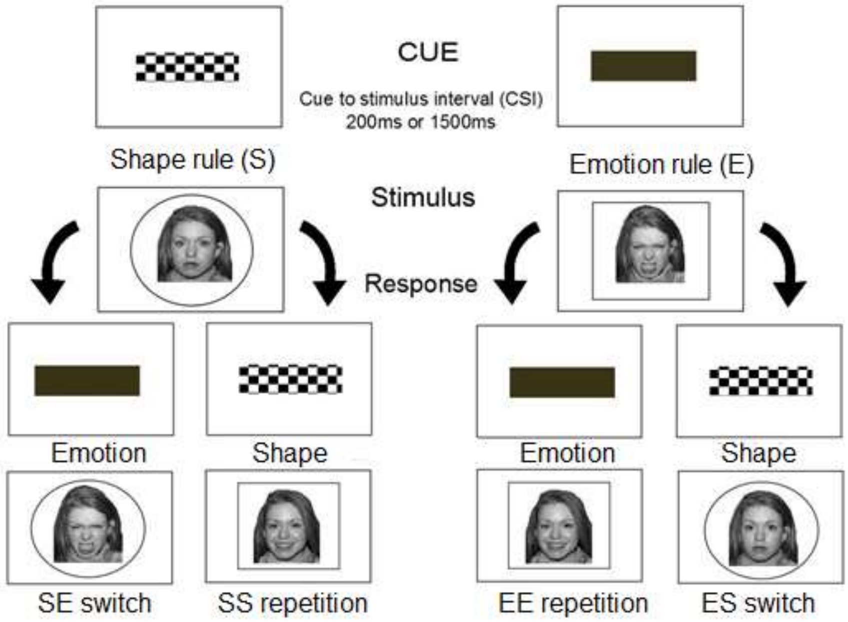

Figure 3.1. A schematic representation of the attentional control capacity for emotion (ACCE) task. Each trial began with the presentation of a cue which informed the child which rule to apply: an emotional rule (E) or a non-emotional shape rule (S). The cue remained on the screen for 200 ms or 1500 ms until the stimulus was presented and the participants had to make a judgment by pressing a key. Afterwards, a blank screen was presented for an interval of 500 ms followed by the next trial. Thus, the trial could entail either a task switch (emotional to shape rule or shape to emotional rule) or a task repetition (emotion to emotion rule or shape to shape rule). SE switching trials = Shape – Emotional switching trials; SE = Shape – Emotion switch; ES = Emotion – Shape switch; SS = Shape – Shape repetition trial.

The Child version of the Attentional Control Scale (ACS-C; Derryberry & Reed, 2002; translated in Romanian by Susa, Pitică, Benga, & Miclea, 2012) is a 20-item self-report questionnaire which measures the ability to focus and shift attention. Higher scores represent lower levels of attentional control.

3.2.2. Results

Effect of experimental manipulations

Overall, the estimated average log response time differed across the four types of trials, $F(3, 32201) = 36.77$, $p < .001$. Switching trials tended to elicit longer response times than repetition trials as can be seen in Figure 3.2(a) which presents the estimated geometric means for the four types of trials. There was no significant difference in the estimated means of log response time in the two types of repetition trials ($p = .15$). On the other hand, all else being equal, SE trials had longer estimated log mean response times than ES trials ($p = .023$), with a difference of 0.043 ($SE = 0.019$, $p = .023$) in the condition of interest: feedback and short CSI. The interaction between trial type and CSI, $F(1, 32201) = 12.51$, $p < .001$, reflects the fact that the difference between switching and repetition trials is higher at short CSIs than at long CSIs (see Figure 3.2.(a)).

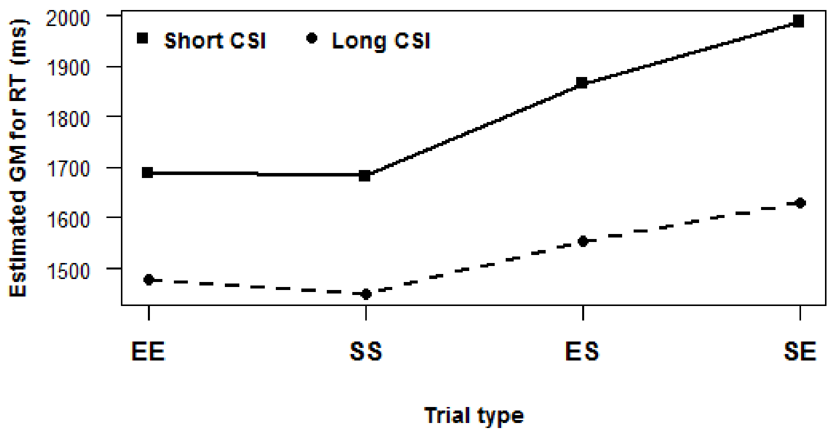

Figure 3.2.(a). Estimated geometric means (GM) of response time by trial type and Cue to Stimulus interval (CSI). Short CSI = 200 ms; Long CSI = 1500 ms; EE = Emotion – Emotion repetition; SS = Shape – Shape repetition; ES = Emotion – Shape switch; SE = Shape – Emotion switch.

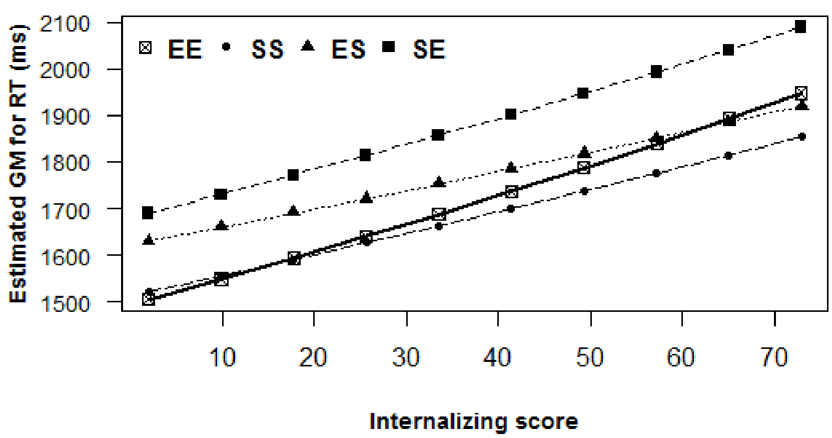

Figure 3.2.(b). Estimated geometric means of response time by Internalizing symptoms and trial type in the feedback condition. EE = Emotion – Emotion repetition; SS = Shape – Shape repetition; ES = Emotion – Shape switch; SE = Shape – Emotion switch

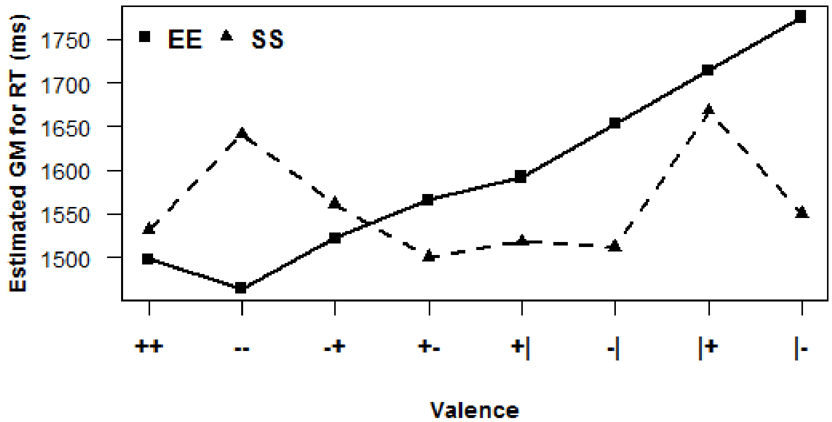

Figure 3.2.(c). Estimated geometric means of response time by valence for repetition trials.
++ = Positive Face – Positive Face; -- = Negative Face – Negative Face; -+ = Negative Face – Positive Face; +- = Positive Face– Negative Face; +| = Positive Face – Neutral Face; -| =Negative Face – Neutral Face; |+ = Neutral Face – Positive Face; |- = Neutral Face - Negative Face; EE = Emotion – Emotion repetition; SS = Shape – Shape repetition;

CSI length was a very good predictor of performance on its own, $F(1, 32201) = 492.52$, $p < .001$, with shorter estimated average log response times occurring at longer CSIs than at short CSIs keeping all else constant. Further, the presence of feedback was associated with longer estimated mean log response times, $F(1, 32201) = 28.99$, $p < .001$, and its effect depended on the CSI. The disadvantage brought by the presence of feedback was smaller at long CSIs than at short CSIs, $F(1, 32201) = 32.50$, $p < .001$, and was influenced by trial type, $F(1, 32201) = 13.20$, $p < .001$, being larger during ES trials than EE trials.

Effects of Age and Gender

There were also differences in performance related to age, $F(1,104) = 36.64$, $p < .001$, and gender, $F(1,104) = 4.38$, $p = .04$. A one-year difference in age between two participants was associated with an estimated difference of 0.084 on the log scale; in other words, the one-year older child is expected to have the geometric mean of response time shorter by 8.4% than the younger child (all other things being equal).

Boys took longer to respond than girls, but the effect of gender depended on the trial type, $F(3, 32201) = 10.91$, $p < .001$. The effect was largest for SE trials, as boys were estimated to have an 11% increase in the geometric mean compared to girls ($p = .01$). Boys also performed worse in the EE condition compared to girls (7% increase, $p = .03$), but post-hoc tests revealed they did not differ significantly from girls in the SS ($p = .30$) and ES ($p = .30$) conditions.

Effect of internalizing symptoms

Higher Internalizing scores were associated with a general detrimental effect on response times when controlling for age, gender, and the experimental manipulations, $F(1, 104) = 7.12$, $p = .01$. The effect of Internalizing symptoms differed as a function of feedback presentation, $F(1, 32201) = 4.03$, $p = .04$, and trial type, $F(1, 32201) = 3.03$, $p = .03$, as suggested by Figure 3.2(b) which charts the estimated geometric means for response times in each condition. Internalizing had a larger impact on trials where feedback was presented, and within this condition it was most pronounced for EE trials (b = 0.004, SE = 0.001, p = .004). Thus, an increase of 10 points on the Internalizing scale was estimated to lead to a 1.04 times larger expected geometric mean for response times. The effect of Internalizing was non-significant in EE trials without feedback (p = .31), and overall non-significant for ES trials (p = .42), and then for SE (p = .16) and SS trials (p = .24) after the application of multiple testing corrections, although still in the range of interest for exploratory studies.

Post-hoc analysis of stimulus valence

The stimuli in this study were valence-sensitive and switches occurred at times between stimuli with different emotional valences. We wanted to explore potential differences in performance related to the valence of the stimuli, and ultimately to adjust for valence as this could be a potential confounder of the effects of the other experimental manipulations. However, due to the presence of different types of valences with switching and repetition trials, as well as the small number of trials within each valence switch category, we only included this predictor in post-hoc analyses. Valence was a significant predictor only for response times of repetition trials. In order to better understand the effects of valence, two models were estimated for EE and SS trials. The comparisons between the different valences did not lead to a facile interpretation in the case of SS trials (the estimated marginal geometric means of response times for each valence can be observed in Figure 3.2.(c). However, in EE trials, valence was not only a highly significant predictor, $F(8, 1655) = 48.59$, $p < .001$), but it appears that repetitions between two emotionally valenced stimuli were easier to complete than repetitions between neutral-emotional or emotional-neutral stimuli.

3.2.3. Discussion

The purpose of this study was to investigate how AF links to individual differences in internalizing symptoms during an under-investigated developmental period (7-11 years). To this end, we adapted the ACCE task, which has been previously used with adults, to be able to investigate a shifting AF during middle childhood. Our findings are consistent with the task-switching paradigm literature by showing the presence of more errors and longer response times during switching compared to repetition trials. Also, shorter CSIs (200 ms vs. 1500 ms) resulted in losses in performance both in terms of accuracy and reaction times, and this affected switching trials to a greater extent than repetition trials.

The results also showed that ***older children were significantly faster*** during the AF task than the younger children.

We also found ***gender-related difference*** in reaction times, indicating that boys took longer compared to girls in applying the emotional rule after performing a non-emotional one, or a different emotional rule.

In line with the ACT, ***higher levels of anxiety (and depression)*** did not impact performance accuracy, but affected reaction times under certain circumstances. The negative association between internalizing symptoms and response speed was present only during the EE trials and only when feedback was provided.

A collateral aim was to investigate *whether* ***self-reported attentional control capacity could act as a protecting factor*** against the adverse effects of internalizing symptoms on simple AF performance. This hypothesis was not confirmed in the present study.

Looking at ***the effects of valence***, post-hoc analyses revealed a significant effect on response times only in the case of repetition trials. More specifically, during EE trials, applying consecutively the emotional facial expression rule was associated with shorter response times than consecutive trials which included an emotional and a neutral facial expression.

3.3. Study 2: Relating affective flexibility with internalizing symptoms and affective executive functioning during adolescence

In the current study we sought to address four research questions. Firstly, we wanted to investigate the degree to which affective measures of executive functions (EF) and shifting AF in particular ***improve from middle childhood to adolescence***.

Secondly, the purpose of this study was to replicate the results obtained in Study 2 by ***examining any potential anxiety-related impairment*** in terms of shifting AF in an older sample. We expected to replicate our findings from the first study in which such anxiety related deficits were reported especially when participants had to repeat applying the emotional rule.

Thirdly, we aimed to analyze ***the specific effect of emotional valence*** (positive, angry, and neutral) on the three key EFs (flexibility, inhibition and working memory).

Lastly, we wanted to explore ***whether the affective measures of inhibition and working memory predict the ability to shift between emotional and non-emotional rules*** (measured with the ACCE task that was used in Study 1). In addition to the ACCE task which represents a measure of AF, participants completed two affective measures of executive functions (EFs) taping into inhibition and working memory processes which enabled us to examine the contribution of inhibition and working memory to AF.

3.3.1. Method

Participants

A total of 110 children (54 girls), aged between 12 and 18 years old (*M* = 15.36, *SD* = 2.07 years) participated in this study. The children were enrolled either in middle school (n = 56) or high school (n = 54). Given the difference in age (three years), age was treated as a dichotomous variable corresponding to the two educational levels: 50.60 % comprised the middle school children (6^{th} and 7^{th} grade), who were aged between 12 years and 2 months and 15 years and four months, while 49.10 % comprised the high school children (10^{th} and 11^{th} grade), who were aged between 16 years and 3 months and 18 years and four months.

Measures

The Attentional Control for Emotion Task (ACCE task, Mocan, Stanciu, & Visu-Petra, 2014) was used to assess cognitive flexibility. The task was identical to that used in Study 1, except that there were two differences: (1) in order to increase task difficulty in this older age group the stimulus presentation interval was reduced from 5000 ms to 3000 ms and (2) participants completed only the ACCE version (180 trials) without trial-by-trial feedback.

The Emotional Stroop task (EmoStroop, adapted after Preston & Sheffield, 2008) was used to assess children’s inhibition when dealing with emotional information. In each trial, participants were presented with stimuli consisting of affective adjectives (positive, negative or neutral) superimposed on different emotional facial expressions (positive, negative or neutral) and had to categorize each word according to its valence while ignoring the emotional expression of the background image (see Figure 3.4). Three types of responses were possible: happy, angry and neutral. For each word, children had to press a corresponding key.

The Emotional 2-back test (Casey et al. 2000; Varga, Visu-Petra, Miclea, & Visu-Petra, 2015) was used to assess working memory for emotional and neutral information (see Figure 3.5). The emotional stimuli consisted in faces of several individuals, of both genders, that could be of three possible ages: young, middle-aged and old. The emotional valence (positive, negative or neutral) was kept constant across conditions, except for the white screen condition. During the task, participants were instructed to detect any letter that appeared two letters previously/ that was displayed two presentations back/ (e.g., M-L-M). The task was delivered in four blocks which differed as a function of the background condition (neutral, positive, negative or no image). Every block consisted of 30 trials, for a total of 120 trials.

Academic performance

We took into account children's general grade score from the first semester given that our participants enrolled in this study at the beginning of the second semester. This general grade score represented a mean of all the grades the children had received during the previous semester.

The Attentional Control Scale for children (ACS-C; Derryberry & Reed, 2002) has been described in Study 1 and was used to assess children's AF performance.

The Revised Child Anxiety and Depression Scale (Chorpita, Yim, Moffitt, Umemoto, & Francis, 2000) has been presented in Study 1. The presence of symptoms was assessed through child reports.

The Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA; Gullone & Taffe, 2012; MacDermott, Gullone, Allen, Tonge, & King, 2010) is a revised version of the Emotion Regulation Questionnaire (Gross & John, 2003) and includes 10 items assessing the emotion regulation strategies of cognitive reappraisal (6 items) and expressive suppression (4 items).

The Behaviour Assessment System for Children, Second Edition (BASC-2, Reynolds & Kamphaus, 2004) was used in order to measure externalizing behavioral problems. We applied only the Hyperactivity/Inattention sub-scale as we were mainly interested in assessing externalizing problems.

The Raven Progressive Matrices (Raven, 1938) was used to test participants' fluid intelligence. Children were presented with a series of black and white figures arranged in a 3 x 3 matrix, on a computer screen. Each figure consisted in an incomplete matrix. Departing from 6 or 8 figures arranged below the matrix, participants were instructed to choose only one figure which completed correctly that particular pattern.

Procedure

Participants were tested in a group setting, in a quiet room situated in the school building. The experimenter provided verbal instructions using a PowerPoint presentation and instructions were also displayed at the beginning of each task or questionnaire. Participants completed the measures in three different sessions situated a week apart.

3.3.2. Results

Main Analysis

The effects of age on executive functions performance

We performed several independent-samples t-test to compare the two age groups (middle and high school children) in terms of their reaction times as well as task accuracy for the cognitive flexibility (repetition and switch trials), inhibition (congruent, incongruent emotional and incongruent neutral trials) and working memory (overall index of accuracy and RTs) measures. The results are briefly presented in Table 3.1 and they show significant improvements in terms of executive functioning (both reaction time and accuracy) between the two age groups. Our findings indicate that adolescents outperformed the middle aged children in terms of their performance accuracy in all the affective measures of EFs. When looking at reaction times, the adolescents had significantly faster reaction times during the inhibition and working memory task but not during the cognitive flexibility task compared to the younger sample. Even though during the cognitive flexibility task adolescents tended to respond faster than their younger counterparts, this difference was not significant.

Table 3.1. Independent Samples t Tests for the EF (accuracy and reaction times) as a function of age group (middle school children and adolescents)

		Middle school children (N=56)		Adolescents (N=54)					
Task	Outcome	M	SD	M	SD	T	p	95% CI	Cohen's D
ACCE task	Repetition trials Acc	76.39	29.57	100.62	14.25	-5.44	<0.001	[-33.06, -15.40]	1.04
	Switching trials Acc	34.16	15.05	49.05	8.36	-6.38	<0.001	[-19.52, -10.26]	1.22
	Repetition trials RTs	1086.15	177.98	1031.74	178.48	1.60	0.11	[-12.97, 121.78]	0.30
	Switching trials RTs	1224.97	201.51	1187.47	189.10	1.00	0.31	[-36.42, 111.41]	0.19
Emotional N-back task	Total Acc	10	8.12	32.77	7.60	-6.02	<0.001	[-12.08, -6.10]	2.89
	Mean RTs	859.75	158.54	744.64	181.05	3.53	0.001	[50.58, 179.63]	0.67
Emotional Stroop task	Congruent Acc	156.77	25.24	174.62	8.78	-4.90	<0.001	[-25.06, -10.63]	0.94
	Incongruent emotional Acc	99.01	18.95	113.12	9.13	-4.92	<0.001	[-19.78, -8.43]	0.94
	Incongruent neutral Acc	51.87	8.53	57.46	4.42	-4.27	<0.001	[-8.18, -2.99]	0.82
	Congruent trials RTs	1066.30	188.52	961.59	141.46	3.26	0.001	[41.12, 168.30]	0.62
	Incongruent emotional trials RTs	1104.32	206.24	1015.24	142.55	2.61	0.011	[21.43, 156.72]	0.50
	Incongruent neutral trials RTs	1074.17	195.10	965.65	124.60	3.44	0. 001	[46.06, 170.98]	0.66

The effect of internalizing symptoms and gender on EFs performance (reaction times)
Affective flexibility

We performed a repeated-measure ANOVA with Task condition (EE and SS repetition trials, ES and SE switch trials) as within-subjects factor, gender as a between-subjects factor and internalizing symptoms as a covariate for the mean RT data. Mauchly`s test showed that the assumption of sphericity had been violated, $\chi^2(5) = 34.75$, $p < .001$ and therefore a Huynh-Feldt correction was used ($\varepsilon = .81$). The results indicated that there was a main effect of condition $F(2, 269) = 726.43$, $p < 0.001$, MSE = 12748002.10, $\eta_p^2 = .87$. Overall, participants were faster in responding to the repetition trials as compared to the switching trials (see Figure 3.3). Posthoc pairwise comparisons (with Fisher's least significant difference - LSD) indicated that the most difficult condition was represented by the SE switch trials, as participants took longer to complete these trials in comparison to the ES switch trials and the two types of repetition trials ($p < .001$). Looking at repetition trials EE repetition trials were more demanding compared to SS repetition trials ($p < .001$).

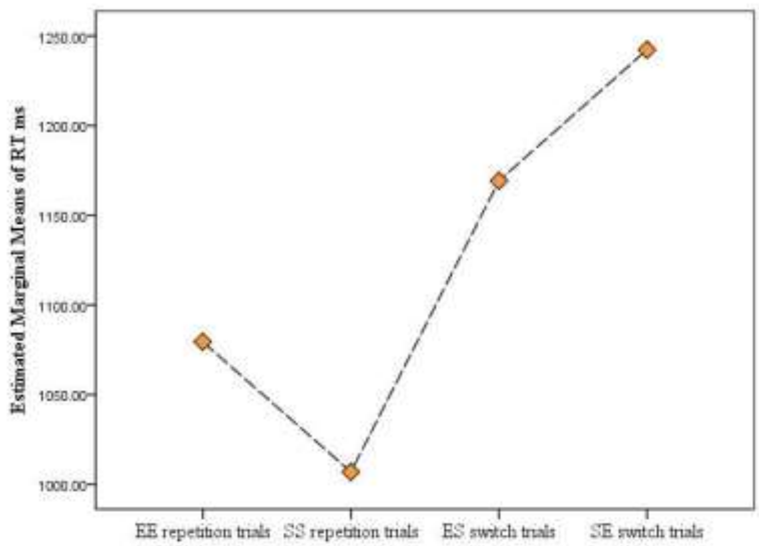

Figure 3.3. Estimated marginal means of reaction time for the ACCE conditions.

Also, we found an interaction between gender and task condition, $F(2.88, 311) = 3.52$, $p = .035$ revealing that girls (M = 1201.40, SD = 28.80) provided faster responses than boys (M = 1281.65, SD = 28.28) only during the SE switch trials (See Figure 3.4). Looking at the impact of internalizing symptoms, our analysis didn't reveal any significant effect exerted by individual differences in internalizing symptoms on the conditions of the ACCE task. Hence, we did not find a two-way interaction between internalizing symptoms and task conditions $F(3,305) = .79$ (p =.49).

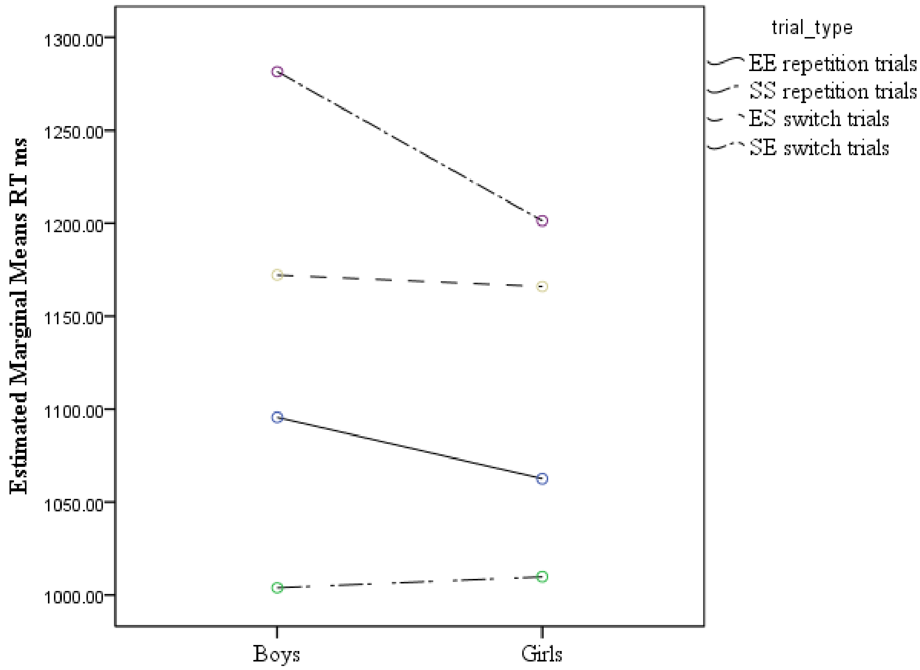

Figure 3.4. Estimated marginal means of reaction time for the ACCE conditions as a function of gender differences

Working memory

We performed a one-way repeated-measures ANOVA with Task condition (no background, negative background, neutral background and positive background) as a within-subjects factor, gender as a between-subjects factor and internalizing symptoms as a covariate for the mean RT data. The results indicated that there was a main effect of task condition $F(3,300) = 5.15$, $p = .002$, MSE = 129287.31, $\eta_p^2 = .049$. Posthoc pairwise comparisons (with Fisher's least significant difference - LSD) indicated that participants were faster on the no background condition as compared to the emotional background conditions ($p < .001$). We found no significant differences between the three emotional background conditions (see Figure 3.5). Even though girls displayed a tendency to respond slower compared to boys as revealed by a marginally main effect of gender $F(1,100) = 3$ ($p = .86$), this difference was not revealed in the task conditions and we failed to find a two way interaction between gender and task condition $F(3,300) = .49$ ($p = .68$).

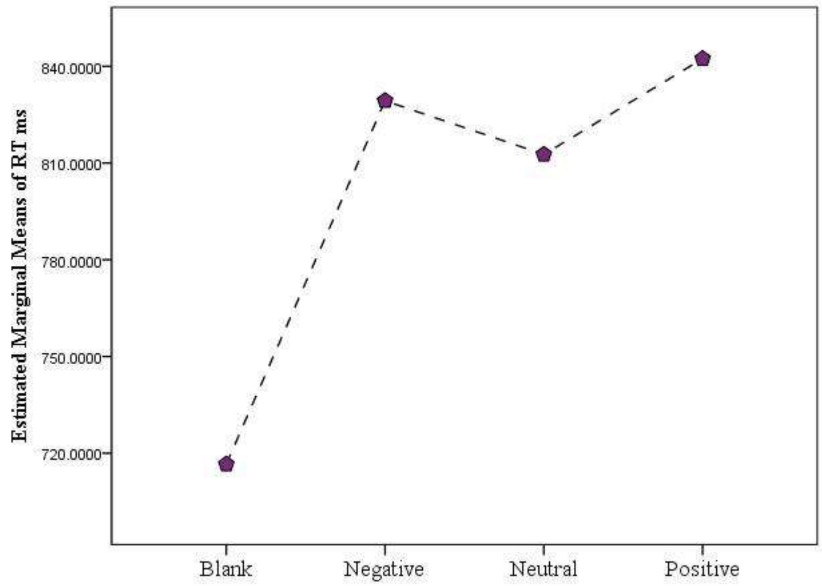

Figure 3.5. Estimated marginal means of reaction time for the N-back conditions.

Inhibition

We conducted a one-way repeated-measures ANOVA on the mean reaction time data with Task condition (Congruent (3 types): Happy, Angry and Neutral; Incongruent Emotional (4 types): Angry word-Happy face, Happy word-Angry face, Neutral word-Angry face and Neutral word-Happy face; Incongruent neutral (2 types): Angry word-Neutral face and Happy word-Neutral face) as within-subjects factor, gender as a between-subject factor and internalizing symptoms as a covariate. Mauchly`s test showed that the assumption of sphericity had been violated, $\chi^2(35) = 142.32$, $p < .001$ and therefore a Huynh-Feldt correction was used ($\varepsilon = .70$). Our findings revealed a main effect of Task condition $F(6,628) = 6.63$, $p < 0.001$, MSE = 58281.801, $\eta_p^2 = .06$ while we didn’t find a main effect of gender (p=.61). We used posthoc pairwise comparisons (with Fisher's least significant difference - LSD) to investigate the main differences between the task conditions. When looking at the comparisons between the congruent conditions, our findings indicate that the Neutral words were more demanding in terms of reaction times compared to the Happy ($p < .001$) and the Angry words ($p < .001$). However, within the congruent condition no significant difference was found between the Happy and the Angry words ($p = .84$). Furthermore, our results revealed significant differences between all four conditions of the Incongruent Emotional category: the Neutral word-Angry face was the most difficult condition followed by the Happy word-Angry face condition as participants took longer to solve these trials compared to the other Incongruent Emotional types of trials (see Figure 3.6). Also, the Incongruent Emotional Angry word-Happy face condition was the less difficult followed by the Incongruent Emotional Happy word-Angry face, also both conditions differed significantly from each other and from the other Incongruent Emotional types of trials. Nevertheless, the Incongruent Neutral trials did not differ significantly between them ($p = .21$). We failed to find a two-way interaction between gender and task condition $F(8,824)=.42$, $p = .32$, or an interaction between internalizing symptoms and task condition $F(8,824) = .61$, $p = .77$.

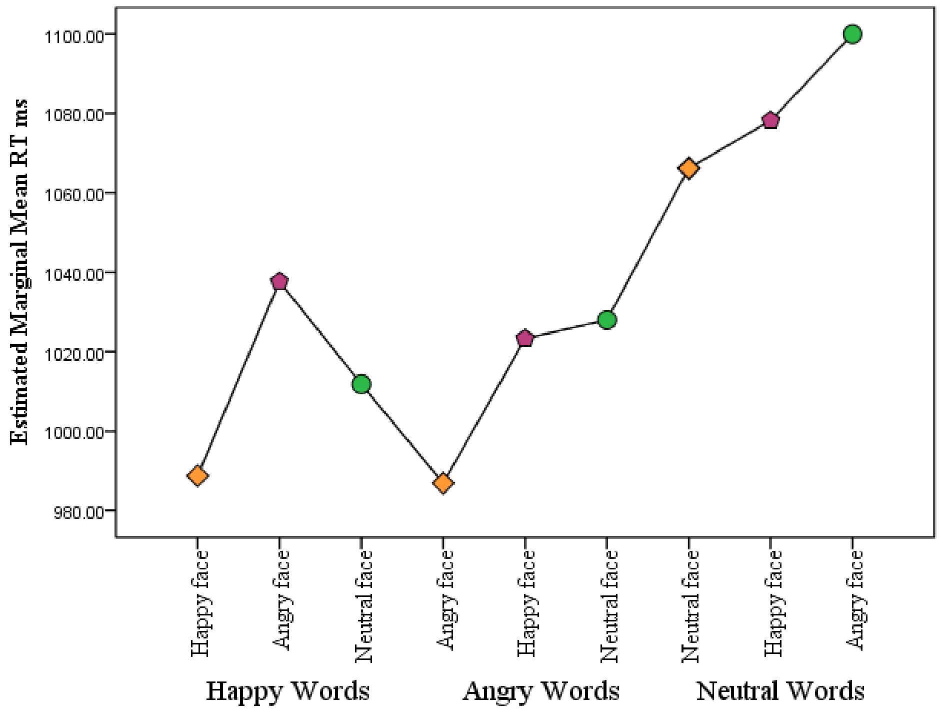

Figure 3.6. Estimated marginal means of reaction time for the Emotional Stroop task conditions. Congruent trials are depicted by orange diamonds, incongruent–emotional by purple hexagons and incongruent–neutral by green circles. Trials are grouped by the valence of the words, with the facial expression labeled vertically on the x-axis.

Contribution of inhibition and working memory to affective flexibility

To test whether inhibition and working memory processes are significant predictors for children`s AF, we performed two hierarchical multiple regression analyses. The first analysis was performed on reaction times outcomes by including AF as a dependent variable while inhibition and working memory were entered as predictors. The predictors were entered in the analysis in a specific order in which they had been documented in the developmental literature. In the first regression analysis the inhibition measure was introduced as a predictor in the first model (r = .58) while in the second model we added the working memory task in addition to the inhibition task (r = .63). As Table 3.2 shows, the inhibition function alone explained a significant 34% portion of the AF variance and the inhibition and working memory functions taken together accounted for 39.7% of AF variance.

Table 3.2. Predictors of affective flexibility performance (RTs)

Predictor	R	R^2	R^2 change	P
Inhibition RTs	.588	.346	.340	<0.001
Inhibition RTs + working memory RTs	.630	.397	.385	<0.001

The second hierarchical multiple regression was similar to the first except it was performed on accuracy performance by taking into account the total number of correct responses for the predictors and the dependent variables. In order to investigate the explanatory value of inhibition and working memory functions to children`s cognitive flexibility accuracy performance we entered in step one inhibition and then we entered in step two the working memory measure (see Table 3.3). A significant 54% portion of variance was explained by the inhibition measure alone while the two EFs together managed to account for 63% of the CAF variance.

Table 3.3. Predictors of affective flexibility performance (Accuracy)

Predictor	R	R^2	R^2 change	P
Inhibition Acc	.735	.540	.536	<0.001
Inhibition Acc + working memory Acc	.803	.645	.638	<0.001

3.3.3. Discussion

The findings from the current study shed new light on the development of emotional aspects of EF during middle childhood and adolescence. This study measured for the first time, to the authors' knowledge, the relation between individual differences in AF and affective measures of inhibition and working memory processes. Specifically, we employed three EF tasks using emotional stimuli namely the ACCE task, the Emotional N-back task and the Emotional Stroop task in order to assess affective aspects of inhibition, working memory and flexibility.

Firstly, we will discuss findings regarding *the role of individual differences in internalizing symptoms, age and gender* on AF.

Regarding *age-related improvements* in affective executive functioning, our findings revealed that affective EFs still continue to develop from middle childhood to late adolescence.

We also found an interesting *gender-related difference* in terms of reaction times, boys presenting longer response times compared to girls when applying the emotional rule after performing a non-emotional, or a different emotional rule.

However, our data did not reveal the same *internalizing-related detrimental effects* in terms of AF in particular and the other two executive functions in general. We failed to replicate the findings of the first study which was focused on a younger sample (7-11 years old) and which showed that internalizing symptoms were associated with a detrimental impact on repetition trials (in terms of reaction times) especially when children had to repeat applying the emotional rule. The discrepancy in findings between our two studies could be accounted by different levels of internalizing symptoms obtained by participants in our two studies. However, we ruled out this possibility given that in our first study children's levels of internalizing symptoms were lower (*M*=21.34, *SD*=14.50) than in the second study (*M*=25.50, *SD*=17.87). Another possibility could be that in older children the effects of internalizing were not that detrimental as they were in the case of younger samples. This suggests that some developmental windows (middle childhood) might be more vulnerable than others in terms of a presence of detrimental effects exerted by internalizing symptoms.

Looking at the specific impact of *emotional valence* on EF performance, the results show that the emotional valence has a strong impact when it acts as task-relevant (during the shifting AF and inhibition tasks) but also when it acts as task-irrelevant (during the working memory task).

Lastly, we also wanted to provide insights into *how AF relates to affective aspects of inhibition and working memory* during middle childhood and early adolescence. Our findings show that AF is predicted by both inhibition and working memory processes at the level of accuracy performance and reaction time.

3.4. General Discussion

Affective flexibility is a crucial ability which is important for many aspects of children’s life (see Chapter 1). However, very little is known about (1) the way in which individual differences in age, gender and internalizing symptoms are related to AF during middle childhood and (2) the relation between affective measures of inhibition and working memory and AF during middle childhood and adolescence.

The present studies bring several important contributions to the very limited literature on shifting AF in children and adolescents. Taken together, these two studies show that the ACCE task is a reliable measure for assessing shifting AF during both middle childhood and adolescence. Also, during mid-childhood children are already quite proficient in a shifting AF measure in which they have to flexibly alternate between emotional and non-emotional rules according to contextual cues, although their processing efficiency continues to improve gradually into adolescence.

Findings from our two studies show *that during middle childhood and adolescence girls appear to be faster than boys* in engaging emotional rules.

In the first study we showed that (1) higher levels of internalizing symptoms are negatively related to children's speed in alternating between two emotional rules and when feedback is provided. Also, irrespective of internalizing levels, children have difficulties especially in applying repeated emotional rules. When trial-by-trial feedback is provided, children are more cautious and make fewer errors, and this tendency is stronger in children with higher levels of internalizing symptoms.

In the second study we explored *the relation between affective aspects of inhibition, working memory and AF* by showing that: (1) inhibition, working memory and flexibility over emotional content continue to develop during middle childhood through adolescence, (2) the effect of emotional faces is visible in all three EF measures (3) internalizing symptoms seem to exert no influence on affective measures of EFs in general and shifting AF specifically (4) during this age interval children draw upon affective aspects of inhibition and working memory to behave in a flexible manner when confronted with emotional content.

CHAPTER 4.

The influence of individual differences on generative cognitive and affective flexibility in preschoolers, preadolescents and adults

4.1. Introduction

As children develop they learn to represent an object or event in multiple ways, and to flexibly switch between these representations in order to select the one that best suits a given situation. Cognitive flexibility reflects the ability to change thinking processes adaptively in response to situational demands and individual goals (Lezak, 1995). This ability underlies very simple problem-solving operations, such as when a child uses an object (e.g., a chair) in a new way (e.g., as a climbing tool), but also underpins more complex, affectively-laden processes, such as reappraising a negative situation to find a positive interpretation. Furthermore, when operating with emotional material, cognitive flexibility intersects with affective flexibility (Genet et al., 2013; Malooly et al., 2013), which is the ability to flexibly switch between alternative ways of processing emotional material (Malooly et al., 2013). Traditionally, cognitive flexibility has been construed as the opposite of functional fixedness, and it is considered to be a key component of creative thinking (see Deák, 2003, for a comprehensive review).

4.1.1. Assessing generative cognitive flexibility: The Flexible Item Selection Task (FIST)

Substantially less research has been devoted to such inductive tasks, although according to several investigators (e.g., Jacques & Zelazo, 2001; Smidts et al., 2004) these tasks are better suited for measuring cognitive flexibility than deductive tasks. Consequently, Jacques and Zelazo (2001) created the Flexible Item Selection Task (FIST), initially to assess cognitive flexibility in preschoolers. This task taps into a generative form of flexibility (See Chapter 1). In the initial three-item version of this task, participants were required to find two pairs of matched stimuli from a set of three, without being told in advance what was the matching criterion for each pair. The advantage of using such inductive tasks is that participants must engage in problem-solving strategies that allow for reinterpretation of a stimulus, by implicating a different stimulus feature (e.g., red instead of circle) when inferring the second shift rule (Yerys et al., 2012). The ability to identify the dimensions on which pairs of stimuli items match, and to flexibly switch between these dimensions, requires generative flexibility, as participants need to integrate subordinate goals that are in conflict (i.e., the classification of stimuli in terms of alternative dimensions) into a hierarchical comprehensive goal system (Bunge & Zelazo 2006; Qu et al., 2013). The FIST can therefore sensitively assess generative cognitive flexibility by tapping variability in the ease with which participants can successfully shift between independently inferred matching criteria. Employing this three-item version of the FIST for preschoolers, Jacques and Zelazo (2001) found that 4-year-olds were able to identify an initial matching pair, but generally failed to identify a second matching pair, thereby demonstrating poor generative cognitive flexibility. While 6- and 8- years old children reached ceiling performance on this generative flexibility task, performance on more demanding versions of this task continued to improve until the age of 10 (Dick, 2014).

The majority of studies on cognitive flexibility in early preadolescence have used tasks that capture children’s shifting flexibility ability, namely their capacity to switch between two different task rules. However, they do not provide insight into generative cognitive flexibility beyond the task-switching component, in terms of pinpointing the different processes that underlie generative cognitive flexibility. In this study, we wanted to examine preadolescents' ability to switch between task rules as well as their ability to generate different perspectives towards an object (generative cognitive flexibility) or emotional content (generative affective flexibility). Additionally, even though the number of studies looking at affective flexibility has increased during the last couple of years (see Chapter 1 for a list of studies), few of these studies have looked at both cognitive and affective flexibility in young and older children.

As a result, we still lack age appropriate affective flexibility tasks in order to measure affective flexibility ability from early on and to follow its progress across development. We argue for the need of developing valid and reliable measures of affective flexibility as they are indispensable for the field of theory and research. A number of measures have been employed in recent research to investigate cognitive flexibility but notably even the DCCS task, which has been widely used, has been reported to lack adequate test–retest reliability (Beck, Schaefer, Pang, & Carlson, 2011). We wanted to address this limitation by developing an age-appropriate affective flexibility measure and then investigate the test-retest reliability of this measure in young children.

4.1.2. The effect of valence on affective flexibility performance

Recently, there has been a considerable interest in the association between individual differences in affective flexibility during the processing of emotional information, across the developmental trajectory. Such research has been motivated in part by the idea that compromised affective flexibility may represent a potential vulnerability factor for psychopathology. All of these studies use emotional content as (1) task-relevant by looking at the direct effects of emotions on cognitive performance or (2) task-irrelevant by looking at the indirect effects of emotions when they are presented in the background and are not a direct target of evaluation. Studies have confirmed a link between cognitive and affective flexibility and stress reactivity in adults. For example, impaired shifting flexibility during the processing of emotional task-relevant material has been shown to moderate the association between stress and rumination (De Lissnyder et al., 2012). The very few studies that have directly assessed children's cognitive flexibility during the processing of emotional material have focused mostly on preschoolers (but see also Morton et al., 2003, for an investigation with 6-year-old children). Qu and Zelazo (2007, study 2) examined the effect of emotional and neutral stimuli on an elementary cognitive and affective flexibility in 3- to 4-years old children using a standard DCCS and a version of the DCCS that presented emotional faces as task-irrelevant information (background information), while children had to sort the faces on the basis of age or gender. Results revealed that compared to the standard version, children performed better on the elementary affective flexibility measure when presented with happy faces, but not when presented with sad or neutral faces as a background. This finding was interpreted as a possible consequence of mild positive affect, transiently induced by exposure to these positive emotional stimuli (Qu & Zelazo, 2007). A similar approach was adopted by Wong et al. (2008) to assess generative cognitive and affective flexibility in preschoolers (3 to 5-years olds) using the modified four-item FIST (Jacques, 2012), together with a novel affective flexibility measure (emotional FIST) in which children had to match pairs of stimuli in terms of gender, hair color, or size, while ignoring task-irrelevant emotional information. Results indicated that this generative affective flexibility measure was more difficult than the generative cognitive flexibility measure, but only when angry or neutral faces were presented, and not when happy faces were used. Again, the investigators suggested that the presence of these positive emotional stimuli may have induced a transient, mildly positive mood, which served to enhance the children's generative affective flexibility. While these findings suggest that task-irrelevant emotional information may influence generative affective flexibility in young children, they do not inform us about affective flexibility when emotional information is rendered task-relevant, nor do they indicate how such cognitive and affective flexibility may differ in younger, as compared to older children or adults.

The present study was designed to clarify these issues, by employing two FIST task versions designed to assess generative forms of both cognitive and affective flexibility - that directly involves switching to and from the processing of emotional stimulus information. In particular, we conducted three separate studies in which we investigated the direct or indirect effects of emotions on generative cognitive and affective flexibility in young children, preadolescents and young adults. More specifically, in the first study we addressed the indirect impact of emotions on affective flexibility performance by employing emotional information as task-irrelevant in a sample of preschoolers. Then, in the second and third study we considered the direct impact of emotions on affective flexibility performance for the situation in which emotion was task-relevant in both preadolescents and younger adults.

4.1.3. The impact of trait anxiety on cognitive and affective flexibility in children and adults

The potential impact of individual differences in anxiety on cognitive and affective flexibility is an important, but under-investigated research issue. According to the literature, adolescents with increased internalizing problems are at risk for multiple academic and social problems, including the development of depression and anxiety disorders later in life (Weissman et al., 1999). Preadolescents are required to gradually learn how to independently regulate their emotions and behaviors while taking into account long-term goals and consequences (Steinberg, 2005). Researchers have speculated that adolescents with efficient executive functions have superior emotional information processing skills. This leads to a more flexible adaptive control over their own day to day activity and hence to a reduced risk for psychopathology (Han et al., 2015; Martel et al., 2007; Micco et al., 2009). Therefore, it is of paramount importance to investigate if the ability to flexibly alternate between different ways of processing emotional material continues to develop during this vulnerable period, and to examine how this ability relates to emotional vulnerability. In adults, there is some evidence that reduced psychological flexibility may portend psychopathology. Anxiety disorders are characterized by behavioral inflexibility, such that people with clinical levels of anxiety often display a restricted and stereotyped repertoire of behavioral responses when engaging with their environment (Kashdan & Rottenberg, 2010). While anxiety-linked variation in cognitive and affective flexibility has been less studied, the influential Attentional Control Theory put forward by Eysenck and colleagues (ACT; Eysenck et al., 2007; Eysenck & Derakshan, 2011) predicts that elevated trait anxiety scores will have a detrimental impact on executive functioning especially during the processing of emotional information.

4.2. Study 3: The influence of individual differences on generative cognitive and affective flexibility in preschoolers

The current study aims to provide information on the adaptation and validity of a 3-item card sorting task that measures a generative form of affective flexibility in preschoolers. The main focus of our study was to ***examine the validity of our measure of affective flexibility*** by looking at its test-retest reliability and at its validity. This was undergone by contrasting the affective flexibility measure to two different measures of cognitive flexibility that included neutral stimuli. We wanted to explore the hypothesis advanced by previous literature in adults, showing that affective flexibility is a separate construct and is thus unrelated to cognitive flexibility (Malooly et al., 2013).

A second aim was to investigate the association between ***individual differences in gender, anxiety and emotion regulation*** to affective flexibility.

Lastly, we wanted to investigate ***the impact of valence*** during the 3-item EM-FIST task which was designed specifically for this purpose. In this task, emotional stimuli are presented in the background but they do not represent the direct target of evaluation (task irrelevant). We wanted to compare the three types of backgrounds used (e.g., neutral, happy and angry faces) and to see if they have a different impact upon performance during this affective flexibility measure.

4.2.1. Method

Participants

Study participants included 41 preschoolers (21 girls) aged between 5 and 6 years and five months (M_{months} = 69.80, SD = 4.02). These children were recruited from a local kindergarden and written, informed consent was obtained from parents and children before testing.

Measures

The Spence Children's Anxiety Scale **(**Spence, Rapee, McDonald, & Ingram, 2001; Benga, Ţincaş, & Visu-Petra, 2010) is a measure designed to evaluate children's symptoms of separation anxiety, social phobia, obsessive-compulsive disorder, generalized anxiety and fears of physical injury.

The Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997) has been used to assess emotion regulation through parental report.

The 3-item Flexible Item Selection Task (FIST, Jacques & Zelazo, 2001, see Figure 4.1.) is an inductive measure of cognitive flexibility used with preschoolers. This task taps into a generative form of flexibility, as it requires participants to shift between two different ways of viewing an item, in a trial-by-trial manner. During this task, participants are presented with three cards and are first told to select a pair of cards that go together in one way. Participants are then required to select another pair of cards that go together but in a different way. In a trial-by-trial manner participants are presented with three colored cards that vary as a function of shape (a kettle, a boat and a shoe), size (big, medium and small) and color (red, blue and yellow). The 3-item FIST task is comprised of two demonstration trials, two practice trials and 15 test trials.

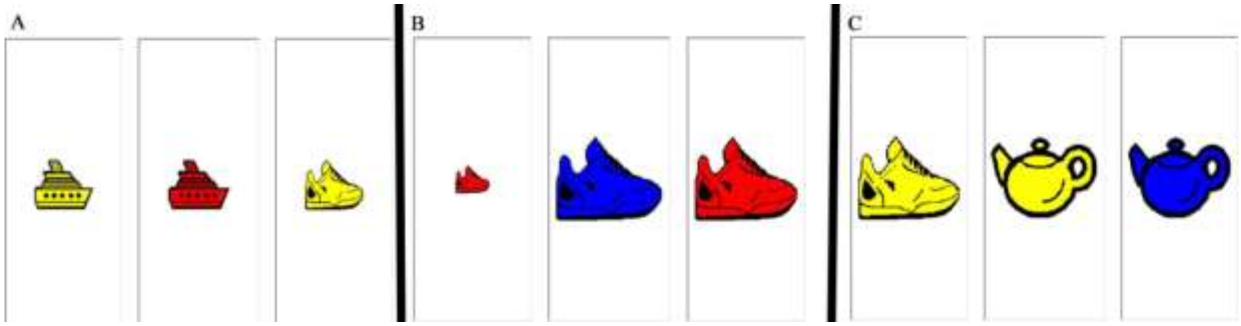

Figure 4.1. A depiction of the 3-item Flexible Item Selection Task (FIST). A – Participants have to select the first two items as they have the same shape and the first and third item as they share the same color. B – Participants have to select the first and the third image because they share the same color and then select the second and the third image because they have the same size. C – Participants have to select the first and the second image because they share the same color and then select the second and the third image as they have the same shape.

The Emotional 3-item Flexible Item Selection Task (EM-FIST**;** adapted after Jacques & Zelazo, 2001, see Figure 4.2.) was developed for this study departing from the standard computerized 3-item FIST version. In a given trial, three emotionally congruent faces (happy, angry or neutral) were presented and participants were required to select two cards that match according to a non-emotional rule, and then select a second pair of cards that match according to a different non-emotional rule. There were three non-emotional rules: hair color (blond, red), stimulus size (big or small) and gender (male or female).

Figure 4.2. An illustration of the 3-item EM-FIST task; A - Angry condition in which children had to select the first two items (same size) and the second and the third item (same identity); B - Neutral condition in which children had to select the first two items (same identity) and the second and the third item (same hair color); C - Happy condition in which children had to select the first two items (same identity) and the first and the third item (same hair color).

The Dimensional Change Card Sort task and the Borders DCCS (DCCS; Zelazo, 2006) is a deductive measure of flexibility and has been mostly used with preschoolers. In this study, we employed the standard DCCS task followed by the DCCS borders and we computed a total accuracy score for these two measures. During the DCCS task, participants have to sort cards according to the color rule or the shape rule. Hence, children are provided with cards depicting a rabbit or a boat of different colors (red or blue) and they need to put them in one of the two boxes according to the two rules.

The Listening Recall Task measures verbal working memory and is part of the AWMA battery (Alloway, Gathercole, Willis, & Adams, 2004), being designed as a „span" task. The task starts with the first block which contains six lists with one sentence each. At first, the child is presented with one list consisting in one sentence at a time (e.g. „*Humans have two eyes*") and is asked to judge whether the sentence is true or false by responding with „*yes*" or „*no*". Then, the child is asked to recall the last word of that sentence (e.g., „*eye*"). Afterwards, for each block that contains lists with two or more sentences, the child has to mention for each sentence, whether it was true or false, and then to recall the last word of each sentence in the same initial order of presentation.

The Wack-a-mole Task (Casey et al., 1997; Shapiro, Wong, & Simon, 2013, see Figure 4.3.) is a version of a Go/NoGo response inhibition task (see Figure 4.3). Children were required to press a key as quickly as possible when a cartoon represented by a mole appeared on the screen (Go trial). They were also required to refrain from pressing that key when a vegetable was displayed (No-Go trial).

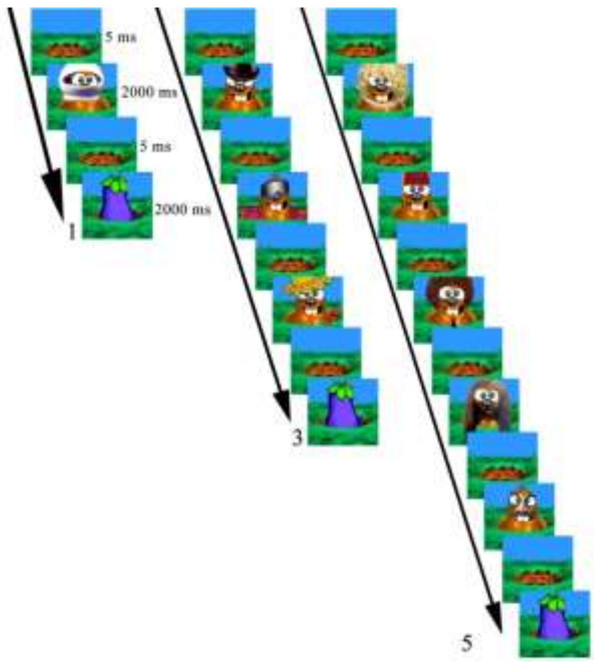

Figure 4.3: Example of trials from the Go/No-Go task. Children were instructed to press a key as quickly as possible when a mole appeared on the screen (Go trial), but to avoid pressing this key when a vegetable appeared (No-Go trial). No-Go trials were preceded by one, three, or five Go trials.

The colored Raven Progressive Matrices test **(**Raven, 1949, 1956) is a measure of general intelligence developed for 4-11 year old children. This test contains three series (A, Ab and B) and each series includes 12 colored matrices. Each matrix displays a figure or a succesion of abstract figures that has a missing part. Participants have to find the missing part by analyzing a set of available options. The difficulty of the task increases gradually. The highest score that can be obtained on the Raven test is 36.

Procedure

Preschoolers were individually administered the battery of executive tasks designed to measure cognitive and affective flexibility, inhibition, and working memory, by a trained examiner in a quiet room. The battery of tasks was administered in three sessions which took place in the kindergarten and lasted about 30 minutes each.

4.2.2. Results

Preliminary analysis

Firstly, we were interested to explore the presence of gender effects on the measures of executive functions. To this end, we performed several analyses of variance (ANOVAs) for each task with gender as a between-participant factor. We found a gender effect in terms of affective flexibility performance during the EM-FIST task, $F(1, 39) = 5.06$, $p = .027$, showing that girls ($M = 70$, $SD = 2.12$) had better affective flexibility compared to boys ($M = 67.95$, $SD = 4.32$). We also found gender differences in cognitive flexibility using the borders DCCS task, $F(1, 39) = 4.36$, $p = .043$. Our findings indicate that girls ($M = 20.85$, $SD = 2.90$) are more flexible than boys ($M = 19.25$, $SD = 1.88$) on the borders DCCS task. When looking at working memory performance, we found a significant effect of gender, $F(1, 39) = 6.42$, $p = .015$, as our results demonstrate that girls ($M = 12.52$, $SD = 3.76$) have superior working memory capacity compared to boys ($M = 9.50$, $SD = 3.87$). There were no significant gender differences on the standard FIST task ($p = .93$) or the Go/No-go task ($p = .92$).

Main analyses

The validity of the 3-item EM-FIST

In the first set of analyses, we assessed the test-retest validity of the 3-item EM-FIST for its use with preschoolers. A Pearson *r* correlation for test–retest reliability was computed. The results indicated a moderate positive association between the two time points $r = .58$ ($p < .01$). We also wanted to contrast the EM-FIST to the other two measures of cognitive flexibility. Findings indicate that affective flexibility is not related to cognitive flexibility as measured with a similar task with neutral stimuli, namely the FIST $r =.28$ ($p = .07$) or the borders DCCS task $r =.21$ ($p = .18$). Furthermore, we wanted to investigate the construct validity by looking at the relation between this measure and two other measures of executive functioning. Our affective flexibility measure was positively related to working memory $r =.48$ ($p < .001$), measured with the Listening span task. Also, the EM-FIST task was not related to the inhibition task $r =.01$ ($p = .92$) measured with the Go/No-go task.

The effect of valence and gender on affective flexibility

Our aim was to investigate gender-related effects in terms of both cognitive and affective flexibility and to see the relation between different forms of flexibility. To look at the impact of valence and examine how efficient boys and girls were in selecting the first pair compared to the second pair of items, during an affective flexibility measure, we performed repeated measures ANOVA on the EM-FIST accuracy data. We introduced selection (Selection 1 and Selection 2) and condition (Happy, Angry and Neutral) as within-subjects factors and gender as a between-subjects factor. The results revealed a main effect of selection, $F(1, 39) = 23.91$, $p < .001$, with the second selection ($M = 11.08$, $SD = .17$) being more challenging compared to the first selection ($M = 11.91$, $SD = .03$). Also, there was a marginal effect of gender, $F(1, 39) = 3.77$, $p = .059$. Additionally, there was a two-way interaction between gender and selection, $F(1, 39) = 4.34$, $p <. 05$, indicating that girls ($M = 11.42$, $SD = .23$) outperformed boys ($M = 10.73$, $SD =.24$) only on the second selection while no differences emerged on the first selection (see Figure 4.4). However, the main effect of condition was not significant ($p = .47$), which means that the emotional valence of the stimuli did not exert a significant influence on children's flexibility performance.

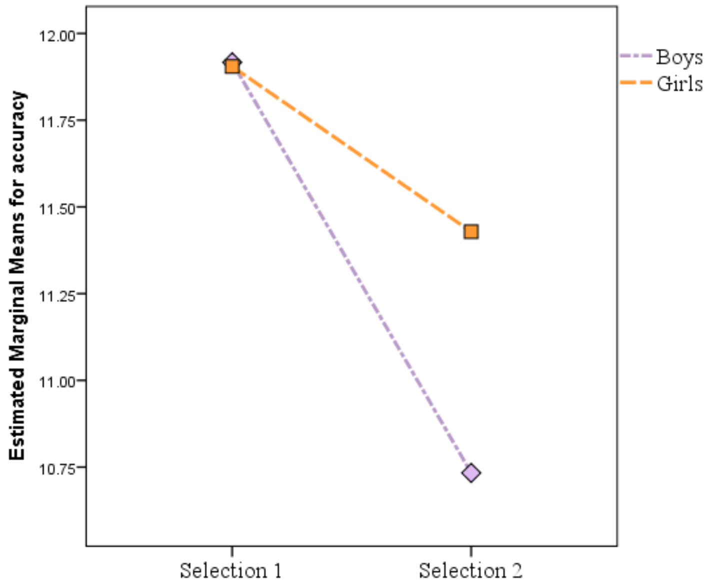

Figure 4.4. Accuracy performance for the first selection and second selection as a function of gender for the EM-FIST

The link between emotion regulation and cognitive/affective flexibility

We examined the relation between the performance on the cognitive and affective flexibility tasks and emotion regulation with a series of bivariate correlations. We did not find any significant associations between cognitive or affective flexibility and emotion regulation abilities (see Table 4.1).

Table 4.1. Correlations between emotion regulation and measures of both cognitive and affective flexibility

	1	2	3	4
Emotion regulation	–	.17	.16	.05
EM-FIST		–	.21	.28
DCCS			–	.20
Standard FIST				–

The impact of individual differences in anxiety on affective flexibility

In order to test ACT's predictions regarding the detrimental effect of anxiety upon affective flexibility, we conducted a repeated measures ANOVA analysis on the accuracy data for the EM-FIST task. In this analysis we included the Condition (Happy, Angry and Neutral) as a within factor and anxiety symptoms were introduced as a covariate. Our results reveal a two-way significant interaction between condition and anxiety, $F(2,78) = 3.64$, $p = .024$. Taking a closer look at this interaction, it seems that anxiety only exerted an effect upon accuracy performance in the happy condition of the EM-FIST task (see Figure 4.5). In this condition, higher levels of anxiety were associated with better accuracy performance. This facilitative effect of anxiety was found only in this condition.

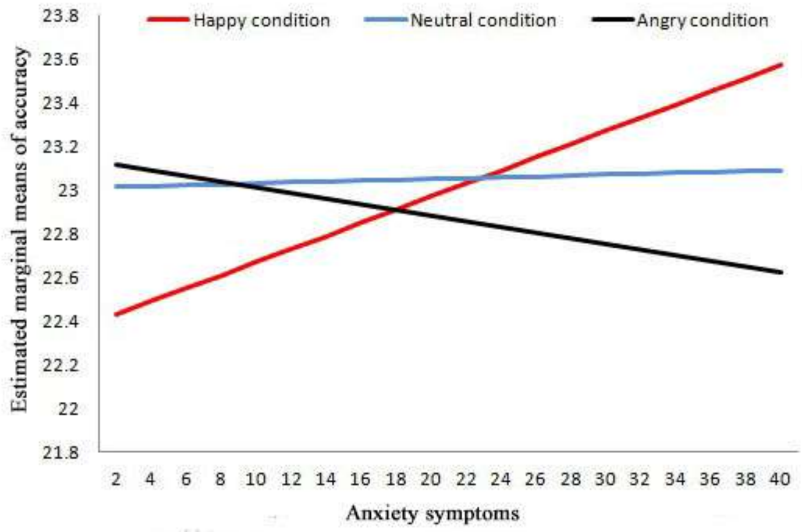

Figure 4.5. Accuracy performance for each condition of the EM-FIST task as a function of anxiety symptoms

4.2.3. Discussion

The current study presents information regarding the adaptation and validity of a generative flexibility task, namely the 3-item Emotional Flexible Item Selection Task. This task assesses children's (5-6 years old) ability to shift attention between different aspects of emotional stimuli.

Our first aim was ***to adapt an affective flexibility measure and to evaluate the validity of our measure of generative affective flexibility*** by analyzing its test retest reliability and by comparing it to similar measures of cognitive flexibility. Also, we aimed to relate this measure of affective flexibility to measures of executive functions. Our findings indicate that this task has good test-retest reliability over a one month period. Additionally, our results show that our measure of generative affective flexibility is not a measure of cognitive flexibility as it was not associated with elementary or generative measures of cognitive flexibility. Similar to the findings of studies with adults (Malooly et al., 2013), our affective flexibility task assesses a unique construct that has discriminative validity. Furthermore, our study indicates that preschooler's generative affective flexibility was strongly related to their working memory capacity. This result is in line with studies conducted with older children (6 -10 years old) showing that the development of working memory capacity contributes to the development of generative forms of non-affective flexibility measured with the standard FIST (Dick, 2014). However, we did not find an association between affective flexibility and inhibition which suggests that this generative affective flexibility task relies more upon children's working memory skills and less upon their inhibitory skills.

Our second aim was to investigate ***the impact of emotional valence and gender on affective flexibility***. The findings reveal the presence of gender-related differences as girls were more flexible than boys, with this difference being found only on the most difficult second selection that required children to view one item in two different manners. This finding was replicated during the borders version of the DCCS task, in which girls had better performance compared to boys. These findings are in agreement with previous studies showing that young girls were significantly more likely than boys to pass the emotional DCCS task, which represents an elementary form of affective flexibility (Visu-Petra, Stanciu, Benga, & Cheie, 2014). Our task represents a generative affective flexibility measure but it is similar to the elementary affective flexibility task employed by Visu-Petra et al. (2014) due to the need to operate with emotional content (applying the emotional rule) which might have favored the performance of preschool girls. Support for this idea comes from studies showing that girls have a better performance at decoding emotions when provided with different facial expressions (Boyatzis, Chazan, & Ting, 1993). However, we did not find any gender related effects during the FIST task which included non-emotional stimuli. Lastly, we did not find any performance related differences between the different emotional valence conditions of our affective flexibility task, which suggests that the emotional stimuli exerted no influence on children's flexibility performance.

Our third aim was to investigate ***the association between emotion regulation and affective flexibility during the preschool years***. We did not find a relation between the affective flexibility measure and emotion regulation strategies in children. This finding is at odds with the study conducted by Wilson et al. (2007) in which they found that greater flexibility over negative emotional stimuli predicted children's emotion regulation skills. In their study, they measured a basic form of flexibility, in which children had to switch their attention between two different emotional stimuli and press a key when a certain emotion was displayed.

Lastly, we found a novel and ***puzzling effect of anxiety on affective flexibility performance*** in the opposite direction from what we previously expected. The results have shown that anxiety had a facilitating effect upon affective flexibility only when emotional happy faces needed to be processed. Children with higher levels of anxiety tended to be more flexible when processing happy faces and when they were required to view happy faces in two different ways.

4.3. Study 4: The influence of individual differences on generative cognitive and affective flexibility in preadolescents[2]

To our knowledge, the current study is the first to investigate cognitive and affective flexibility in preadolescents (11 to 14 years old), and to relate variability in such cognitive and affective flexibility to individual differences in trait anxiety during this sensitive age interval.

Our first major aim was to address ***a developmental question***. We investigated whether cognitive flexibility and affective flexibility, improve from middle childhood through adolescence (Cragg & Nation, 2009; Davidson et al., 2006; Huizinga et al., 2006). We hypothesized that older children (13–14 years old) would exhibit greater flexibility than younger children (11–12 years old).

Our second major aim was to address ***an individual differences research question***. Specifically we explored whether cognitive flexibility and affective flexibility, varies as a function of participant differences in trait anxiety and gender. With respect to trait anxiety, we

[2] Study 4 described in this chapter has been already published in the *Journal of Abnormal Child Psychology*: Mărcuş, Stanciu, MacLeod, Liebregts, & Visu-Petra (2016) doi:10.1007/s10802-015-0110-z

sought to test the prediction generated by the Attentional Control Theory (ACT) that elevated trait anxiety will be characterized by impaired cognitive and affective flexibility. This would be supported by the finding that performance impairments on flexible trials, compared to non-flexible trials, is disproportionately greater for highly trait anxious participants. According to the Attentional Control Theory, elevated trait anxiety should impair cognitive and affective flexibility performance, and such findings have been reported in adult participants. We wanted to examine if, as predicted by the ACT, similar effects are observed in preadolescents. With respect to gender, we sought to explore the hypothesis that girls display greater cognitive flexibility, and/or affective flexibility, than boys. There is some preliminary developmental evidence of a female advantage on other affective flexibility tasks (Visu-Petra et al., 2014).

Lastly, we wanted to investigate ***the relation between cognitive and affective flexibility*** during this developmental window and elucidate if the two constructs are intertwined or if they share no relation as we have already shown in the case of preschoolers.

Method

Participants

A total of 112 children (50 girls), aged between 11 and 14 years (M = 12.92, SD = 1.03 years) were recruited from two local schools. The children were enrolled either in the 5th (n = 67) or 7th grade (n = 45). Given the bimodal distribution of age in our sample (with peaks situated two years apart), we treated age as a dichotomous variable corresponding to the two grades.

Materials

Revised Child Anxiety and Depression Scale (RCADS; Chorpita et al., 2000). The RCADS is a 47-item self-report scale adapted from the Spence Children's Anxiety Scale (SCAS; Spence, 1998), and was used in the present study to provide our measure of trait anxiety.

The Flexible Item Selection Task (FIST). During the FIST, trial displays presented four geometric shapes that differed in size (small, medium or large), color (red, blue or yellow), and/or shape (circle, square or triangle). The four stimuli varied on only two of these three stimulus dimensions, and the value of the third dimension was constant across items. Children were always required to first identify a pair of items that matched in terms of one of the three dimensions, and then identify a pair of items that matched in terms of a different dimension. On flexible trials, the identification of two pairs required the use of one stimulus item twice, and so children needed to first code this item in terms of one dimension and then shift to classify it in terms of another dimension (see Figure 4.6c). In non-flexible trials the identification of two pairs did not involve the use of any item twice, and so there was no need for children to shift between classifying an item in terms of an alternative stimulus dimension (see Figure 4.6a).

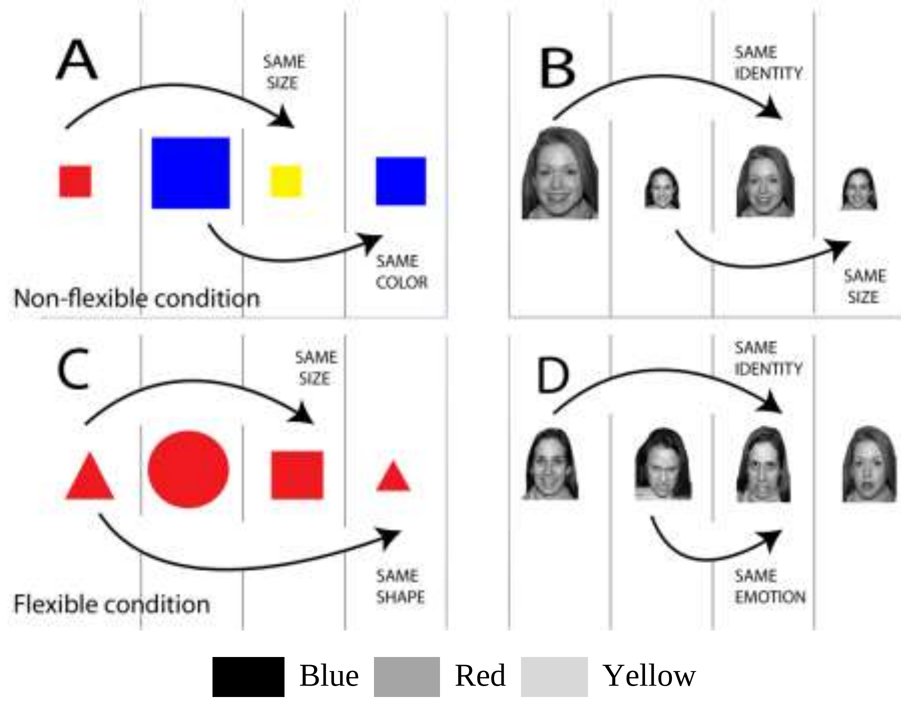

Figure 4.6. Depiction of the Emotional Flexible Item Selection Task (EM-FIST). A, B. Example of a nonflexible trial, in the FIST a and EM-FIST b. Children selected two completely distinct pairs of items, matched on two criteria (e.g., size and color – A; identity and size – B). Example of a flexible trial, in the FIST c and EM-FIST d. Children selected two partially overlapping pairs of items (one item belonged to both selections), matched on two criteria (e.g., size and shape – C; identity and emotion – D)

The Emotional FIST (EM-FIST). To familiarize children with the EM-FIST task, the experimenter illustrated two emotional trials using printed cards. Each card showed the type of display presented on a trial in the computerized version of the task, depicting a set of four items (see Figure 4.6b and d). When presented with a card, children were asked to first select two items that go together in one way and then select two items that go together, but in another way. Trial displays in the EM-FIST presented four emotionally expressive faces, of the same gender as the participant, taken from the MacBrain Face Stimulus Set (Tottenham et al., 2002). These items differed on the dimensions of size (small, medium and large), identity (individuals one, two, and three) and emotional expression (happy, angry and neutral). Similar to the FIST, during the EM-FIST participants were presented with flexible (see Figure 4.6d) and non-flexible trials (see Figure 4.6b).

Procedure

Only those children who gave their verbal assent to take part, and who also brought back the signed guardian consent form, were included in the Participants first completed the trait anxiety questionnaire (RCADS). Following this, the computerized experimental tasks were administered individually to all children in a single session lasting approximately 45 minutes. All participants completed the FIST followed by the EM-FIST, with a five minute break between tasks.

Results
FIST
Although accuracy was high overall, mean accuracy was lower in the flexible condition (*M* = 87.55 %, *SD* = .07) than in the nonflexible condition (*M* = 92.90 %, *SD* = .06). The estimated difference in raw scores of 5.78 (95 % CI [4.47, 7.10]) was statistically significant, $\chi2(1)$ = 74.12, $p < .001$. No other predictors reached significance levels. The RT results concur on the effect of flexibility condition as the mean RT was longer on average, by 115.86 ms (95 % CI from 88.21 to 143.51) for flexible trials than for non-flexible trials, $\chi2(1) = 67.44$, $p < .001$ (see Fig. 4.7a). This supports our expectation that the need to make a shift between processing alternative dimensions of the same pivot stimulus would increase task difficulty.

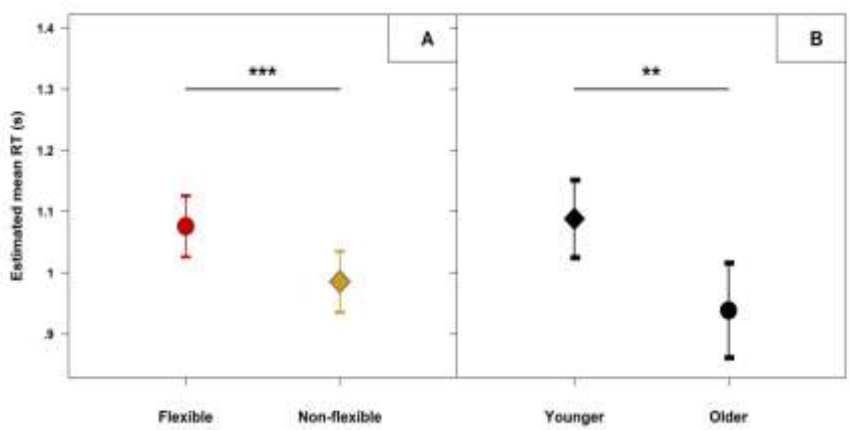

Figure 4.7. Estimated reaction times on the FIST as a function of: a Flexibility condition; b Age group. ** p < .01; *** p < .001

Further, older children outperformed younger children by 159.64 ms (95 % CI [56.62, 262.66]), $\chi2(1) = 9.43$, $p = .01$ (see Fig. 4.7b).

EM-FIST
On the EM-FIST, the difference in accuracy between the flexible (*M* = 80.01 %, *SD* = 11.49) and non-flexible condition (*M* = 91.42 %, *SD* = 6.63) was maintained. The estimated difference of 14.26 in raw scores (95 % CI [12.02, 15.04]) was statistically significant, $\chi2(1)$ = 158.51, $p < .001$. Further, the interaction between condition and age group was significant, $\chi2(1) = 7.72$, $p = .01$, as well as the main effect of age group, $\chi2(1) = 5.69$, $p = .02$. The interaction arose as the estimated difference in accuracy between the older and younger children was significant in the flexible condition, 4.50 (95 % CI [0.76, 8.23]), but not in the nonflexible condition, −0.44 (95 % CI [−4.18, 3.29]). The parameter estimates for the RT model are shown in Table 4.2. Mean RT was longer in the flexible condition than in the non-flexible condition, $\chi2(1) = 249.58$, $p < .001$, again supporting our expectation that the need to make a shift between processing alternative dimensions of the same pivot stimulus would increase task difficulty.

Table 4.2. Parameter estimates for the fixed effects of the RT model for the Emotional FIST.

Predictor	Estimate	95% CI		p-value
		Lower	Upper	
Intercept*	1646.01	1561.33	1730.69	<.001
Flexibility : Non-Flexible	-280.32	-315.11	-245.54	<.001
Age group: Older children	-258.65	-368.37	-148.92	<.001
Age group x Flexibility	91.64	47.46	135.82	<.001
Gender: Female	-214.48	-326.05	-102.91	.05
Gender x Flexibility	107.29	62.06	152.52	<.001
Trait anxiety	5.28	1.03	9.53	.01
Trait anxiety x Flexibility	-2.12	-3.91	-.32	.02

*Trait anxiety was centered around the sample mean.

Specifically, mean RTs were 280.32 ms longer (95 % CI [245.54, 315.10]) in the flexible condition compared to the nonflexible condition for the worst performing group, young boys. Of greatest relevance to the hypotheses under scrutiny in this study, the RT model revealed that the impact of the flexibility condition on RT was significantly moderated by each of the three interindividual variables under consideration. We will now assess the impact of each inter-individual variable in turn. The effect of age group was significant, $\chi2(1) = 21.83$, $p < .001$, as well as its interaction with the flexibility condition, $\chi2(1) = 16.53$, $p < .001$. The existence of such an interaction was predicted by our hypothesis that the older children would show greater cognitive flexibility than younger children, which would be evidenced by a reduction in the degree to which RTs were slowed on flexible trials relative to the non-flexible trials, in the older children compared to the younger children. Figure 4.8a illustrates the observed two way interaction between age group and flexibility condition, and it can be seen that its nature is fully consistent with this experimental prediction. Specifically, the interaction reflects the fact that the magnitude of the elevation in RT on the flexible condition, compared to the non-flexible condition, was significantly smaller (by 91.64 ms, 95 % CI [47.46, 135.82]) in the older group than was the case in the younger group. As predicted by our hypotheses that girls would show greater cognitive flexibility than boys, gender also moderated the effect of flexibility condition (see Figure 4.8b), giving rise to a significant two way interaction between these factors, $\chi2\ (1) = 21.62$, $p < 0.001$. The nature of this interaction is consistent with the predictions generated by our hypothesis, reflecting an attenuation in the degree to which RTs were slowed on the flexible condition relative to the non-flexible condition for girls compared to boys, by 107.28 ms (95 % CI [62.06, 152.52]).

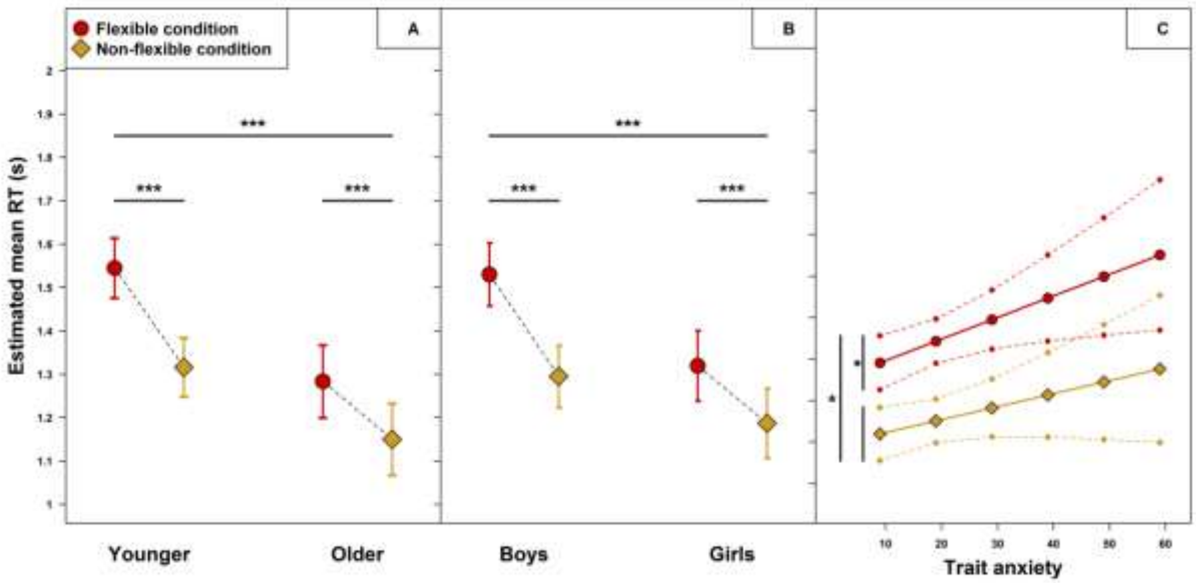

Figure 4.8. Estimated reaction times on the Emotional FIST as a function of: a Flexibility condition and age group; b Flexibility condition and gender; c Flexibility condition and trait anxiety. *** $p < 0.001$

Higher levels of trait anxiety were generally associated with longer response latencies, $\chi2(1) = 6.08$, $p = .01$. Of greater importance to the hypotheses under consideration, trait anxiety significantly moderated the impact of flexibility condition, $\chi2(1) = 5.35$, $p = 0.02$. Such a two way interaction was predicted by our hypothesis derived from the ACT, namely that heightened levels of trait anxiety would be characterized by reduced cognitive flexibility. Specifically, the degree to which RTs were slowed in the flexible condition relative to the non-flexible condition became larger with increasing levels of trait anxiety. Figure 4.8c displays this two way interaction between trait anxiety and flexibility condition, and shows that increased trait anxiety levels were associated with a relative slowing in the flexible condition, but not on the non-flexible condition.

Lastly, we wanted to investigate the extent to which generative cognitive and affective flexibility are related during preadolescence. We performed a correlation analysis on the reaction time data which revealed that the two measures are highly correlated, $r = .60$, $p = 0.01$.

Discussion

The present study was designed to extend the current understanding of generative cognitive flexibility by incorporating the dimension of affective flexibility in preadolescents. As expected, across the whole sample and in each of the two tasks, children's performance was poorer in the condition which demanded greater cognitive flexibility. Hence, in the flexible condition children exhibited a diminished performance as compared to the nonflexible condition.

Our primary aim was to determine whether cognitive flexibility, and/or affective flexibility, ***improve from middle childhood through adolescence***, as suggested by previous literature (Cragg & Nation, 2009; Davidson et al., 2006; Dick, 2014; Huizinga et al., 2006). There were no age-related differences in accuracy. However, both older (13–14 year olds) and younger children (11–12 year olds) exhibited slower RTs in the flexible than in the non-flexible condition. Of greatest importance, we found that the costs associated with the flexibility condition were greater for the younger children compared to the older children, consistent with an age-related improvement in cognitive flexibility which takes place at the level of response speed, rather than affecting performance accuracy. This offers additional evidence that cognitive flexibility improves from middle childhood to adolescence as reflected by older children's enhanced efficiency (Cragg & Nation, 2009; Davidson et al., 2006; Dick, 2014; Huizinga et al., 2006).

Our second aim was to test the key predictions generated by the Attentional Control Theory (ACT; Eysenck et al., 2007; Eysenck & Derakshan, 2011), ***concerning the impact of trait anxiety*** on cognitive flexibility in general, and on cognitive affective flexibility in particular. We found that trait anxiety had a deleterious effect only on the affective cognitive flexibility measure, in terms of both accuracy and response latency. Hence, anxiety had a detrimental impact upon performance accuracy in the case of older children, as compared to younger ones when the flexible demands were higher. This result fits nicely with the ACT premise that anxiety impairs performance most greatly on tasks that impose heavier executive demands and involve distracting emotional stimuli.

A final objective was to investigate the presence of ***gender differences in cognitive and affective flexibility***. Consistent with previous studies, we observed a female advantage in the processing of emotional material, indicated by the fact that girls showed speeded responses compared to boys overall on the EM-FIST. This is in agreement with a recent study which found that preschool girls were significantly more likely to pass an emotional DCCS task than boys (Visu-Petra et al., 2014). Girls' superior performance over boys in the emotional task might be explained by their advantage in processing emotional faces, which has been reported during childhood and adolescence (McClure, 2000). This findings has been previously reported in Chapter 3 as girls were faster than boys to shift between emotional and neutral judgments, and also when repeating an emotional judgment.

4.4. Study 5: The influence of individual differences on generative cognitive and affective flexibility in adults

In the present study, our first aim was to replicate the findings already obtained with preadolescents (Study 4). We wanted to investigate the presence of ***any gender related differences in terms of affective flexibility*** in an adult sample. Additionally, we examined if the flexible condition, where participants were required to view one item in two different ways, were more demanding than nonflexible ones during both the EM-FIST and FIST task.

Secondly, we wanted to take a closer look at ***the potential detrimental effects of anxiety*** on cognitive and affective flexibility in adults. Specifically, this study addressed whether individuals with high levels of anxiety exhibit poorer performance on a generative affective flexibility task and if this effect is more debilitating in the flexible condition.

The last aim was ***to clarify the relationship between cognitive and affective flexibility during this age interval*** given our mixed results with preschoolers and preadolescents. We wanted to investigate the extent to which these two abilities are linked to each other during early adulthood.

4.4.1. Method

Participants

Participants for the current study consisted of 35 young students (*M* = 18.48, *SD* = 1.03) who were recruited from the University of Western Australia to participate in this study. Participants gave their oral assent as well as written consent to take part in this study.

Measures

The State–Trait Anxiety Inventory (STAI; Spielberger, 1983) includes two sub-scales measuring two anxiety constructs namely an individual's levels of state and trait anxiety. For each scale, participants are required to rate a set of 20 items on a 4-point Likert-type scale, ranging from 1 (almost never) to 4 (almost always). The total score ranges from 20 to 80, with higher scores demonstrating greater levels of anxiety. In the present study we only included in the final analysis the trait anxiety sub-scale.

The Attentional Control Scale (ACS; Derryberry & Reed, 2002) employs 20 items that assess both attention focusing and attention shifting. Each item is answered using one of the four possible response choices (0 = almost never; 1 = sometimes; 2 = often; 3 = always) with higher scores indicating lower levels of attentional control.

The 4-item EM-FIST task was used to assess adults' ability to alternate between emotional and non-emotional rules (i.e., affective flexibility). This task has already been described in Study 4.

The 4-item FIST task was used to assess generative cognitive flexibility and has been already described in Study 4.

Procedure

Participants were tested individually in a quiet room. They first completed the computerized questionnaires which measured state and trait anxiety as well as self-report levels of attentional control. The experimenter then provided instructions for the FIST task and participants completed this task followed by the EM-FIST task.

4.4.2. Main results

Are there any gender differences in cognitive* and *affective flexibility in adults?

Next, we wanted to explore the effects of gender upon both cognitive and affective flexibility performance and to control for possible gender-related differences in subsequent analysis. Having this objective in mind, we performed two one way ANOVAs on both the accuracy and reaction times outcomes with condition (Flexible and Nonflexible) as within factors and Gender as a between-subjects factor. We failed to find any gender related effects in the case of the flexible (p = .40) and nonflexible condition (p = .60) in terms of reaction times during the FIST. The same finding was found for the accuracy data. Moving on to the EM-FIST we found the same results as gender seems to exert no effect on the flexible (p = .11) or non-flexible condition (p = .11) in terms of reaction times. The same pattern of results was obtained for the accuracy data.

Is the cost of flexibility more pronounced in the affective or non-affective task?

We wanted to replicate the findings reported in our sample of preadolescents (Experiment 2) showing that the flexible condition is more demanding compared to the non-flexible one. To answer this question, we performed a repeated measures ANOVA with condition (Flexible and

Non-flexible) as a within factor on the FIST as well as the EM-FIST. For the FIST, no main effect of condition emerged for the reaction times data (p = .78) as well as the accuracy data (p = .32) which suggests there are no differences between the flexible and non-flexible conditions. Next, looking at the EM-FIST we found a significant main effect of condition $F(1,34) = 23.37$, $p < .001$, showing that adults took longer to respond on the flexible condition (M = 1029.78, SD = 50.07) than on the nonflexible condition (M = 946.73, SD = 43.45). This difference is also shown in Figure 4.9.

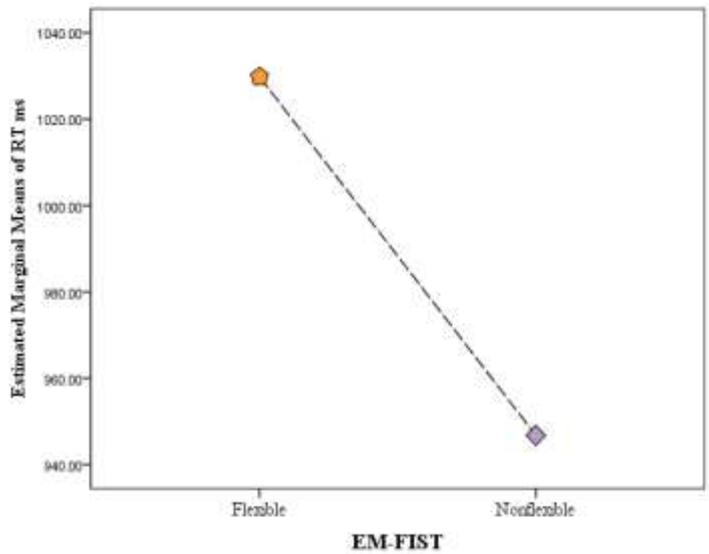

Figure 4.9. Mean reaction times for the flexible and nonflexible conditions in the EM-FIST

Moreover, this main effect was also found in the case of the accuracy data, $F(1,34) = 22.24$, as adults tended to do worse on the flexible condition (M = 44.11, SD = 1.29) as compared to the nonflexible one (M = 48.22, SD =.82) which is in the same direction as the reaction times data (see Figure 4.10).

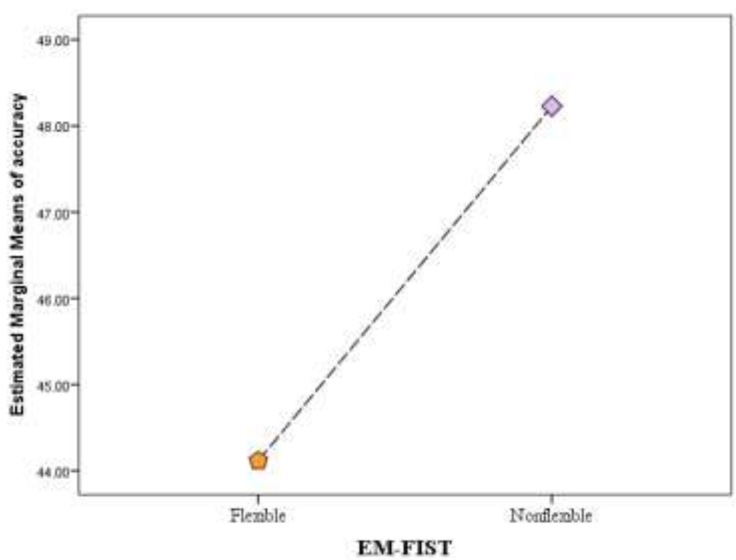

Figure 4.10. Mean accuracy performance for the flexible and nonflexible conditions in the EM-FIST

Are cognitive and affective flexibility related in adults?

Based on the previous literature, we wanted to investigate the extent to which there is an association between cognitive and affective flexibility in adults. To this end, we ran some correlational analysis which revealed that these two abilities are closely related in terms of reaction times (r = .58), p = .01, and in terms of accuracy performance (r = .53), p = .01.

Does anxiety exert an impact upon cognitive and affective flexibility in adults?

To investigate the presence of any detrimental effects of anxiety upon both cognitive and affective flexibility performance, we ran several repeated measures ANOVA for both the accuracy as well as reaction times outcomes. We included the condition (Flexible and Nonflexible) as a within factor and trait anxiety as a covariate. In the case of the FIST, we failed to find any effect of anxiety, as the interaction between the condition and trait anxiety was not significant for the RT data (p = .13), as well as for the accuracy data (p = .31). Furthermore, no evidence of an anxiety effect was present in the case of the EM-FIST given that the interaction between condition and trait anxiety was not significant for the RT data (p = .43), as well as for the accuracy data (p = .29).

4.4.3. Discussion

The present investigation was designed to replicate previous findings obtained with preadolescents (Experiment 2) by employing similar measures in an older sample of young adults. We applied the same generative measures of cognitive and affective flexibility and we used a different measure of anxiety to investigate the degree to which anxiety impairs these higher level forms of flexibility. Firstly, we wanted to investigate the existence of any potential gender differences in terms of generative affective flexibility in an adult sample. Our findings did not reveal the presence of gender differences in our young adult sample. Next, we examined if the flexible condition, where participants were required to view one item in two different ways, was more demanding than the nonflexible one during both the EM-FIST and FIST task. In light of this, we found that the flexible condition was indeed more demanding compare to the non-flexible one, but this was found only in the generative affective flexibility measure. Furthermore, we aimed to take a closer look at the potential detrimental effects of anxiety on generative cognitive and affective flexibility in adults. Specifically, this study addressed whether individuals with high levels of trait anxiety exhibit poorer performance on a generative affective flexibility task and if this effect is more pronounced in the flexible condition as compared to the nonflexible one. Surprisingly, our findings do not offer support for this hypothesis as they indicate that in our sample of young adults there were no anxiety-related effects. The last aim was to clarify the relationship between cognitive and affective flexibility during this age interval given our mixed results with preschoolers and preadolescents. We wanted to investigate the extent to which these two abilities are related during early adulthood. Our findings indicate that these two abilities are indeed strongly related in young adults which extend our previous findings with preadolescents to an adult sample and which is at odds with previous investigations in adults (Malooly et al., 2013).

Conclusions

Our results indicate a gender difference in flexibility, such that during the preschool and preadolescence period, girls displayed greater affective flexibility than boys when processing emotional information. Our findings indicate that the novel EM-FIST task employed in the current study has the capacity to contribute to a better understanding of affective flexibility development, and the individual difference factors that affect and are affected by such flexibility, from childhood to adolescence and even into adulthood. Such theoretical advancements may have vital practical implications, potentially contributing to our ability to enhance affective flexibility in children and preadolescents in ways that may improve emotional regulation skills, and reduce vulnerability to psychopathology. Future research in this direction could shed important light on the cognitive and affective mechanisms that underpin vulnerability and resilience to internalizing problems, while also yielding direct applied benefits in terms of better targeted delivery of preventive interventions.

CHAPTER 5.

Interindividual differences in cognitive and affective flexibility: Conclusions

5.1. General conclusions

5.1.1. Thesis overview

The present thesis has investigated ***cognitive and affective flexibility*** in order to provide a better understanding of the developmental trajectory of these ability as well as the interindividual differences that exert an influence on these abilities throughout development. The first chapter offers a broader conceptualization of affective flexibility by integrating previous studies focusing mostly on cognitive flexibility and by introducing a new way of conceptualizing this ability. Hence, we proposed a componential account which includes three different forms of flexibility which vary as a function of complexity: elementary, shifting and generative flexibility. ***Elementary flexibility*** refers to the basic ability to alternate only once between two different rules, different behaviours, tasks or emotions according to different environmental cues. For instance, when children find two different uses for a given object (e.g., a chair used as a climbing tool) as they make use of the ability to alternate between two different perspectives towards that object. ***Shifting flexibility*** refers to the ability to frequently alternate between different behaviours, tasks or emotions in order to select the best response as a function of contextual cues. For instance, when children switch back and forth between two different tasks such as solving a given homework and talking to a colleague in a class. ***Generative flexibility*** refers to the ability to successfully alternate in a successive manner between different behaviours, tasks or emotions as well as the ability to select or actively generate the best choice especially when the contextual environmental cues are missing. For instance, the ability to generate a positive interpretation to an ongoing negative situation and to do this a couple of times (during a long conflict).

The second chapter described a review study which proposed two different ways of looking at affective flexibility by addressing the direct (emotion is task relevant) and indirect (emotion is task irrelevant) effects of emotion in both typical and atypical populations. This study revised a small number of studies looking at the influence of emotions on different forms of affective flexibility throughout development and a large number of corresponding researches in adults. This review stresses for the need of conducting additional investigations to capture the critical conditions under which emotional valence has an influence on the ability to flexibly adapt to a permanently changing environment especially during middle childhood and adolescence. The next two chapters build upon this study by addressing the impact of direct and indirect effects of emotion as well as interindividual differences (age, gender, and internalizing symptoms) on shifting affective flexibility (Chapter 3) and generative affective and cognitive flexibility (Chapter 4). In what follows, we will revise the main findings as well as suggest future research directions (see Table 5.1. for a summary of results).

Research questions: Main findings

First of all our studies extend previous studies on cognitive flexibility (e.g., Johnson, 2009a, 2009b; Monsell, 2003) to affective flexibility ability in children, adolescents and adults. Our first two studies converge on the finding that switching trials are more demanding than repetition trials, as children and adolescents take longer to complete switching trials and less time to complete the repetition trials. Also, we presented three different studies focused on generative flexibility (Chapter 4). We looked at generative affective flexibility in preschoolers (Chapter 4, Study 3) and our findings with preschoolers indicate that the requirement to view one item in two different ways (selection 2) is more taxing as compared to selecting two different pictures that match according to one rule (selection one) when emotional information is task-irrelevant in preschoolers. Across Study 4 and 5 which were conducted with older children and adults we also reveal that flexible trials (in which participants had to view one item in two different ways) are more demanding than nonflexible trials.

Does emotion exert an influence on affective flexibility?

Moving on to our main research questions, we firstly wanted to address the ***effects exerted by emotion*** on affective flexibility performance. To this end, we distinguish two possible roles played by emotion (the direct and indirect effects) in our attempt to investigate the specific conditions under which emotion can facilitate or hinder different forms of affective flexibility. In order to address the specific effect of emotional valence we conducted two different studies focusing on two forms of flexibility. In Chapter 3, in Study 1 we focused on shifting affective flexibility during mid-childhood (7-11 years). We have shown that valence had an effect only on repetition trials, more specifically when participants had to repeat applying the emotional rule (e.g., EE trials). These consecutive emotional facial expression rules were associated with shorter response times than consecutive trials which included an emotional and a neutral facial expression. This finding is in line with the previous speculation about the existence of an "emotional switching" cost between emotional and neutral facial expressions. The pattern of results can be accounted for by an automatic exogenous process whereby attention is drawn preferentially to emotional stimuli (Vuilleumier, Armony, Driver, & Dolan, 2001), which predictably aids a task that explicitly requires to repeatedly apply the emotional rule and thus judge the valence of each stimulus. In Chapter 3 (Study 2) we also investigated the effect of emotional valence on shifting affective flexibility in adolescents (12-18 years). In both of our studies (Study 1 and 2) we looked at the effect of emotions by investigating the conditions in which emotion impairs flexibility. We wanted to look at more taxing conditions during an affective flexibility task and as a result we analyzed the two types of switching trials. In this regard, these two studies have replicated Johnson's findings (2009a), as we found longer response times for disengaging a neutral rule and engaging an emotional rule than for the opposite switch (emotional to neutral). This finding also offers support for the "dominant" nature of the emotional rule hypothesis put forward by Reeck and Egner (2014). Our findings lend support to this hypothesis as they suggest it is harder to switch from a non-emotional to an emotional rule than the other way around during middle childhood and adolescence.

Do interindividual differences (age, gender and internalizing symptoms) have an impact on cognitive and affective flexibility?

The second research question of the thesis was to investigate whether there is an impact of interindividual differences ***in age, gender and internalizing symptoms*** (especially anxiety) on cognitive and affective flexibility performance during childhood. We will analyze each of these interindividual differences factors in what follows.

Firstly, we will focus on ***age-related effects***. In our first study (Chapter 3) we conducted two different studies to address age-related improvements in shifting affective flexibility. In Study 3, the predicted age-related improvements were most visible in terms of response time, as older children were significantly faster in their overall response speed. Also, this progress was translated into a modest age-related reduction in error rates, considering that overall accuracy on the ACCE task was already high even for the youngest children. This effect was replicated in Study 4 in terms of performance accuracy. Nevertheless, in Chapter 4 we presented a study in which we investigated age-related improvements in a generative form of cognitive and affective flexibility (Study 4). Our findings indicate that there were no age-related differences in accuracy. However, both older (13–14 year olds) and younger children (11–12 year olds) exhibited slower RTs in the flexible as compared to the non-flexible condition. Of greatest importance, we found that the costs associated with the flexibility condition were greater for the younger children compared to the older children, consistent with an age-related improvement in cognitive flexibility in terms of response speed, rather than affecting performance accuracy. Taken together, these findings confirm the constant rate of improvement in flexibility during mid-childhood, previously reported by other studies (e.g., Cragg & Nation, 2009; Davidson et al., 2006; Dick, 2014; Huizinga, Dolan, & van der Molen, 2006; Rosso, Young, Femia, & Yurgelun-Todd, 2004).

Secondly, we will discuss our findings regarding ***the effects of gender*** on cognitive and affective flexibility. In our first study (Chapter 3) we conducted two studies in which we found the presence of gender-related differences in a form of switching affective flexibility during middle childhood and adolescence. Both of our studies conducted with middle school children and adolescents reveal an intriguing gender-related difference in response speed. Hence, boys presented longer response times compared to girls when applying the emotional rule after performing a non-emotional (switching trials), or a different emotional rule (emotion repetition trials). However, this difference was not present when switching to or when repeating a non-emotional rule. In Chapter 4, we also checked for any gender-related effects in a form of generative affective flexibility in preschoolers, preadolescents and young adults. In Study 3 conducted with preschoolers we reported the presence of gender-related differences as girls were more flexible than boys, with this difference being found only on the most difficult second selection that required children to view one item in two different manners (i.e., the flexible trials). Moreover, in Study 4 we reported a female advantage in the processing of emotional material, indicated by the fact that girls showed speeded responses compared to boys overall on the EM-FIST. Nevertheless, in our last study (Study 5) with young adults we did not find any gender-related differences in generative affective flexibility which might suggests that these gender differences are only found during the developmental period. Taken together, these findings are congruent with a study which found that preschool girls were significantly more likely to pass an emotional DCCS task than boys (Visu-Petra et al., 2014). Girls' superior performance over boys in the emotional task might be explained by their advantage in processing emotional faces, which has been reported during childhood and adolescence (McClure, 2000). Additionally, a second explanation for this female advantage result comes from studies showing that girls have a better performance at decoding emotions when provided with different facial expressions (Boyatzis, Chazan, & Ting, 1993).

Thirdly, we will now turn to examining if ***internalizing symptoms (especially anxiety)*** exert a detrimental influence on cognitive and affective flexibility. This line of research has crucial implications given that individuals who exhibit inflexibility have trouble adapting to variable demands of the environment, as they display an inflexible behaviour and a tendency to stick to previous behaviours (a form of rigidity), as well as they have difficulty in adapting to changing plans or alterations to daily routines. In all of our studies we analyzed the impact of anxiety (and depression) symptoms on cognitive and affective flexibility. Our findings indicate that children with high levels of internalizing symptoms (anxiety and depression) showed an impaired performance on consecutive emotional trials (repetition trials). Importantly, this association was evident only when participants had to alternate between two different emotional judgments and when feedback was provided (compared to a lack of feedback condition). Hence it appears to reflect a specific impairment of affective flexibility in more highly anxious (and depressed) children. This pattern of results was explained by an automatic exogenous process through which attention is drawn preferentially to emotional stimuli (Vuilleumier et al., 2001) thus hindering performance on a task that explicitly requires the repeated employment of the emotional rule. However, we only reported this finding in the first study and only in the feedback condition while in the second we failed to capture any anxiety-related effects on shifting affective flexibility in an older sample. We could speculate that the deleterious effects of internalizing symptoms are only observed in younger samples or that this effect is specific to a shifting affective flexibility task that only incorporates trial by trial feedback. In Chapter 4 we investigated the link between anxiety and generative cognitive and affective flexibility in three different studies focusing on preschoolers, preadolescents and young adults. Our findings with preschoolers (Study 3) are rather surprising as they reveal a facilitative effect of positive task-irrelevant stimuli during a generative affective flexibility task present only in the case of preschoolers with higher levels of anxiety.

At first, these novel and intriguing findings were puzzling and difficult to integrate into theoretical accounts of anxiety. These theories have focused primarily on impairing or debilitating influences of negative material on flexibility and have entirely overlooked the hindering/facilitating impact of emotional positive content (e.g., The Attentional Control Theory). Previous findings have brought evidence for the facilitative effect of positive emotional stimuli on affective flexibility performance in preschoolers. For instance**,** Qu and Zelazo (2007) found that preschoolers appear to be more flexible when happy faces are used during the DCCS task instead of when the stimuli are neutral objects. Similar results were reported by Wong, Jacques, and Zelazo (2008) with the emotional FIST. This is possibly because human faces attract children's attention (e.g., de Haan, Humphreys, & Johnson, 2002). In addition, happy faces may make preschoolers feel mildly happy and hence increase their attention scope and their flexibility (Ashby et al., 1999). As Fredrickson (2001) suggested, positive mood can broaden momentary thought–action processes so as to increase personal resources. However, all of these findings do not inform us regarding the impact of anxiety on flexibility when emotional stimuli are being processed.

Our findings are at odds with previous developmental studies which have documented the presence of a ”positive bias” present during cognitive tasks in children and adolescents dealing with anxiety. For instance, Hardin et al., (2009) has shown that positive stimuli enhance inhibitory control in healthy adolescents but they do not exert an influence on a group of adolescents with anxiety disorders (Hardin et al., 2010). Additionally, preschoolers with high levels of anxiety were slower and less accurate in detecting and updating happy faces during a working memory task as compared to a low anxious group of preschoolers (Visu-Petra, Țincaș, Cheie, & Benga, 2010). Thus it is evident that, the association between high levels of anxiety and increased affective flexibility for positive stimuli is a novel finding and will require additional exploration. Also, in Chapter 4 we showed that in an older sample (11-14 years old), generative flexibility was related to interindividual differences in trait anxiety (Study 4). Findings show that it was more demanding for high trait anxious children to exhibit flexibility in the EM-FIST (but not in the standard neutral version of this task) than for their low trait anxious counterparts. In conclusion, only two of our studies seem to offer support to the predictions advanced by the Attentional Control Theory (Eysenck et al., 2007) in a sample of middle childhood and preadolescents. Hence our studies suggest that interindividual differences in internalizing (especially anxiety) symptoms play a crucial role in children's shifting and generative affective flexibility. These findings indicate that the hindering effects of anxiety are present especially when emotional stimuli are being processed (affective flexibility) during middle childhood and preadolescence.

More studies need to be conducted that focus on this sensitive period (middle childhood and preadolescence) when children are vulnerable to developing mood disorders. In adult samples, cognitive and affective flexibility tasks proved to be a sensitive predictor of emotional vulnerabilities, like rumination and low trait resilience, beyond neutral cognitive flexibility tasks (e.g., de Lissnyder et al., 2010; Genet et al., 2013). However, our findings obtained with other age groups (preschoolers, adolescents and young adults) indicate that internalizing symptoms (especially anxiety) exert no influence on affective flexibility. Another possibility is that these anxiety-related detrimental effects upon both cognitive and affective flexibility are mostly found in clinical samples of anxiety. So far, studies have indicated that clinical levels of anxiety or depression are associated with inflexibility. For instance, a recent review conducted by Gruner and Pittenger (in press) showed that such deficits are present in the case of adults with obsessive compulsive disorder which is mainly characterized by a pattern of maladaptive and inflexible cognitions and behaviors. Also, studies revealed the presence of generative cognitive flexibility deficits in individuals with major depression disorder (Austin, Ross, O'Carrol, Ebmeier, & Goodwin, 1992; Grant, Thase & Sweeney, 2001; Kindermann, Kalayam, Brown, Burdick, & Alexopoulos, 2000; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999).

Does affective inhibition and working memory contribute to affective flexibility?

Our third research question involved the exploration of the ***contribution of the other key executive functions*** affective inhibition and working memory processes to affective flexibility performance. This research question was addressed in Study 2 (Chapter 3). Our findings extend those from previous investigations focused on the role of "cool" inhibition and working memory processes in cognitive flexibility (Chevalier et al., 2012; Blakey et al., 2016; Brocki & Tilman, 2014) by showing that affective flexibility is predicted by both affective inhibition and working memory processes at the level of accuracy performance and reaction time during adolescence. Also, our study offers empirical support for the idea that flexibility is an inherent "by-product" of the ongoing interplay between inhibition and working memory processes, reflecting inhibition of the task from which to switch away and maintenance of the rules associated with the newly relevant task (Diamond, 2006; Roberts & Pennington, 1996). Even though our data offers strong support for the role of inhibition and working memory to predicting affective flexibility, our data also suggests that flexibility represents more than a simple combination of inhibition and working memory processes. Future studies should provide an in depth analysis of affective aspects of affective flexibility to elucidate the specific sub-components of this executive process beyond inhibition and working memory processes.

5.1.2. Are cognitive and affective flexibility related in children and adults?

Lastly, our last research question addressed the degree to which cognitive ***and affective flexibility are related*** during development. This research question was motivated in part by many of the cognitive flexibility studies on adult samples that did not included tasks on affective flexibility. This is an issue that should be addressed, as the relation between affective and cognitive flexibility lacks clarity. So far, studies seem to indicate dissociation between shifting forms of cognitive and affective flexibility tasks because no correlation has been found between these two forms of flexibility (Malooly et al., 2013). This specific question was examined in Study 4 in which we looked at the way in which generative forms of cognitive flexibility and generative affective flexibility are related in preschoolers, preadolescents and adults (Chapter 4). Our findings indicate a strong association in preadolescents and young adults and dissociation in preschoolers. These findings suggest that the dynamic interplay of emotional and cognitive processes might change over time. Hence, a longitudinal study would be more enlightening regarding when and how emotional stimuli affect cognitive and AF processes.

The present thesis contributes to the developmental literature on cognitive and affective flexibility by integrating methods from developmental and cognitive psychology, by examining the influence of different emotions on different forms of AF, and by investigating specific underlying mechanisms (e.g., anxiety symptoms) for this influence. Overall, this thesis suggests that more research is necessary in order to capture the critical conditions in which emotional valence (through direct and indirect effects) has an influence on the ability to adapt flexibly to a changing environment.

Table 5.1. Summary of main findings and conclusions

Study	Age range	Type of flexibility	Type of emotion effect	Task description	Main findings
Chapter 3 Study 1	7-11 years (N = 108)	Shifting affective flexibility	Emotion task-relevant	**Affective flexibility measured with *the Modified Attentional Control Capacity for Emotion*** (ACCE) task. On each trial children were unpredictably presented with stimuli consisting of emotional faces located within geometrical shapes. Before the stimulus onset, a cue informed participants if they had to attend to the non-emotional (shape: triangle, circle or square) or the emotional rule (emotional valence: happy, angry or neutral). The task had two conditions: one with and one without feedback. DV: accuracy and reaction times.	1. Our findings are consistent with the task-switching paradigm literature by showing the presence of more errors and longer response times during switching compared to repetition trials. 2. Older children were significantly faster during the affective flexibility task than the younger children. This result pinpoints to the fact that affective flexibility continues to improve during middle childhood. 3. We also reported gender-related difference in reaction times, by indicating that boys took longer compared to girls in applying the emotional rule after performing a non-emotional one, or a different emotional rule. 4. Participants high in internalizing symptoms exhibited longer reaction times when they had to repeat the same emotional rule and when feedback was provided. These findings are consisting with the Attentional Control Theory highlighting the presence of anxiety (and depression) effects on affective flexibility. 5. When trial-by-trial feedback is provided, children are more cautious and make fewer errors, and this tendency is stronger in children with higher levels of internalizing symptoms. 6. We did not confirm that self-reported attentional control capacity could act as a protecting factor against the adverse effects of internalizing symptoms on shifting affective flexibility performance. 7. Looking at the effect of valence, this influence was only observed in consecutive emotional facial expression rules. These trials were associated with

					shorter response times than consecutive trials which included an emotional and a neutral facial expression. This finding is in line with the previous speculation about the existence of an "emotional switching" cost between emotional and neutral facial expressions thus judge the valence of each stimulus.
Chapter 3 Study 2	12 -18 years (N = 110)	Shifting affective flexibility	Emotion task-relevant	***The Modified Attentional Control Capacity for Emotion*** (described above) ***The Emotional Stroop Task*****:** used to measure inhition for emotional material ***The Emotional N-back Task*****:** used to assess working memory for emotional material	1. Our findings revealed that affective EFs still continue to develop from middle childhood to late adolescence. 2. Participants had longer reaction times when they switched from the non-emotional rule to the emotional rule and lower reaction times the other way around. Valence did not impact performance in a particular way. 3. However, our data did not reveal the same internalizing-related detrimental effects in terms of affective flexibility in particular and the other two executive functions in general. 4. Our findings show that affective flexibility is predicted by both inhibition and working memory processes at the level of accuracy performance and reaction time.
Chapter 4 Study 3	5-6 years (N = 41)	Generative affective flexibility	Emotion task irrelevant	***3-item FIST*** On each trial, children were presented with three cards depicting objects of different colors and sizes. Participants had to select two pairs of stimuli according to two out of three possible rules (color, stimulus size, and object). ***3-item Emotional FIST*** On each trial, children were presented with three cards depicting emotional stimuli (emotion was kept constant, the stimuli were either happy, angry or neutral) of different sizes,	1. Our findings indicate that the generative affective flexibility task has good test-retest reliability over a one month period. However, this generative affective flexibility task is not associated with a measure of generative cognitive flexibility. Also performance on this task is strongly related to children's working memory capacity while there is no relation with their inhibition processes. 2. We reported gender differences in the generative affective flexibility task with girls outperforming boys especially during the second selection. The advantage of girls has been also found in the borders DCCS task while it is absent in the FIST task. 3. We did not find a relation between the generative

				depicting individuals with different hair colors. Participants had to select two pairs of stimuli according to two out of three possible rules (hair color, stimulus size, and identity). ***Borders DCCS*** DV: number of pairs correctly sorted	affective flexibility measure and emotion regulation strategies in preschoolers. 4. Anxiety had a facilitating effect upon affective flexibility only when emotional happy faces needed to be processed. Hence, children with higher levels of anxiety exhibited better flexibility when processing happy faces and when they were required to view happy faces in two different ways. We failed to reveal the presence of hindering effects exerted by anxiety.
Chapter 4 Study 4	11-14 years olds (N = 112)	Generative affective flexibility	Emotion task-relevant	***4-item FIST:*** On each trial, children were presented with four images depicting shapes of different colors and sizes, in an unpredictable manner. Participants had to select two pairs of stimuli according to two out of three possible rules (color, size, and shape). ***4-item Emotional FIST:*** On each trial, children were presented with four images depicting emotional facial stimuli, in an unpredictable manner. Participants had to select two pairs of stimuli. The relevant sorting criteria were: the emotional rule (emotional valence: happy, angry and neutral) and the two non-emotional rules (the stimulus dimension and the identity used). DV: reaction times and number of pairs correctly sorted.	1. In both tasks, trials requiring greater cognitive flexibility (flexible condition) were more demanding than nonflexible ones, in terms of both response times and accuracy. 2. We found that the costs associated with the flexibility condition were greater for the younger children compared to the older children, consistent with an age-related improvement in cognitive and affective flexibility which takes place at the level of response speed, rather than affecting performance accuracy. 3. Being flexible on the EM-FIST was more demanding in the case of high trait anxious children than for their low trait anxious counterparts. 4. We reported a female advantage in the processing of emotional material, indicated by the fact that girls showed overall faster responses compared to boys on the generative affective flexibility measure. However, this effect was specific to affective flexibility as we did not reveal the presence of a female advantage in the generative cognitive flexibility measure. 5. Also, our findings reveal that generative affective flexibility is related to generative cognitive flexibility in terms of both accuracy and reaction time performance.

Chapter 4 Study 5	17-20 years (N = 35)	Generative affective flexibility	Emotion task-relevant	***4-item FIST*** and ***4-item Emotional FIST*** were used and are described above.	1. Our findings did not reveal the presence of gender differences in our young adult sample. 2. In light of this, we found that the flexible condition was indeed more demanding compared to the nonflexible one, but this was found only in the generative affective flexibility measure. 3. Our findings indicate that in our sample of young adults there were no anxiety-related effects. 4. Our results indicate that generative affective flexibility is related to generative cognitive flexibility in young adults, extending our previous findings with preadolescents to an adult sample.

5.2. Theoretical and empirical contributions

5.2.1. Theoretical contributions

In what follows we will integrate our findings in the existing theoretical frameworks of anxiety which proposes several hypothesis concerning the effects of interindividual differences in trait anxiety on AF (Attentional Control Theory, Eysenck et al., 2007). According to the ACT, it is hypothesized that anxiety will have a detrimental effect on processing efficiency (translated in longer reaction times) emotional stimuli are employed and when the executive task demands are high.

We directly tested these hypotheses in our studies and we will summarize our main original findings. Also, we provide a summary of our findings regarding age improvements and gender differences in cognitive and AF which may inform future developmental theories on executive functioning. Lastly, we discuss the contribution of our findings focused on developmental samples to theories regarding the direct effects of emotions (emotion acting as task-relevant) on flexibility performance in adults (Reeck & Egner, 2014***).***

I. Theoretical contributions of the impact of interindividual differences in anxiety, age and gender on flexibility

Looking at ***the impact of interindividual differences in anxiety*** on AF while emotion is task-relevant, studies conducted with adults indicate the presence of specific flexibility impairments (e.g., Johnson, 2009a). Through this thesis we test these assumptions and extend such findings to a developmental sample. Our findings indicate that children with high levels of anxiety (and depression), show a shifting AF impairment visible only when children had to repeat the same emotional rule and when feedback is provided (Chapter 3, Study 1). We did not find an impact of high levels of internalizing symptoms on switching trials as compared to repetition trials and we also found this effect only in the feedback condition of the task while this effect was absent in the non-feedback condition. Furthermore, in a second study conducted with adolescents we failed to reveal such anxiety (and depression) impairments in a non-feedback condition of the same shifting AF task which suggests that the effects of anxiety (and depression) are specific to circumstances in which children receive trial by trial feedback (Chapter 3, Study 2). Also, we found that for preadolescents with higher levels of anxiety it was more demanding to complete flexible trials as compared to nonflexible trials in the affective generative task than for their low trait anxious counterparts (Chapter 4, Study 4). This finding suggests that interindividual differences in trait anxiety have an impact on generative AF in terms of slower response especially when the task demands are higher (during flexible trials). Taken together, these studies have tested the direct effects of emotion and revealed that it had a specific impact in terms of reaction times in preadolescents with high levels of trait anxiety only under certain circumstances. These studies provide support for the Attentional Control Theory by showing that the deleterious effects of anxiety were more visible when participants had to process emotional information in a flexible manner and when the task demands were high.

Regarding ***the developmental trajectory*** of both cognitive and AF our findings agree that different forms of these abilities continue to develop in middle childhood as compared to adolescence. Specifically, our findings indicate that shifting AF improved during middle childhood (7 and 11 years) as older children provided faster compared to the younger age group (Chapter 3, Study 1). Moreover, this effect was also reported in terms of an improvement in accuracy performance during the shifting AF task in high school children compared to middle school children (Chapter 3, Study 2). Additionally, looking at the developmental trajectory of generative CF and AF we found the presence of age-related improvements during preadolescence (11 to 14 years old) so that older children outperformed younger children at the level of response speed (Chapter 4, Study 4). Our findings could inform future developmental theories looking at the developmental trajectory of ”hot” aspects of flexibility.

Nevertheless, our findings contribute to developmental theories regarding ***gender differences*** in AF across development. All of our developmental studies converge on the finding that girls have an advantage over boys in the flexible processing of emotional stimuli. Two of our studies reveal this advantage in shifting AF during middle childhood and adolescence (Chapter 3, Study 1 and Study 2). Also, two of our studies also report a superior performance of girls compared to boys in generative AF in preschoolers and preadolescents (Chapter 4, Study 3 and Study 4).

II. The emotional "dominance" hypothesis in the context of the task-switching paradigm

In our third chapter we reported longer response times for disengaging a neutral rule and engaging an emotional rule than for the opposite switch (emotional to neutral) in both our studies (Chapter 3, Study 1, Study 2). These results offer support for the "dominant" nature of the emotional rule hypothesis put forward by Reeck and Egner (2014). According to these authors, emotional stimuli have a privileged access to our cognitive resources which will be reflected in affective task-switching paradigm. According to this hypothesis, participants are expected to respond slower when switching from the non-emotional rule to the emotional rule, and to provide faster respond when switching from the emotional rule to the non-emotional rule. Our findings confirm this assumption as they reveal that it is harder to switch from a non-emotional to an emotional rule than the other way around during middle childhood and adolescence, in line with Reeck and Egner's findings (2014) with adults.

5.2.2. Empirical contributions

Chapter 3. Study 1. Relating affective flexibility with internalizing symptoms and affective executive functioning during middle childhood

- To our knowledge, this is the first study to investigate the relation between internalizing symptoms and shifting AF during middle childhood;
- These relations were investigated by creating an affective task-switching paradigm (ACCE task) through the adaptation of a task previously used with adults for the use with children. We made several changes to the original task:
  - We made it suitable for middle school children and adolescents (e.g., increased exposure time for stimuli, reduced number of trials);
  - We included an emotional rule so that children were required to judge the emotional valence of the emotional faces which allowed us to be able to investigate the direct effects of emotions (task relevant) on flexibility;
- Our study indicated that the ACCE task is a reliable measure for assessing shifting AF given that this task can capture age-related changes in shifting AF during middle childhood.
- Our findings also revealed the presence of age-related improvements in shifting AF visible during middle childhood.
- During middle childhood girls appear to be faster than boys in engaging emotional rules. This specific gender effect is novel in this age group given that similar AF impairments have only been reported in preschoolers.

- This is the first developmental study to test the ACT predictions regarding the presence of anxiety related impairments in AF during middle childhood. In this study, higher levels of internalizing symptoms were associated with slower response times only when participants had to alternate between two emotional rules and when feedback was offered.
- Looking at the effects of valence, our findings show that EE repetition trials were associated with shorter response times as compared to consecutive trials which included an emotional and a neutral facial expression.
- We also tested if children's attentional control capacity moderates the adverse effects of internalizing symptoms on shifting AF. Our findings do not provide support for this assumption.
- Our results show that when feedback was offered, participants had longer reaction times compared to the non-feedback condition of the shifting AF task. Also, the deleterious effects of internalizing symptoms were observed only in the feedback condition of the ACCE task.

Chapter 3. Study 2. Relating affective flexibility with internalizing symptoms and affective executive functioning during adolescence

- To our knowledge, this study is the first to investigate the relation between internalizing symptoms and shifting AF during adolescence;
- To our knowledge, this is the first investigation looking at the contribution of affective aspects of inhibition and working memory to shifting AF during adolescence;
- Our findings indicate the presence of a developmental progress in shifting AF during adolescence.
- During adolescence, girls appear to be faster than boys when processing emotional rules as revealed by faster responses obtained in the shifting AF task.
- We also tested the assumptions generated by the ACT regarding the presence of a detrimental effect of anxiety on AF. This effect was not found in our sample of adolescents with high internalizing symptoms.
- This study revealed for the first time that during adolescence children make use of affective aspects of inhibition and working memory processes to act in a flexible manner when dealing with emotional content.

Chapter 4. Study 3. Relating generative cognitive and affective flexibility with anxiety symptoms in preschoolers

- To our knowledge, this study is the first to investigate the relation between anxiety symptoms and both generative cognitive and AF during the preschool years;
- These relations were investigated by creating a generative AF measure departing from the 3-item FIST task which was also included in the present study. We developed a card emotional version of the FIST task for the use with preschoolers. The development of this task was done in order to:
    - To be suitable for preschool children (e.g., card version, reduced number of stimuli presented in a trial by trial manner, reduced number of trials);

- To allow us to investigate the indirect effects of emotions. We included these manipulations by including the requirement for children to judge the non-emotional characteristics of the emotional faces while ignoring their emotional valence;

- Our findings indicate that the novel 3-item EM-FIST task employed in the current study is a valid measure of generative AF in preschoolers as indicated by its moderate test-retest reliability.
- We found gender difference in flexibility, such that during the preschool period, girls exhibited greater generative AF than boys when processing emotional information.
- We report a novel finding: higher levels of anxiety were associated with increased flexibility only when positive task-irrelevant emotional stimuli were processed in preschoolers. In this study, we did not find any detrimental effects of anxiety on cognitive and AF.
- According to our findings, generative forms of both affective and CF are dissociated during the preschool years.

Chapter 4. Study 4. Relating generative cognitive and affective flexibility with anxiety symptoms in preadolescents

- To our knowledge, this study is the first to investigate the relation between anxiety symptoms and both generative cognitive and AF during early adolescence;
- These relations were investigated by creating a computerized generative AF measures departing from the 4-item FIST task. The development of this task was done in order to:
    - To be appropriate for the use with older children/adults respectively in order to allow comparisons across different ages;
    - To allow us to investigate the direct effects of emotions (acting as task-relevant). We included these manipulations by including the requirement for children to judge the emotional valence of the emotional faces;
- We found that trait anxiety had a deleterious effect only on AF, in terms of both accuracy and response latency. Hence, anxiety had a detrimental impact upon performance accuracy when the flexible demands were higher (in the flexible condition). This result fits nicely with the ACT premise that anxiety impairs performance most greatly on tasks that impose heavier executive demands and involve distracting emotional stimuli.
- Our findings show that complex forms of both affective and CF are related during preadolescence.

Chapter 4. Study 5. Relating generative cognitive and affective flexibility with anxiety symptoms in adults

- To our knowledge, this study is the first to examine the link between anxiety symptoms and both generative cognitive and AF in young adults;
- We did not find gender or anxiety related differences in our sample of young adults.
- Our findings show that complex forms of both affective and CF are related during early adulthood.

5.3. Practical implications

Abilities such as cognitive and AF are important for many aspects of children's daily life. AF is crucial for the development of emotion regulation skills in children and for their academic success (e.g., Wilson et al., 2007). Additionally, CF is important for children's academic achievement (e.g., Blair & Razza, 2007; Bull & Scerif, 2001; Engel de Abreu et al., 2014) their cognitive abilities such as theory of mind (e.g., Carlson & Moses, 2001; Müller, Zelazo & Imrisek, 2005) and language (e.g., Deák, 2003). Furthermore, cognitive inflexibility is considered the hallmark of anxiety and depression disorders in adults (Kashdan & Rottenberg, 2010). Hence, studying such inflexibility in children and adolescents with high levels of internalizing symptoms becomes paramount as it allows us to capture the specific conditions under which internalizing symptoms exert a detrimental effect on flexibility. This information is then extremely relevant for the development of effective prevention and intervention programs for children, adolescents, and even adults.

Cognitive and affective flexibility and academic achievement

Our findings have an important contribution for the school context as we can draw some specific suggestions for educators and parents. Our results show that switching between tasks is detrimental to performance (accuracy and reaction times) as compared to repetition trials in children and adolescents. Hence, for optimal performance, children should be less encouraged to constantly switch between tasks and instead focus on the task at hand. For instance, they should inhibit the need to alternate between a given task and talking to a colleague or checking their phones. However, during some activities, switching between perspective is essential for optimal performance such as when a child has to learn a new language (and thus is required to switch between two different conflicting representations) or to solve a given problem in multiple ways. In this situation, using the reflection training strategy (Kloo & Perner, 2003) might be helpful to maintain or increase children's flexibility by teaching children to notice there are two or more perspectives towards a given task or problem. This strategy encourages children to constantly reflect by themselves on their rule representations (two possible ways of solving a task or two translations for a specific word), rather than telling them when an answer is incorrect (Espinet, Anderson, & Zelazo, 2013). Such training procedures might in turn improve children's academic performance. In our studies, academic achievement was indeed positively related to AF. This suggests that improving AF through reflection training might subsequently result in a flexibility progress which might be then transferred to academic achievement.

Our results also show that preadolescents with increased levels of trait anxiety will likely display inflexibility in tasks with high demands (e.g., when they need to switch between two ways of viewing a given problem) especially when they are not provided with the explicit instructions on how to solve a given task (generative flexibility). In a classroom, anxious children might take longer to solve such tasks and in order to improve their performance, teachers might (1) make use of explicit instructions and reminders or (2) teach children how to inhibit a previous response which no longer applies.

Implications for clinical research and practice

Our findings highlight the utility of studying individual differences in AF given that this construct might be crucial for identifying potential deficits in emotional processing in a clinical sample experiencing depression or anxiety symptoms. A task as the Attentional Control Capacity for Emotion task (used in Study 1 and 2, Chapter 3) may act as a tool for clinical psychologists aiming to identify cognitive and emotional deficits in clients with high levels of anxiety. Also, this type of task could be further adapted and included in a cognitive training program aiming to improve AF in people which exhibit emotion regulation and/or executive functioning deficits. The possibility of developing interventions targeting AF may be the next important aim in preventing and ameliorating mood disorders.

These interventions should be appropriate for adults, but feasible in school settings as well. In this regard, Callinan et al. (2014) had already reported a change of performance on shifting AF after an attention training program in adults, although the effect on AF was indirect. One interesting possibility suggested by the present thesis, is that children and adolescents who experience high levels of anxiety (and depression) might benefit from an intense adaptive shifting AF training through the use of a modified version of ACCE task in which the emotional stimuli are task-relevant. If AF performance may be improved through this type of training, this may also provide a way of improving emotion-regulation skills. In light of this, previous work indicates that shifting attention toward a positive stimulus tends to elicit or enhance positive emotions while shifting attention away from a negative stimulus tends to decrease negative affect (Derryberry & Rothbart, 1988). Moreover, inasmuch as deficits in cognitive emotion regulation strategies lie at the centre of many psychological disorders, in particular mood and anxiety disorder (e.g., Joormann & D'Avanzato, 2010), the present thesis has important clinical implications. If AF may be improved through training, this may provide a method of improving an individual's emotion-regulation skills which should be studied further. Regarding emotion regulation, an emerging line of research investigates emotional regulation flexibility which refers to an individual's ability to use different emotional regulation strategies in order to respond to the changing environments (Aldao, Sheppes, & Gross, 2015). It would be interesting to have future clinical studies looking at the link between this ability and AF in order to establish how these two abilities are related.

References

Aboulafia-Brakha, T., Allain, P., & Ptak, R. (2016). Emotion regulation after traumatic brain injury: distinct patterns of sympathetic activity during anger expression and recognition. *The Journal of head trauma rehabilitation, 31*(3), E21-E31. doi: 10.1097/HTR.0000000000000171

Aker, M., & Landrø, N. I. (2014). Executive control of emotional processing: a set-shifting task. *The Clinical Neuropsychologist*, *28*(8), 1311-1320. doi: 10.1080/13854046.2014.984762

Aldao, A., Sheppes, G., & Gross, J. J. (2015). Emotion regulation flexibility. *Cognitive Therapy and Research*, *39*(3), 263-278. doi: 10.1007/s10608-014-9662-4

Alloway, T. P., Gathercole, S. E., Willis, C., & Adams, A. M. (2004). A structural analysis of working memory and related cognitive skills in young children. *Journal of experimental child psychology*, *87*(2), 85-106. doi: 10.1016/j.jecp.2003.10.002

Allport, A., Styles, E. A., & Hsieh, S. L. (1994). Shifting intentional set-exploring the dynamic control of tasks. *Attention and Performance XV: Conscious and Nonconscious Information Processing*, *15,* 421–452

Anderson P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology*, 8:71–82. doi:10.1076/chin.8.2.71.8724

Andreadis, N., & Quinlan, P. T. (2010). Task switching under predictable and unpredictable circumstances. *Attention, Perception, & Psychophysics*, *72*(7), 1776-1790. doi: 10.3758/APP.72.7.1776

Ansari, T. L., Derakshan, N., & Richards, A. (2008). Effects of anxiety on task switching: Evidence from the mixed antisaccade task. *Cognitive Affective & Behavioral Neuroscience, 8*(3), 229–238. doi:10.3758/CABN.8.3.229

Ashby, F. G., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review, 106*(3), 529-550. doi:10.1037/0033-295X.106.3.529

Austin, M. P., Ross, M., O'Carrol, R. E., Ebmeier, K. P., & Goodwin, G. M. (1992). Cognitive function in major depression. *Journal of Affective Disorders, 25,* 21–30

Bates, D., & Maechler, *M.* (2010). lme4: Linear mixed-effects models using S4 classes. R package (Version 0.999375-37).

Beck, D. M., Schaefer, C., Pang, K., & Carlson, S. M. (2011). Executive function in preschool children: Test–retest reliability. *Journal of Cognition and Development*, *12*(2), 169-193. doi: 10.1080/15248372.2011.563485

Benga, O., Ţincaş, I., & Visu-Petra, L. (2010). Investigating the structure of anxiety syntomps among romaniaan preschoolers using the Spence Preschool Anxiety. *Cognitie, Creier, Comportament/Cognition, Brain, Behavior*, *14*(2)

Berggren, N., & Derakshan, N. (2013). Attentional control deficits in trait anxiety: why you see them and why you don't. *Biological Psychology*, *92*(3), 440-446. doi: 10.1016/j.biopsycho.2012.03.007

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development, 81*(6), 1641-1660. doi: 10.1111/j.1467-8624.2010.01499.x

Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive functions after age 5: Changes and correlates. *Developmental Review, 29*(3), 180-200. doi:10.1016/j.dr.2009.05.002

Betts, J., Gullone, E., & Allen, J. S. (2009). An examination of emotion regulation, temperament, and parenting style as potential predictors of adolescent depression risk

status: A correlational study. *British Journal of Developmental Psychology*, *27*(2), 473-485. doi:10.1348/026151008X314900
Blackwell, K. A., Cepeda, N. J., & Munakata, Y. (2009). When simple things are meaningful: Working memory strength predicts children's cognitive flexibility. *Journal of Experimental Child Psychology*, *103*(2), 241-249. doi:10.1016/j.jecp.2009.01.002
Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78*(2), 647-663. doi: 10.1111/j.1467-8624.2007.01019.x
Blakey, E., Visser, I., & Carroll, D. J. (2015). Different Executive Functions Support Different Kinds of Cognitive Flexibility: Evidence From 2-, 3-, and 4-Year Olds. *Child development*. doi: 10.1111/cdev.12468
Blanchette, I. (2006). Snakes, spiders, guns, and syringes: How specific are evolutionary constraints on the detection of threatening stimuli?. *The Quarterly Journal of Experimental Psychology*, *59*(8), 1484-1504. doi: 10.1080/02724980543000204
Blaye, A., & Bonthoux, F. (2001). Thematic and taxonomic relations in preschoolers: The development of flexibility in categorization choices. *British Journal of Developmental Psychology*, *19*(3), 395-412. doi: 10.1348/026151001166173
Botvinick, *M. M*., Braver, T. S., Barch, D. *M*., Carter, C. S., & Cohen, J. D. (2001*).* Conflict monitoring and cognitive control. *Psychological Review*, *108*(3), 624–652. doi: 10.1037/0033-295X.108.3.624
Boyatzis, C. J., Chazan, E., and Ting, C. Z. (1993). Preschool children's decoding of facial emotions. *Journal of Genet. Pers*. 154, 375–382. doi: 10.1080/00221325.1993.10532190
Brocki, K. C., & Tillman, C. (2014). Mental set shifting in childhood: the role of working memory and inhibitory control. *Infant and Child Development*, *23*(6), 588-604. doi: 10.1002/icd.1871
Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: inhibition, switching, and working memory. *Developmental Neuropsychology*, *19*, 273–293. doi:10.1207/S15326942DN1903_3
Bunge, S. A., & Zelazo, P. D. (2006) A brain-based account of the development of rule use in childhood. *Current Directions in Psychology Science*, *15*, 118–121. doi: 10.1111/j.0963-7214.2006.00419.x
Burgess, P. W., Alderman, N., Forbes, C., Costello, A., Coates, L. M.-A., Dawson, D. R., et al. (2006). The case for the development and use of ''ecologically valid'' measures of executive function in experimental and clinical neuropsychology. *Journal of the International Neuropsychological Society: JINS*, *12*(2), 194–209. doi:10.1017/S1355617706060310
Callinan, S., Johnson, D., & Wells, A. (2014). A randomised controlled study of the effects of the attention training technique on traumatic stress symptoms, emotional attention set shifting and flexibility. *Cognitive Therapy and Research*, *39*(1), 4-13. doi: 10.1007/s10608-014-9634-8
Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, *72*, 1032–1053. doi: 10.1111/1467-8624.00333
Casey, B. J., Thomas, K. M., Welsh, T. F., Livnatn, R., Eccard, C. H. (2000) Cognitive and behavioral probes of developmental landmarks for use in functional neuroimaging. In Ernst M, Rumsey JM, editors. *Functional Neuroimaging in Child Psychiatry*. New York: Cambridge University Press. pp. 155–168

Casey, B. J., Trainor, R. J., Orendi, J. L., Schubert, A. B., Nystrom, L. E., Giedd, J. N., ... & Forman, S. D. (1997). A developmental functional MRI study of prefrontal activation during performance of a go-no-go task. *Journal of cognitive neuroscience, 9*(6), 835-847

Chevalier, N., & Blaye, A. (2009). Setting goals to switch between tasks: effect of cue transparency on children's cognitive flexibility. *Developmental Psychology, 45*(3), 782. doi: 10.1037/a0015409

Chevalier, N., Sheffield, T. D., Nelson, J. M., Clark, C. A., Wiebe, S. A., & Espy, K. A. (2012). Underpinnings of the costs of flexibility in preschool children: the roles of inhibition and working memory. *Developmental neuropsychology, 37*(2), 99-118. doi:10.1080/87565641.2011.632458

Chorpita, B. F., Yim, L., Moffitt, C., Umemoto, L. A., & Francis, S. E. (2000). Assessment of symptoms of DSM-IV anxiety and depression in children: a revised child anxiety and depression scale. *Behaviour Research and Therapy, 38*(8), 835–855

Corbett, B. A., Constantine, L. J., Hendren, R., Rocke, D., & Ozonoff, S. (2009). Examining executive functioning in children with autism spectrum disorder, attention deficit hyperactivity disorder and typical development. *Psychiatry research*, *166*(2), 210-222. doi:10.1016/j.psychres.2008.02.005

Cragg, L., & Chevalier, N. (2012). The processes underlying flexibility in childhood. *The Quarterly Journal of Experimental Psychology*, *65*(2), 209-232. doi: 10.1080/17470210903204618

Cragg, L., & Nation, K. (2009). Shifting development in mid-childhood: The influence of between-task interference. *Developmental Psychology, 45*(5), 1465. doi:10.1037/a0015360

Cromheeke, S., & Mueller, S. C. (2014). Probing emotional influences on cognitive control: an ALE meta-analysis of cognition emotion interactions. *Brain Structure and Function*, *219*(3), 995-1008. doi: 10.1007/s00429-013-0549-z

Dajani, D. R., & Uddin, L. Q. (2015). Demystifying cognitive flexibility: Implications for clinical and developmental neuroscience. *Trends in neurosciences*, *38*(9), 571-578. doi: 10.1016/j.tins.2015.07.003

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*(11), 2037-2078. doi: 10.1016/j.neuropsychologia.2006.02.006

Davis, R. N., & Nolen-Hoeksema, S. (2000). Cognitive inflexibility among ruminators and nonruminators. *Cognitive Therapy and Research*, *24*(6), 699-711. doi: 10.1023/A:1005591412406

De Haan, M., Humphreys, K., & Johnson, M. H. (2002). Developing a brain specialized for face perception: A converging methods approach. Developmental Psychobiology, 40(3), 200-212. doi: 10.1002/dev.10027

De Lissnyder, E., Koster, E. H. W., Derakshan, N., & De Raedt, R. (2010). The association between depressive symptoms and executive control impairments in response to emotional and non-emotional information. *Cognition & Emotion, 24*(2), 264–280. DOI: 10.1080/02699930903378354

De Lissnyder, E., Koster, E. H. W., Goubert, L., Onraedt, T., Vanderhasselt, M. A., & DeRaedt, R. (2012). Cognitive control moderates the association between stress and rumination. *Journal of Behavior Therapy and Experimental Psychiatry, 43*, 519–525. doi:10.1016/j.jbtep.2011.07.004

De Los Reyes, A., & Kazdin, A. E. (2005). Informant discrepancies in the assessment of childhood psychopathology: A critical review, theoretical framework, and recommendations for further study. *Psychological Bulletin, 131*(4), 483–509. doi: 10.1037/0033-2909.131.4.483

De Raedt, R., Koster, E. H., & Joormann, J. (2010). Attentional control in depression: a translational affective neuroscience approach. *Cognitive, Affective, & Behavioral Neuroscience, 10*(1), 1-7. doi:10.3758/CABN.10.1.1

De Vries, M., & Geurts, H. M. (2012). Cognitive Flexibility in ASD; Task Switching with Emotional Faces. *Journal of Autism and Developmental Disorders*, *42*(12), 2558–2568. http://doi.org/10.1007/s10803-012-1512-1

Deák, G. O. (2003). The development of cognitive flexibility and language abilities. *Advances in Child Development and Behavior*, *31*, 273-328. doi: 10.1016/S0065-2407(03)31007-9

Deák, G. O., Ray, S. D., & Pick, A. D. (2004). Effects of age, reminders, and task difficulty on young children's rule-switching flexibility. *Cognitive Development*, *19*(3), 385–400. doi:10.1016/j.cogdev.2004.05.002

Demanet, J., Liefooghe, B., & Verbruggen, F. (2011). Valence, arousal, and cognitive control: a voluntary task-switching study. *Frontiers in Psychology*, *2: 336*. doi:10.3389/fpsyg.2011.00336

Dennis, J. P., & Vander Wal, J. S. (2010). The cognitive flexibility inventory: Instrument development and estimates of reliability and validity. *Cognitive therapy and research*, *34*(3), 241-253. doi:10.1007/s10608-009-9276-4

Derakshan, N., & Eysenck, *M*. W. (2009). Anxiety, Processing Efficiency, and Cognitive Performance New Developments from Attentional Control Theory. *European Psychologist, 14*(2), 168–176. doi: 10.1027/1016-9040.14.2.168

Derakshan, N., Smyth, S., & Eysenck, *M*. W. (2009). Effects of state anxiety on performance using a task-switching paradigm: An investigation of attentional control theory. *Psychonomic Bulletin & Review, 16*(6), 1112–1117. doiI: 10.3758/PBR.16.6.1112

Derryberry, D., & Reed, *M*. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology, 111*(2). 225–236. doi: 10.1037/0021-843X.111.2.225

Derryberry, D., & Rothbart, M. K. (1988). Affect, arousal, and attention as components of temperament. *Journal of Personality and Social Psychology, 55,* 958–966. doi:10.1037/0022-3514.55.6.958

Deveney, C. M., & Deldin, P. J. (2006). A preliminary investigation of cognitive flexibility for emotional information in major depressive disorder and non-psychiatric controls. *Emotion*, *6*(3), 429. doi: 10.1037/1528-3542.6.3.429

Diamond, A. (2006). The early development of executive functions. *Lifespan cognition: Mechanisms of change*, 70-95. doi: 10.1093/acprof:oso/9780195169539.003.0006

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135. doi: 10.1146/annurev-psych-113011-143750

Dick, A. S. (2012). Sources of cognitive inflexibility in set-shifting tasks: insights into developmental theories from adult data. *Journal of Cognition and Development, 13*(1), 82-110. doi: 10.1080/15248372.2011.573516

Disner, S. G., Beevers, C. G., Haigh, E. A., & Beck, A. T. (2011). Neural mechanisms of the cognitive model of depression. *Nature Reviews Neuroscience*, *12*(8), 467-477. doi:10.1038/nrn3027

Doebel, S., & Zelazo, P. D. (2015). A meta-analysis of the Dimensional Change Card Sort: Implications for developmental theories and the measurement of executive function in children. *Developmental Review*, *38,* 241-268. doi: 10.1016/j.dr.2015.09.001

Dolcos, F., & Denkova, E. (2015). Dissociating Enhancing and Impairing Effects of Emotion on Cognition. *Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource*. doi: 10.1002/9781118900772.etrds0079

Dreisbach, G., & Goschke, T. (2004). How positive affect modulates cognitive control: reduced perseveration at the cost of increased distractibility. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*(2), 343-353. doi: 10.1037/0278-7393.30.2.343

Eisenberg, N., Cumberland, A., Spinrad, T. L., Fabes, R. A., Shepard, S. A., Reiser, M., Murphy, B. C., Losoya, S. H., Guthrie, I. K. (2001). The relations of regulation and emotionality to children's externalizing and internalizing problem behavior. *Child Development*, *72,* 1112–1134

Ekman, P., & Friesen, W. V. (1976). Measuring facial movement. *Environmental psychology and nonverbal behavior*, *1*(1), 56-75

Emerson, C. S., Mollet, G. A., & Harrison, D. W. (2005). Anxious-depression in boys: an evaluation of executive functioning. *Archives of Clinical Neuropsychology*, *20*(4), 539–546. DOI: 10.1016/j.acn.2004.10.003

Engel de Abreu, P. M. J., Abreu, N., Nikaedo, C. C., Puglisi, M. L., Tourinho, C. J., Miranda, M. C., … Martin, R. (2014). Executive functioning and reading achievement in school: a study of Brazilian children assessed by their teachers as "poor readers." *Frontiers in Psychology, 5*, 550. doi: 10.3389/fpsyg.2014.00550

Eslinger, P. J., & Grattan, L. M. (1993). Frontal lobe and frontal-striatal substrates for different forms of human cognitive flexibility. *Neuropsychologia*, *31*(1), 17-28

Espinet, S. D., Anderson, J. E., & Zelazo, P. D. (2013). Reflection training improves executive function in preschool-age children: Behavioral and neural effects. *Developmental Cognitive Neuroscience*, *4*, 3-15. doi:10.1016/j.dcn.2012.11.009

Everaert, J., Duyck, W., & Koster, E. H. W. (2014). Attention, interpretation, and memory biases in subclinical depression: A proof-of-principle test of the combined cognitive biases
hypothesis. Emotion, 14(2), 331–340. doi:10.1037/a0035250

Everaert, J., Grahek, I., & Koster, E. H. (2016). Individual differences in cognitive control over emotional material modulate cognitive biases linked to depressive symptoms. *Cognition and Emotion*, 1-11. doi:10.1080/02699931.2016.1144562

Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory. *Personality and Individual Differences, 50*(7), 955–960.doi:10.1016/j.paid.2010.08.019.

Eysenck, *M*. W., Derakshan, N., Santos, R., & Calvo, *M*. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, *7*(2), 336–353. doi: 10.1037/1528-3542.7.2.336

Field, A. P., & Wright, D. B. (2011). A Primer on Using Multilevel Models in Clinical and Experimental Psychopathology Research. *Journal of Experimental Psychopathology, 2*(2), 271–293. DOI: 10.5127/jep.013711

Flanagan, R. (1995). A review of the Behavior Assessment System for Children (BASC): Assessment consistent with the requirements of the Individuals with Disabilities Education Act (IDEA). *Journal of School Psychology*, *33*(2), 177-186.

Fox, J. (2003). Effect Displays in R for Generalised Linear Models. *Journal of Statistical Software, 8*(15), 1–27Fredrickson, B. L. (2001). The Role of Positive Emotions in Positive Psychology: The Broaden-and-Build Theory of Positive Emotions. *The American Psychologist, 56*(3), 218–226. doi: 10.1037//0003-066X.56.3.218

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: a review using an integrative framework. *Psychological Bulletin*, *134*(1), 31-60. doi: 10.1037/0033-2909.134.1.31

Genet, J. J., Malooly, A. M., & Siemer, M. (2013). Flexibility is not always adaptive: Affective flexibility and inflexibility predict rumination use in everyday life. *Cognition & Emotion*, *27*(4), 685-695. doi: 10.1080/02699931.2012.733351

Genet, J. J., & Siemer, M. (2011). Flexible control in processing affective and non-affective material predicts individual differences in trait resilience. *Cognition and Emotion*, *25*(2), 380-388. doi: 10.1080/02699931.2010.491647

Geurts, H. M., Corbett, B., & Solomon, M. (2009). The paradox of cognitive flexibility in autism. *Trends in cognitive sciences*, *13*(2), 74-82. doi:10.1016/j.tics.2008.11.006

Grant, M. M., Thase, M. E., & Sweeney, J. A. (2001). Cognitive disturbance in outpatient depressed younger adults: Evidence of modest impairment. *Biological Psychiatry*, *50*, 35–43. doi:10.1016/S0006-3223(00)01072-6

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of personality and social psychology*, *85*(2), 348. doi:10.1037/0022-3514.85.2.348

Gruner, P., & Pittenger, C. (2016). Cognitive inflexibility in obsessive-compulsive disorder. *Neuroscience*. doi:10.1016/j.neuroscience.2016.07.030

Gullone, E., & Taffe, J. (2012). The Emotion Regulation Questionnaire for Children and Adolescents (ERQ–CA): A psychometric evaluation. *Psychological assessment*, *24*(2), 409. doi:10.1037/a0025777

Han, G., Helm, J., Iucha, C., Zahn-Waxler, C., Hastings, P. D., & KlimesDougan, B. (2015). Are executive functioning deficits concurrently and predictively associated with depressive and anxiety symptoms in adolescents? *Journal of Clinical Child & Adolescent Psychology*,1-15. doi:10.1080/15374416.2015.1041592

Happaney, K., Zelazo, P. D., & Stuss, D. T. (2004). Development of orbitofrontal function: Current themes and future directions. *Brain and cognition*, *55*(1), 1-10. doi:10.1016/j.bandc.2004.01.001

Hardin, M. G., Mandell, D., Mueller, S. C., Dahl, R. E., Pine, D. S., & Ernst, M. (2009). Inhibitory control in anxious and healthy adolescents is modulated by incentive and incidental affective stimuli. *Journal of Child Psychology and Psychiatry*, *50*(12), 1550-1558. doi:10.1111/j.1469-7610.2009.02121.x

Heim, S., & Keil, A. (2012). Developmental trajectories of regulating attentional selection over time. *Frontiers in Psychology, 3*, 277. doi:10.3389/fpsyg.2012.00277

Hothorn, T., Bretz, F. and Westfall, P. (2008). Simultaneous Inference in General Parametric Models. *Biometrical Journal*, *50*(3), 346–363. doi: 10.1002/bimj.200810425

Huizinga, *M*., Dolan, C. V., & van der Molen, *M*. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, *44*(11), 2017–2036. doi: 10.1016/j.neuropsychologia.2006.01.010

Ionescu, T. (2012). Exploring the nature of cognitive flexibility. *New ideas in psychology*, *30*(2), 190-200. doi: 10.1016/j.newideapsych.2011.11.001
Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of personality and social psychology*, *47*(6), 1206. doi:10.1037/0022-3514.47.6.1206
Isen, A. M., Niedenthal, P. M., & Cantor, N. (1992). An influence of positive affect on social categorization. *Motivation and Emotion*, *16*(1), 65-78. doi:10.1007/BF00996487
Jacques, S. (2012). The 4-item computerized flexible item selection task (FIST). Computerized program for administering the FIST.
Jacques, S., & Zelazo, P. D. (2001). The flexible item selection task (FIST): a measure of executive function in preschoolers. *Developmental Neuropsychology, 20,* 573–591. doi:10.1207/S15326942DN2003_2
Jacques, S., & Zelazo, P. D. (2005). On the possible roots of cognitive flexibility. Homer, Bruce D. (Ed); Tamis-LeMonda, Catherine S. (Ed) *In The development of social cognition and communication*, (pp. 53-81)
Johnson, D. R. (2009a). Attentional control capacity for emotion: An individual-difference measure of internal controlled attention. *Cognition & Emotion, 23*(8), 1516–1536. doi: 10.1080/02699930802437095
Johnson, D. R. (2009b). Emotional Attention Set-Shifting and Its Relationship to Anxiety and Emotion Regulation. *Emotion, 9*(5), 681–690. doi:10.1037/a0017095
Joormann, J., & D'Avanzato, C. (2010). Emotion regulation in depression: Examining the role of cognitive processes: Cognition & Emotion Lecture at the 2009 ISRE Meeting. *Cognition and Emotion*, *24*(6), 913-939. doi:10.1080/02699931003784939
Joormann, J., & Gotlib, I. H. (2008). Updating the contents of working memory in depression: interference from irrelevant negative material. *Journal of Abnormal Psychology, 117*(1), 182-192. doi: 10.1037/0021-843X.117.1.182
Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical psychology review, 30*(7), 865-878. doi:10.1016/j.cpr.2010.03.001
Kertz, S. J., Belden, A. C., Tillman, R., & Luby, J. (2015). Cognitive Control Deficits in Shifting dand Inhibition in Preschool Age Children are Associated with Increased Depression and Anxiety Over 7.5 Years of Development. *Journal of abnormal child psychology*, 1-12. doi: 10.1007/s10802-015-0101-0
Kiesel, A., Steinhauser, M., Wendt, M., Falkenstein, M., Jost, K., Philipp, A. M., & Koch, I. (2010). Control and interference in task switching - A review. *Psychological Bulletin, 136*(5), 849-874. doi:10.1037/a0019842
Kindermann, S. S., Kalayam, B., Brown, G. G., Burdick, K. E., Alexopoulos, G. S. (2000). Executive functions and P300 latency in elderly depressed patients and control subjects. *American Journal of Geriatric Psychiatry, 8,* 57–65. doi:10.1016/S0006-3223(00)01072-6
Kindt, M., & van den Hout, M. (2001). Selective attention and anxiety: A perspective on developmental issues and the causal status. *Journal of Psychopathology and Behavioral Assessment*, *23*(3), 193–202
Kloo, D., & Perner, J. (2003). Training transfer between card sorting and false belief understanding: Helping children apply conflicting descriptions. *Child development*, *74*(6), 1823-1839. doi: 10.1046/j.1467-8624.2003.00640.x
Kloo, D., Perner, J., Aichhorn, M., & Schmidhuber, N. (2010). Perspective taking and cognitive flexibility in the Dimensional Change Card Sorting (DCCS) task. *Cognitive Development*, *25*(3),208-217, doi:10.1016/j.cogdev.2010.06.001

Kloo, D., Perner, J., Kerschhuber, A., Dabernig, S., & Aichhorn, M. (2008). Sorting between dimensions: conditions of cognitive flexibility in preschoolers. *Journal of Experimental Child Psychology, 100*(2), 115–134. doi: 10.1016/j.jecp.2007.12.003

Kohler, C. G., Hoffman, L. J., Eastman, L. B., Healey, K., & Moberg, P. J. (2011). Facial emotion perception in depression and bipolar disorder: a quantitative review. *Psychiatry research*, *188*(3), 303-309. doi: 10.1016/j.psychres.2011.04.019

Koster, E. H., De Lissnyder, E., & De Raedt, R. (2013). Rumination is characterized by valence-specific impairments in switching of attention. *Acta psychologica*, *144*(3), 563-570. doi: 10.1016/j.actpsy.2013.09.008

Lang, P. J., Greenwald, *M*. K., Bradley, *M. M*., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30,* 261–273. doi: 10.1111/j.1469-8986.1993.tb03352.x

Lantrip, C., Isquith, P. K., Koven, N. S., Welsh, K., & Roth, R. M. (2016). Executive function and emotion regulation strategy use in adolescents. *Applied Neuropsychology: Child*, *5*(1), 50-55. doi:10.1080/21622965.2014.960567

Lezak, M. D. (1995). Neuropsychological ssessment (3rd ed.,). New York: Oxford University Press.

Lipp, O. V., & Derakshan, N. (2005). Attentional bias to pictures of fear-relevant animals in a dot probe task. *Emotion*, *5*(3), 365-369. doi: 10.1037/1528-3542.5.3.365

Lonigan, C. J., Carey, *M*. P., & Finch, A. J. (1994). Anxiety and Depression in Children and Adolescents: Negative Affectivity and the Utility of Self-Reports. *Journal of Consulting and Clinical Psychology, 62*(5), 1000–1008. doi: 10.1037/0022-006X.62.5.1000

Luciana, *M*., Gunnar, *M*. R., Davis, E. P., Nelson, C. A., & Donzella, B. (2005). Children’s “catastrophic responses” to negative feedback on CANTAB’s ID/ED set-shifting task: Relation to indices of a depressive temperamental style. *Cognition, Brain, Behavior, 9*, 343-361

MacDermott, S. T., Gullone, E., Allen, J. S., King, N. J., & Tonge, B. (2010). The emotion regulation index for children and adolescents (ERICA): a psychometric investigation. *Journal of Psychopathology and Behavioral Assessment*, *32*(3), 301-314. doi:10.1007/s10862-009-9154-0

Mahy, C. E., & Munakata, Y. (2015). Transitions in Executive Function: Insights From Developmental Parallels Between Prospective Memory and Cognitive Flexibility. *Child Development Perspectives*, *9*(2), 128-132. doi:10.1111/cdep.12121

Malooly, A. M., Genet, J. J., & Siemer, M. (2013). Individual differences in reappraisal effectiveness: the role of affective flexibility. *Emotion, 13*(2), 302–313. doi:10.1037/a0029980

Marcovitch, S., Boseovski, J. J., Knapp, R. J., & Kane, M. J. (2010). Goal neglect and working memory capacity in 4- to 6-year-old children. *Child Development, 81,* 1687–1695. doi:10.1111/j.1467-8624.2010.01503.x

Marcovitch, S., & Zelazo, P. D. (2009). A hierarchical competing systems model of the emergence and early development of executive function. *Developmental science*, *12*(1), 1-18. doi:10.1111/j.1467-7687.2008.00754.x

Martel, M., Nikolas, M., & Nigg, J. T. (2007). Executive function in adolescents with ADHD. *Journal of the American Academy of Child & Adolescent Psychiatry*, *46*, 1437–1444. doi:10.1097/chi.0b013e31814cf953

Mărcuş, O., Stanciu, O., MacLeod, C., Liebregts, H., & Visu-Petra, L. (2016). A FISTful of emotion: individual differences in trait anxiety and cognitive-affective flexibility during preadolescence. *Journal of abnormal child psychology*, *44*(7), 1231-1242. doi: 10.1007/s10802-015-0110-z

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin, 126*(3), 424-453. doi: 10.1037/0033-2909.126.3.424

Merriam, E. P. Thase, M. E., Haas, G. L., Keshavan, M. S., & Sweeney, J. A. (1999). Prefrontal cortical dysfunction in depression determined by Wisconsin Card Sorting Test performance. *American Journal of Psychiatry, 156,* 285-295

Micco, J. A., Henin, A., Biederman, J., Rosenbaum, J. F., Petty, C., Rindlaub, L. A., Murphy, M., & Hirshfeld-Becker, D. R. (2009). Executive functioning in offspring at risk for depression and anxiety. *Depression and Anxiety, 26*, 780–790. doi:10.1002/da.20573

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49-100. doi: 10.1006/cogp.1999.0734

Mocan, O., Stanciu, O., & Visu-Petra, L. (2014). Relating individual differences in internalizing symptoms to emotional attention set-shifting in children. *Anxiety, Stress, & Coping*, *27*(5), 509-526. doi: 10.1080/10615806.2014.888419

Monsell, S. (2003). Task switching. *Trends in Cognitive Sciences*, *7*(3), 134-140. doi: 10.1016/S1364-6613(03)00028-7

Morton, J. B., Trehub, S. E., & Zelazo, P. D. (2003). Sources of inflexibility in 6-year-olds' understanding of emotion in speech. *Child Development, 74*(6), 1857–1868. doi: 10.1046/j.1467-8624.2003.00642.x

Muris, P., van der Pennen, E., Sigmond, R., & Mayer, B. (2008). Symptoms of anxiety, depression, and aggression in non-clinical children: Relationships with self report and performance-based measures of attention and effortful control. *Child Psychiatry and Human Development, 39*, 455–467. doi: 10.1007/s10578-008-0101-1

Müller, U., Zelazo, P.D., & Imrisek, S. (2005). Executive function and children's understanding of false belief: how specific is the relation? *Cognitive Development*, *20,* 173–189. doi: 10.1016/j.cogdev.2004.12.004

Nadler, R. T., Rabi, R., & Minda, J. P. (2010). Better mood and better performance learning rule-described categories is enhanced by positive mood. *Psychological Science*, *21*(12), 1770-1776. doi: 10.1177/0956797610387441

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children's anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behavior Research and Therapy, 42*, 813–839. doi:10.1016/S0005-7967(03)00200-6

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., Lupianez, J., (2010). Attention and anxiety: different attentional functioning under state and trait anxiety. *Psychological Science, 21*, 298–304. doi: 10.1177/0956797609359624

Paulitzki, J. R., Risko, E. F., Oakman, J. M., & Stolz, J. A. (2008). Doing the unpleasant: How the emotional nature of a threat-relevant task affects task-switching. *Personality and Individual Differences*, *45*(5), 350-355. doi:10.1016/j.paid.2008.05.003

Perez-Edgar, K., & Fox, N. A. (2007). Temperamental contributions to children's performance in an emotion-word processing task: A behavioral and

electrophysiological study. *Brain and Cognition, 65*(1), 22–35. doi:10.1016/j.bandc.2006.10.010
Pessoa, L. (2009). How do emotion and motivation direct executive control? *Trends in Cognitive Sciences*, *13*(4), 160-166. doi:10.1016/j.tics.2009.01.006
Peters, S., & Crone A. C. (2014). Cognitive Flexibility in children and adolescents. In Grange, J., & Houghton, G. (Eds.) *Task switching and cognitive control*. Oxford University Press. doi: 10.1093/acprof:osobl/9780199921959.001.0001
Peterson, E., & Welsh, M. C. (2014). The Development of Hot and Cool Executive Functions in Childhood and Adolescence: Are We Getting Warmer? In *Handbook of Executive Functioning* (pp. 45-65). Springer New York. doi: 10.1007/978-1-4614-8106-5_4
Piguet, C., Cojan, Y., Sterpenich, V., Desseilles, M., Bertschy, G., & Vuilleumier, P. (2016). Alterations in neural systems mediating cognitive flexibility and inhibition in mood disorders. *Human brain mapping*, *37*(4), 1335-1348. doi:10.1002/hbm.23104
Pinheiro, J., Bates, D., DebRoy, S., Sarkar, S., & R Development Core Team. (2010). *nlme*: Linear and Nonlinear Mixed Effects Models. R package version Version 3.1-97.
Plunkett, K. (2006). Learning how to be flexible with words. In Y. Munakata, & M. H. Johnson (Eds.), *Attention and performance XXI: Processes of change in brain and cognitive development* (pp. 233–248). New York, NY: Oxford University Press.
Preston, S. D., & Stansfield, R. B. (2008). I know how you feel: Task-irrelevant facial expressions are spontaneously processed at a semantic level. *Cognitive, Affective, & Behavioral Neuroscience*, *8*(1), 54-64. doi: 10.3758/CABN.8.1.54
Qu, L., Finestone, D. L., Qin, L. J., & Reena, L. Z. (2013). Focused but fixed: The impact of expectation of external rewards on inhibitory control and flexibility in preschoolers. *Emotion*, *13*(3), 562-572. doi: 10.1037/a0027263
Qu, L., & Zelazo, P. D. (2007). The facilitative effect of positive stimuli on 3-year-olds' flexible rule use. *Cognitive Development*, *22*(4), 456-473. doi: 10.1016/j.cogdev.2007.08.010
Raven, J. (1938). Progressive matrices. ECPA.
Raven, J. C. (1949). *Progressive Matrices: Sets A, AB, B*. Heron.
Raven, J. C., Raven, J. E., & John Hugh Court. (1956). *Coloured progressive matrices: sets A, AB, B*. Oxford Psychologist Press.
Reeck, C., & Egner, T. (2011). Affective privilege: asymmetric interference by emotional distracters. *Frontiers in Psychology, 2,* 1–7. doi: 10.3389/fpsyg.2011.00232
Reeck, C., & Egner, T. (2014). Emotional task management: neural correlates of switching between affective and non-affective task-sets. *Social cognitive and affective neuroscience*, nsu153. doi: 10.1093/scan/nsu153
Reynolds, C. R., & Kamphaus, R. W. (2004). *The behavior assessment system for children* (2nd ed.). Bloomington, MN: Pearson.
Roberts Jr, R. J., & Pennington, B. F. (1996). An interactive framework for examining prefrontal cognitive processes. *Developmental neuropsychology*, *12*(1), 105-126. doi: 10.1080/87565649609540642
Rogers, *M*. A., Kasai, K., Koji, *M*., Fukuda, R., Iwanami, A., Nakagome, K., Fukuda, *M*., Kato, N. (2004). Executive and prefrontal dysfunction in unipolar depression: a review of neuropsychological and imaging evidence. *Neuroscience Research, 50*(1), 1-11
Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General, 124*(2), 207–231. doi: 10.1037/0096-3445.124.2.207

Rosso, I. *M*., Young, A. D., Femia, L. A., & Yurgelun-Todd, D. A. (2004). Cognitive and emotional components of frontal lobe functioning in childhood and adolescence. *Annals of the New York Academy of Sciences, 1021*, 355–362. DOI: 10.1196/annals.1308.045

Sarason, I. G. (1986). Self-related cognitions in anxiety and motivation In Test anxiety, worry, and cognitive interference. *Self-related cognitions in anxiety and motivation*, 19-33

Shapiro, H. M., Wong, L. M., & Simon, T. J. (2013). A cross-sectional analysis of the development of response inhibition in children with chromosome 22q11. 2 deletion syndrome. *Frontiers in psychiatry*, *4*, 81. doi: 10.3389/fpsyt.2013.00081

Shields, A., & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. *Developmental Psychology, 33*(6), 906-916

Sibrava, N. J., & Borkovec, T. D. (2006). The cognitive avoidance theory of worry. In G. C. L. Davey & A. Wells (Eds.), *Worry and its psychological disorders: Theory, assessment, and treatment* (pp. 239 –258) West Sussex, England: Wiley.

Smidts, D. P., Jacobs, R., & Anderson, V. (2004). The object classification task for children (OCTC): a measure of concept generation and mental flexibility in early childhood. *Developmental Neuropsychology*, *26* (1) , 3 8 5 – 4 0 1 . doi: 10. 1207/s15326942dn2601_2

Spence, S. H. (1997). Structure of anxiety symptoms among children: A confirmatory factor-analytic study. *Journal of Abnormal Psychology, 106*(2), 280–297. doi: 10.1037/0021-843X.106.2.280

Spence, S. H. (1998). A measure of anxiety symptoms among children. *Behaviour Research and Therapy, 36*(5), 545–566

Spence, S. H., Rapee, R., McDonald, C., & Ingram, M. (2001). The structure of anxiety symptoms among preschoolers. *Behaviour Research and Therapy*, *39*(11), 1293-1316.

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences, 9*(2), 69–74. doi:10.1016/j.tics.2004.12.005

Susa, G., Pitica, I., Benga, O., & Miclea *M*. (2012). The self regulatory effect of attentional control in modulating the relationship between attentional biases toward threat and anxiety symptoms in children. *Cognition & Emotion*, *26*(6), 1069–1083. doi: 10.1080/02699931.2011.638910.

Tincas, I., Cheie, L., Mocan, O., Benga, O., & Visu-Petra, L. (in preparation). Validating the Revised Child Anxiety and Depression Scale on the Romanian population

Tincas, I., Dragos R., Ionescu, T., & Benga, O. (2007). Attentional set-shifting in preschoolers: Anxiety-related response patterns. *Cognition, Brain, Behavior, 3*, 553–570Tottenham, N., Borscheid, A., Ellertsen, K., Marcus, D. J., & Nelson, C. A. (2002). Categorization of facial expressions in children and adults: Establishing a larger stimulus set. *Journal of Cognitive Neuroscience*, *14*, S74

Varga, M., Visu-Petra, G., Miclea, M., & Visu-Petra, L. (2015). The “Good Cop, Bad Cop” Effect in the RT-Based Concealed Information Test: Exploring the Effect of Emotional Expressions Displayed by a Virtual Investigator. *PloS one*, *10*(2), e0116087. doi:10.1371/journal.pone.0116087.s001

Visu-Petra, L., Miclea, *M*., & Visu-Petra, G. (2012). Individual Differences in Anxiety and Executive Functioning: A Multidimensional View. *International Journal of Psychology, 48(4),* 1–11. doi: 10.1080/00207594.2012.656132

Visu-Petra, L., Stanciu, O., Benga, O., Miclea, M., & Cheie, L. (2014). Longitudinal and concurrent links between memory span, anxiety symptoms, and subsequent executive functioning in young children. *Frontiers in psychology*, *5*, 443. doi:10.3389/fpsyg.2014.00443

Visu-Petra, L., Ţincaş, I, Cheie, L., & Benga, O. (2010). Anxiety and visual-spatial memory updating in young children: An investigation using emotional facial expressions. *Cognition & Emotion [Special issue on Emotional states, attention, and working memory]*, In N. Derakshan, M.W. Eysenck (Eds.), *24*(2), 223–240. doi:10.1080/02699930903387546

Vuilleumier, P., Armony, J. L., Driver, J., Dola, R. J. (2001). Effects of attention and emotion on face processing in the human brain: an event-related fMRI study. *Neuron, 30*, 829–841. doi: 10.1016/S0896-6273(01)00328-2

Weissman, M. M., Wolk, S., Wickramaratne, P., Goldstein, R. B., Adams, P., Greenwald, S., Ryan, N. D., Dahl, R. E., & Steinberg, D. (1999). Children with prepubertal-onset major depressive disorder and anxiety grown up. *Archives of General Psychiatry, 56*, 794–801

Whitmer, A. J., & Banich, M. T. (2007). Inhibition versus switching deficits in different forms of rumination. *Psychological science*, *18*(6), 546-553. doi: 10.1111/j.1467 9280.2007.01936.x

Wild, B., Erb, M., & Bartels, M. (2001). Are emotions contagious? Evoked emotions while viewing emotionally expressive faces: quality, quantity, time course and gender differences. *Psychiatry research*, *102*(2), 109-124. doi:10.1016/S0165-1781(01)00225-6

Wilson, B. J. (2003). The role of attentional processes in children's prosocial behavior: Shifting attention and emotion. *Development and Psychopathology, 15,* 313–329

Wilson, B. J., Derryberry, D., & Kroeker, R. (2006). A computerized task for investigating the relation between attentional and emotional processes in children. *The Journal of genetic psychology*, *167*(4), 415-431

Wilson, B. J., Derryberry, D., & Kroeker, R. (2007). A computerized task for investigating the relation between attentional and emotional processes in children. *The Journal of Genetic Psychology*, *167*(4), 415-431. doi: 10.3200/GNTP.167.4

Wong, S. S., Jacques, S., & Zelazo, P. D. (2008). A preliminary investigation of the effects of emotional stimuli on 4-year old children's abstraction and cognitive flexibility on the flexible item selection task (FIST). *University of Toronto Journal of Undergraduate Life Sciences*, *2*(1), 34–42

Yerys, B. E., Wolff, B. C., Moody, E., Pennington, B. F., & Hepburn, S. L. (2012). Brief report: Impaired Flexible Item Selection Task (FIST) in school-age children with autism spectrum disorders. *Journal of autism and developmental disorders*, *42*(9), 2013-2020.doi:10.1007/s10803-012-1443-x

Zelazo, P. D. (2006). The Dimensional Change Card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols*, *1*(1), 297. doi: 10.1038/nprot.2006.46

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*, *6*(4), 354-360. doi: 10.1111/j.1750-8606.2012.00246.x

Zelazo, P. D., Craik, F. I. M., & Booth, L. (2004). Executive function across the life span. *Acta Psychologica*, *115*, 167–183. doi: 10.1016/j.actpsy.2003.12.005

Zelazo, P. D., & Müller, U. (2002). Executive function in typical and atypical development. doi: 10.1002/9780470996652.ch20

Zelazo, P. D., Müller, U., Frye, D., Marcovitch, S., Argitis, G., Boseovski, J., ... & Carlson, S. M. (2003). The development of executive function in early childhood. *Monographs of the society for research in child development*, i-151

Zelazo, P. D., Qu, L., & Kesek, A. C. (2010). Hot executive function: Emotion and the development of cognitive control. In S. D. Calkins & M. A. Bell (Eds.), *Child development at the intersection of emotion and cognition* (pp. 97-111). Washington, DC: American Psychological Association. doi: 10.1046/j.1467-8624.2003.00643.x

Zelazo, P. D., Qu, L., & Müller, U. (2005). Hot and cool aspects of executive function: Relations in early development. In W. Schneider, R. Schumann-Hengsteler & B. Sodian (Eds.), *Young children's cognitive development: Interrelationships among executive functioning, working memory, verbal ability, and theory of mind* (pp. 71-93). Mahwah, NJ: Erlbaum.