Dear future me: behavioral and neural mechanisms underlying self-concept development in relation to educational decision-making in adolescence

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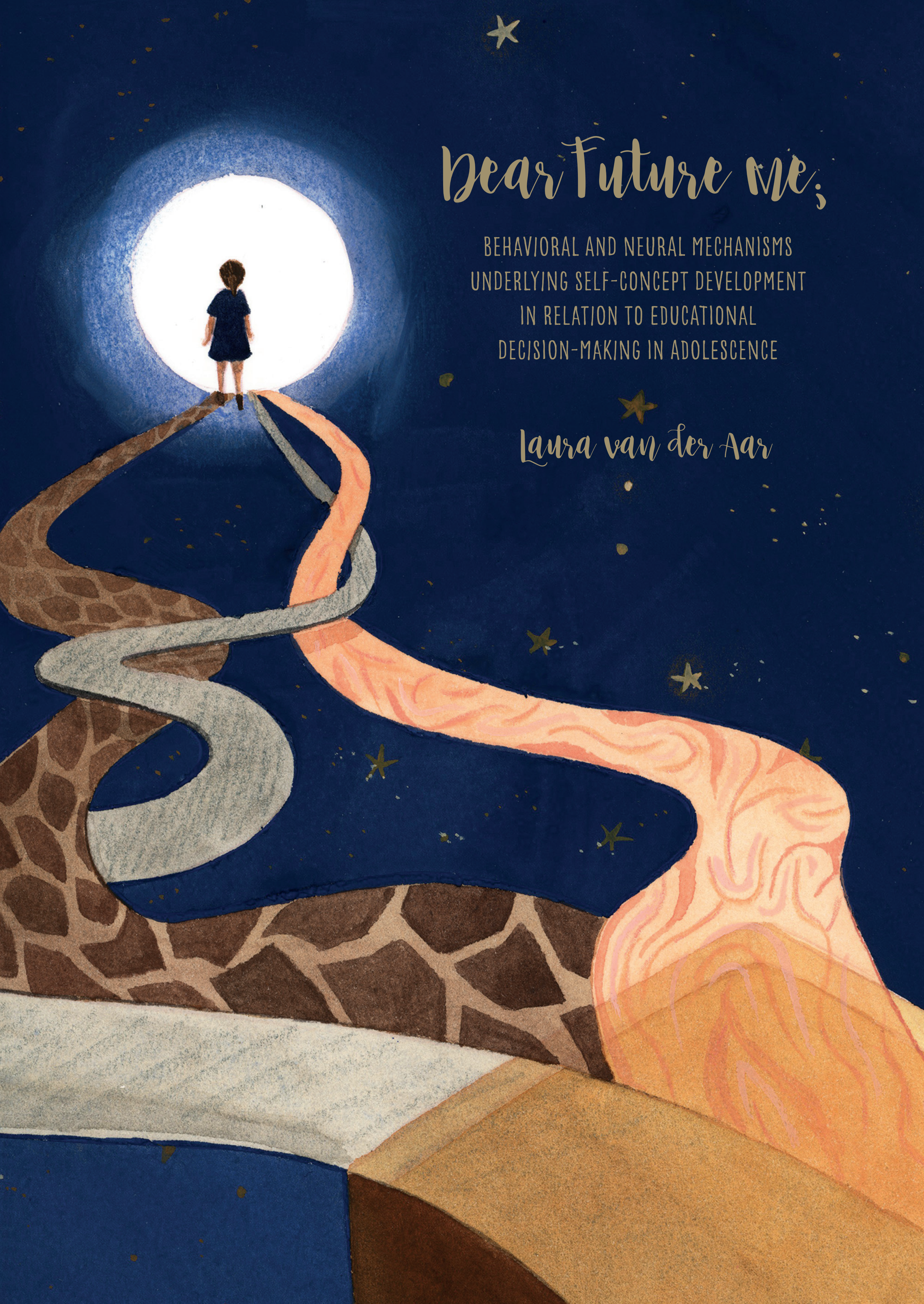

Dear Future me;

BEHAVIORAL AND NEURAL MECHANISMS UNDERLYING SELF-CONCEPT DEVELOPMENT IN RELATION TO EDUCATIONAL DECISION-MAKING IN ADOLESCENCE

Laura van der Aar

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Voor mijn ouders

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Op welk seizoen lijk jij het meest en waarom?
“De herfst. Alle bladeren verkleuren en worden anders,
net zoals ikzelf.”
Marjolein, 15 jaar

Chapter 1

GENERAL INTRODUCTION

This chapter is partly based on:
van der Aar, L.P.E., van der Cruijsen, R., & Crone, E.A. (2021). Hvem er jeg? Utvikling av selvbegrep i ungdomstiden [Who am I? Self-concept development in adolescence]. *In Nevrokognitiv utviklingspsykologi [Neurocognitive developmental psychology]* (Ed. Christian K. Tamnes). Gyldendal Akademisk. Oslo, Norway.

GENERAL INTRODUCTION

"Describe yourself in three words". You might recognize this as an assignment from school or a job interview at some point in your life. To describe yourself, it is necessary to reflect upon your traits, and ask yourself questions such as: "Who am I?" and "What am I good at?"

The way we view and evaluate ourselves, our self-concept, has been a topic of interest for centuries. This is not surprising as our self-concept has a large influence on the way we think, feel, behave, and make decisions in our daily lives (Orth, Robins, & Widaman, 2012). The outcomes of these decisions can have short-term effects. For example, I generally see myself as a social and outgoing person, so I would probably choose to take the invite for a party rather than staying in and reading a book. And although I would love to describe myself as adventurous, I know that I am not (excluding the one time I intentionally jumped out of a plane when I was 21). So when faced with the choice of a fun holiday, I would most likely take a safe city trip over a bold backpacking experience.

Not only does our self-concept have an influence on these short-term decisions, such as how to spend our evenings or holidays, it also serves as an important guide when it comes to making bigger decisions with more long-term consequences, for example when choosing which college to go to, what topic to study or career path to take (Fenning & May, 2013; Germeijs, Luyckx, Notelaers, Goossens, & Verschueren, 2012; Rogers & Creed, 2011). A developmental period during which many of these important life decisions are made is adolescence, the transitional phase between childhood and adulthood, roughly covering an age-range between 10 – 25 years (Crone & Dahl, 2012). Adolescence is widely regarded as a special time for self-exploration and identity development (Erikson, 1968). Compared to children, adolescents increasingly seek autonomy, experiment with different roles and selves, report greater self-consciousness, and become more concerned with opinions of others about the self (Pfeifer & Peake, 2012). This heightened focus on the self is stimulated by the school environment as well, as from a relatively young age adolescents are expected to make decisions regarding their academic future that require a significant amount of self-reflection (e.g. what courses should I choose in high school? What are my skills and interests and how can I align these with possible programs in higher education?)

However, making these future-oriented educational decisions can be complex, which is reflected in the large number of adolescents who experience difficulties when faced with the task to choose a suitable major in higher education (Dutch Ministry of Education, 2018). They delay the need to make a decision (e.g., by taking a gap year), do not make a decision at all (career indecision), or make the wrong decision and, as a result, may drop out from college. Because adolescence is particularly a phase in which the ability for self-reflection is still developing, how adolescents think about and evaluate themselves could play an important role in explaining individual differences in the process of future-oriented educational decision-making. Additionally, recent neuroimaging research indicates that developmental changes in self-concept might co-occur with changes in neuroanatomical development and functional brain activity in regions involved in self-processing (Burnett, Bird, Moll, Frith, & Blakemore, 2009; Pfeifer & Peake, 2012; Sebastian, Burnett, & Blakemore, 2008). Therefore, in this thesis I aim to investigate the development of self-concept during adolescence from both a behavioral and neuroscientific perspective. Within this topic, I particularly focus on the role of self-concept in the process of future-oriented educational decision-making in the transitional period from high school to higher education.

The current introduction starts out with a background of self-concept as a complex and multifaceted construct. This is followed by a section on factors influencing self-concept development during adolescence. Finally, I focus on the neural correlates of self-processing and highlight how measures of individual differences and training could contribute to a better understanding of the role of self-concept in the context of educational decision-making. I end the introduction with an outline of the empirical chapters.

What is self-concept?

Self-concept is defined as a person's self-perceptions which are formed through experiences with and interpretations of one's social environment (Shavelson, Hubner, & Stanton, 1976). As this definition underlines, self-concept development always occurs in interaction with the social environment, and one might argue that developing a sense of self is not possible in the absence of social contact. Therefore, self-concept is also often referred to as a "social construct" (Harter, 2012).

Self-concept is subjective, meaning that aspects of our self-concepts are based on our own impressions of ourselves (e.g. 'I am attractive') rather than objective facts (e.g. 'I have brown hair'). As self-concept is a subjective experience, it is often non-visible and can be difficult to measure. Researchers therefore investigate self-concept by asking people about their self-perceptions. These perceptions can describe how you see yourself, and how you think other people see you. They can take the form of, for example, character traits (e.g. being curious) or competencies (e.g. being good at math). It is notable that these descriptions are generally evaluative in nature; we view them as relatively positive or negative. Therefore, self-descriptions or perceptions can also be referred to as 'self-evaluations' and research often focuses on investigating the valence, or positivity, of the self-concept. This positivity can be examined by categorizing self-evaluations into certain domains (Marsh & Shavelson, 1985). For example, these domain-specific self-evaluations could refer to someone's abilities in a school context (academic self-concept), behavior in groups or social skills (social self-concept) or to an evaluation about one's appearance (physical self-concept).

Other than examining the valence of the self-concept on a domain-specific level, one could also investigate the overall evaluation of the self, better known as "self-esteem". Self-esteem is defined as an individual's general attitude towards the self and reflects the overall feeling of worth or value (Rosenberg, 1965). It is considered as the central evaluative component of the self and is regarded as a fundamental psychological construct (von Soest, Wichstrøm, & Kvalem, 2015). Although self-esteem is less concrete than the more domain-specific self-evaluations that make up the self-concept, it does interconnect with these self-evaluations. According to the competencies model by William James (1890), global self-esteem is based on people's own perceptions of their accomplishments in certain areas where they consider success to be important. For example, the math grades of someone who thinks math skills are very important to possess will influence their self-esteem to a greater extent than for someone who does not share these beliefs. The sociometer model of self-esteem, on the other hand, emphasizes the social nature of self-esteem (Leary, Tambor, Terdal, & Downs, 1995). It predicts that self-esteem is primarily rooted in our relationships with others. Therefore, it is expected that self-esteem would be most influenced by self-evaluations in domains of social relevance, such as feeling socially included. As beauty and attractiveness have a central focus in Western societies and have been linked to social acceptance, it is unsurprising that in many studies with different kinds of target groups the evaluation of one's physical appearance was found to be the strongest predictor for general self-esteem (Harter, 2012).

Both domain-specific self-evaluations and general self-esteem have been studied in relation to important psychosocial outcomes. Whereas self-esteem has often been related to mental health outcomes, such as positive relations with life satisfaction and negative relations with mental illnesses such as anxiety and depression (Orth et al., 2012; Steiger, Allemand, Robins, & Fend, 2014; von Soest et al., 2015), domain-specific self-evaluations have been linked to outcomes in more specific contexts. For example, there is a large body of research that has shown relations between academic self-concept and educational outcomes, such as students' school engagement and interests (Marsh & Martin, 2011), motivation (Valentine, Dubois, & Cooper, 2004) academic adjustment or wellbeing (Wouters, Germeijs, Colpin, & Verschueren, 2011), and school achievement or performance (Huang, 2011). However, the role of both academic self-concept and general self-esteem in the context of future-oriented educational decision-making remains less well understood.

In addition to examining the *valence* of the contents of self-concept on a domain-specific or global level, another way of studying the self is by investigating the *structure* of how these contents are organized, also referred to as self-concept clarity.

Self-concept clarity (SCC) is the extent to which beliefs about the self are clearly and confidently defined, stable over time, and internally consistent (Campbell, 1990). It can be viewed as a clear indication of self-certainty; the degree of confidence with which self-descriptions can be held. To date, research has linked SCC to a number of positive indices of psychosocial adjustment such as mental health, relationships with parents and peers, and commitment-making (Schwartz, Klimstra, Luyckx, Hale, & Meeus, 2012; Van Dijk et al., 2013). SCC has also often been associated with self-esteem. That is, individuals with higher self-esteem also tend to be more consistent in their self-ratings and hold their self-views with more confidence (Story, 2004). Although there seems to be a large overlap between self-esteem and SCC, recent research suggests that both constructs can have unique associations with future adjustment (Findley & Ojanen, 2013). However, studies investigating both constructs in relation to educational outcomes are limited.

In this thesis, I focus on examining both the valence of the self-concept (on a domain-specific and global level) as well as the structure of the self (concerning self-certainty and self-concept clarity) during the developmental phase in which the sense of self changes profoundly: the period of adolescence.

Factors influencing self-concept development during adolescence

Many people are preoccupied with the fundamental question “Who am I?”. The idea of being ‘someone’, the concept of having a ‘self’, develops very early on in life. Around the age of eighteen months, babies can already start to recognize themselves in the mirror. When children are around three years old, they start to understand that what they want can differ from what somebody else wants (Harrigan, Hacquard, & Lidz, 2018). Yet, the self-concept in all its complexity does not fully unfold until adolescence. Not only do adolescents acquire more complex cognitive abilities that allow for more abstract perspectives of the self (Elkind, 1967; Selman, 1980), they also become increasingly sensitive to the peer context and show greater interest in the opinions of others about the self (Gunther Moor, van Leijenhorst, Rombouts, Crone, & Van der Molen, 2010; Nelson, Leibenluft, McClure, & Pine, 2005; Pfeifer & Peake, 2012). In this section, I will discuss two important aspects that characterize the changes that occur in the way adolescents view themselves: increases in self-concept complexity and social influences.

Self-concept becomes more complex

From the onset of adolescence, teenagers start evaluating themselves in more refined and diverse ways. Adolescents will also describe themselves in increasingly complex and abstract terms. Before the onset of adolescence, children still use very basic descriptions of themselves, often in terms of general group memberships, such as ‘I’m six years old' and 'I'm a girl'. Or they make use of labels instead of trait characteristics. For example, they might use sentences like "being good at 'running', 'jumping' or 'climbing". However, due to an increase in cognitive abilities, adolescents are able to make higher-order abstractions that integrate these labels into one trait: being athletic. Adolescents are also increasingly capable of describing their own strengths and weaknesses such as 'I'm good at swimming, but not good at drawing'. They, to a larger degree than children, additionally describe themselves according to how they think other people see them (e.g. 'I am a nice person, because I often babysit'). The factor driving this development is an increase in the ability to take the perspective of others. Perspective-taking allows adolescents to integrate perspectives of others in their perspective of the self (Pfeifer et al., 2009; Sebastian et al., 2008; Selman, 1980) and gives rise to a more all-round self-concept.

Another important development during adolescence that stimulates an increasingly versatile self-concept is related to the increasing set of social contexts adolescents find themselves in. They are not only at home with their parents anymore, but have to be in school, spend time with friends, maybe get a first part-time job, or start to develop romantic relationships. All these different contexts require different roles and behaviors, and thus different selves. Consequently, adolescents may view themselves differently in school (being a student), at home (being a child) or with peers (being a friend). Studies that have investigated this topic indeed found that self-concept becomes increasingly multidimensional with age, with more differentiated self-evaluations across social contexts and domains (Marsh & Ayotte, 2003).

Although the increase in differentiation facilitates a more complex self-concept, this development can at the same time be a cause of confusion, as adolescents are also becoming more aware of the possibility of having several conflicting personality traits (e.g. being outspoken with a best friend but quiet at home). Even though the identification of having different, potentially opposing traits can be contradicting and conflicting at first, adolescents gradually learn to integrate these separate traits into a higher order self-concept (e.g. being shy and cheerful can be integrated to being adaptive) and they can understand that it is okay to be slightly different versions of themselves in different contexts (Harter, Bresnick, Bouchey, & Whitesell, 1997; Harter & Monsour, 1992). The fact that young people are able to indicate whether their traits depend on a certain social situation or on who is describing them, shows that they have started to think about who they are in a differentiated way.

Influence of the social environment on self-concept

As stated earlier, self-concept cannot be seen or formed without an important role for the social environment. This environment can take many different forms, and the ways the environment is used to gain more knowledge about the self also change during adolescence.

First, the influence of the social environment can be expressed in the *feedback* we get from others. This can happen both directly (e.g. in a conversation) and indirectly (e.g. how we think others perceive us). This indirect form of self-perception is also called 'reflected self-concept' (Pfeifer & Peake, 2012). When we are still young, most of the feedback we receive about ourselves comes from our parents and is generally very positive. When we get older, the school context starts to play a larger role as an environmental factor influencing how we view ourselves. For the academic domain specifically, the feedback you get from your teacher or the grades that you receive can give you an indication of your academic skills. In addition, the transition into adolescence is marked by a shift in social focus towards the peer group (Nelson et al., 2005). Not only do adolescents spend more time with peers, they also show a greater interest in the perceived opinions of their peers and start to use their feedback as an important source for self-evaluation (Sebastian et al., 2008). Finally, an important but more indirect form of environmental feedback comes from norms and values in the society we live in. Think back about the babysitting example, where the societal norm is used that it is good to take care of someone else leading to the conclusion that you are a nice person.

A second way of how the environment can serve as a mechanism for self-evaluation is by using it as a reference point to compare oneself to, also known as *social comparison*. Although young children often base their self-concept on changes in their performance or behavior over time (also known as temporal comparisons, e.g. 'I am good at drawing because I am better than I was last year'), they increasingly use cues from the social environment as a means of self-evaluation as they grow into adolescents (e.g. 'I am good at drawing because I am better than my classmates'; Dijkstra, Kuyper, van der Werf, Buunk, & van der Zee, 2008; Harter, 2012). These social comparisons have been found to be an important method to gain more information about one's abilities and characteristics, and as a result develop a more accurate self-concept (Festinger, 1954). However, it remains difficult to disentangle the specific influence of these social comparisons on the development of self-views across adolescence. Moreover, it is still unclear whether social comparisons impact self-evaluations in different domains in similar or distinctive ways. Therefore, an important first aim of this thesis was to test the influence of the social environment within the development of an increasingly complex self-concept during adolescence by using a novel experimental paradigm **(chapter 2).**

Finally, an important factor influencing the development of self-concept concerns the *school environment*. Research has shown that the period surrounding school transitions can especially impact adolescents' self-concept, as these transitions coincide with the need to adapt to a new school system, new obligations, teachers, classmates, and peers (Cole et al., 2001). Subsequently, these changes can temporarily negatively influence the positivity of the self, for example in academic and social domains.

However, not only is the school context full of possibilities to gain more information about the *current* self, it also stimulates adolescents to start to think about their *future* selves. During high school, adolescents face all sorts of choices; from deciding about which graduation subjects to choose, to what major to pursue after high school– a choice that will strongly affect their future career options (Rogers & Creed, 2011). In order to make these decisions successfully, having positive and clear self-perceptions could help adolescents in directing them towards a future choice that fits their personality, interests and skills. As a second aim, I investigate this topic by focusing on how multiple aspects of self-concept can relate to successful future-oriented educational decision-making, and how they can help to explain individual differences in this process. Here, I combine behavioral self-report and experimental measures with neuroimaging techniques to increase our understanding of the underlying neural processes of self-concept in this relationship **(chapter 3 – 5).**

Neural correlates of self-concept

For a long time, it was thought that it would not be possible to retrace something as complex as self-concept to the brain, that is, to identify the neural basis of the self. With the advances in brain imaging techniques, such as functional magnetic resonance imaging (fMRI), it has become possible to examine which brain regions are engaged during rest or when performing a certain task. The use of fMRI can be especially helpful to study the self, as self-concept is not directly observable and self-report may be sensitive to response-bias. Neuroimaging is therefore a useful method for gaining insight in the processes underlying self-reflection.

To date, research examining the neural underpinnings of self-concept has mostly been focused on adults, although more recent studies included adolescents as well. In these studies, self-concept is generally examined by asking participants lying in the MRI scanner whether or not or to what extent a number of trait-adjectives (e.g. 'I am funny') apply to them. Brain activation during the evaluation of these self-referential stimuli is then compared to activation during non-self-referential tasks (e.g. thinking about the traits of other people, or the desirability, malleability or categorization of traits). This allows researchers to closely examine the degree to which activation in these brain regions is associated with thinking about the self, relative to thinking about character traits in general. This body of literature has consistently shown that there is a network of specific brain regions, spanning from the medial prefrontal cortex (mPFC), anterior cingulate cortex (ACC) to posterior cingulate cortex (PCC) and precuneus, that appears to mediate self-referential thoughts (see **Figure 1**; for comprehensive reviews and meta-analyses see Denny, Kober, Wager, & Ochsner, 2012; Murray, Schaer, & Debbané, 2012; Northoff et al., 2006). As these regions are located in the middle of the human cerebral cortex, they are often referred to as cortical midline structures

(CMS; Northoff & Bermpohl, 2004). Self-processing does not solely engage the CMS, but also regions involved in perspective-taking, such as the temporo-parietal junction (TPJ; Saxe & Kanwisher, 2003), striatal regions responsive to salience and reward processing (Jankowski, Moore, Merchant, Kahn, & Pfeifer, 2014; Somerville et al., 2013), and the hippocampus, involved in memory retrieval (Pauly, Finkelmeyer, Schneider, & Habel, 2013).

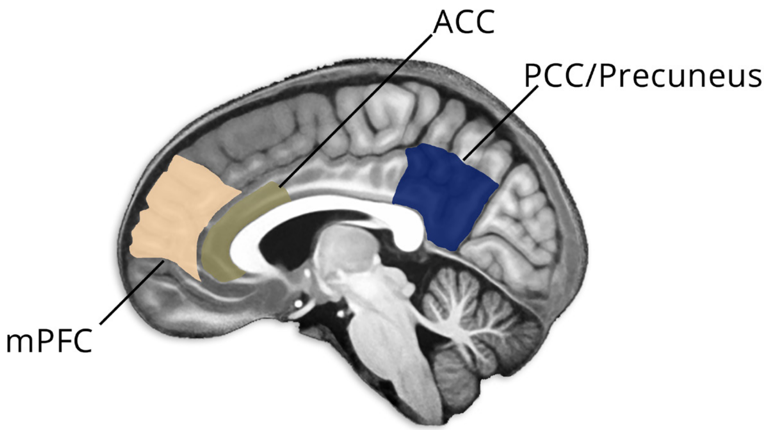

Figure 1. Cortical Midline *Structures (CMS) implicated in self-referential processing. mPFC = medial prefrontal cortex; ACC = anterior cingulate cortex; PCC = posterior cingulate cortex.*

Interestingly, the network recruited during self-referential thought shows a large overlap with brain regions involved in social cognition, also known as the social brain network (Blakemore, 2008). The idea that thinking about or evaluating the self is inherently social (we think about ourselves within a social context; we compare ourselves to others, or ponder over how others view us) is thus also reflected in the brain. Within this network of brain regions involved in self-processing as well as social cognition, there has been an especially great interest in the mPFC, which has been shown to play a key role in the process of mentalizing (attributing mental states to self and others), and is viewed as the core region regarding self-reflective processing (Lieberman, Straccia, Meyer, Du, & Tan, 2019). As the mPFC comprises a large area of cortex, covering multiple Brodmann Areas, researchers have sought for a degree of specialization within the mPFC. That is, whether certain sub regions of the mPFC could be more responsive to thinking about the self versus others, or for thinking about the self from different reflective or temporal perspectives. These studies have suggested that mPFC activity is modulated by self-relevance (Moran, Macrae, Heatherton, Wyland, & Kelley, 2006). For example, thinking about the self and close others (such as one's mother, or close friends) engages a more ventral part of the medial prefrontal cortex (vmPFC), whereas thinking about distant or public others involves a more dorsal part of the medial prefrontal cortex (dmPFC). According to the valuation hypothesis, the vmPFC is associated with affective and motivational processes and may therefore encode the personal significance or value of self-related contents (D'Argembeau, 2013). Interestingly, vmPFC activation during self-processing is often confounded with emotional valence. That is, the vmPFC is often more active for the evaluation of positive traits specifically, as this could reflect the tendency of people to view positive traits as more self-descriptive and therefore more self-relevant (Pauly et al., 2013). With regard to perspective-taking, research has shown that the mPFC responds to self-evaluations from both direct (am I smart?) and reflective perspectives (do my peers think I am smart?), as well as self-evaluations from different temporal perspectives (e.g. thinking about past, present, and future selves) (Packer & Cunningham, 2009; Pfeifer & Peake, 2012). However, the (v)mPFC showed the highest activation for task perspectives most relevant to the self (e.g. thinking about the present self, or from a direct perspective), again demonstrating a sensitivity to the degree of self-relatedness (D'Argembeau et al., 2010).

Although the mPFC has been found to be involved in the processing of a variety of self-related information, it has been questioned whether other regions of the CMS or social brain would differentiate more in responding to trait-evaluations from different domains. This could be especially relevant as earlier studies have shown that self-concept becomes increasingly domain-specific with increasing age (Harter et al., 1997; Marsh & Ayotte, 2003). Recent studies have indicated that, indeed, there are dissociable neural patterns mediating domain-specific self-reflection. For example, in both adults and adolescents it has been found that evaluating social traits specifically activates brain regions that are part of the social brain network, such as the TPJ (Jankowski et al., 2014; van der Cruijsen, Peters, & Crone, 2017). In addition, the evaluation of more 'external', physical traits recruits a large region of both mPFC and PCC, often implicated in autobiographical memory, whereas the evaluation of academic or competence traits is more specifically associated with PCC and precuneus activation (Ma, Wang, Yang, Feng, & Van Overwalle, 2016; van der Cruijsen et al., 2017). Together, these studies suggest there are partly overlapping, and partly separable brain networks involved in the evaluation of self-traits in different domains. Understanding more about the neural underpinnings of domain-specific self-concept, especially the academic domain, could provide additional information in relation with educational outcomes. Yet crucially, the role of the neural correlates of domain-specific self-evaluation in future-oriented educational decision-making remains unexplored.

Individual differences and training in adolescence

It is important to note that the neuroimaging studies described here have generally relied on group analyses to examine common activation during self-processing across subjects. Although examination on a group level allows for statistical benefits to robustly detect general patterns of activity for certain self-related tasks, it is less attentive to individual differences between subjects that could possibly modulate neural responses during self-processing (Dubois & Adolphs, 2016). For example, individuals with different levels of self-positivity or clarity of the self-concept might recruit brain regions during self-evaluation to a different extent. As during adolescence the self-concept becomes more complex and differentiated, differences between individuals can become more pronounced. Therefore, in addition to examining the neural correlates of adolescents' self-concept on a group level, I also adopt a complementary approach of including individual differences in behavioral measures of valence (e.g. self-esteem or domain-specific positivity) and structure (self-concept clarity) of the self to uncover brain regions whose activity covaries with these measures. This method could be especially helpful in relation to the process of successful future-oriented educational decision-making, as it can give insight in possible differences in neural mechanisms underlying self-processing in individuals who do or do not experience difficulties matching their self-views to suitable programs in higher education.

Finally, although studies have indicated that adolescents recruit a similar neural network for self-processing as adults, with a strong involvement of the mPFC (Pfeifer & Peake, 2012; Sebastian et al., 2008), it is not yet understood how these regions are sensitive to changes in self-concept over time. These changes can be related to normative self-concept development. However, within the context of adolescents struggling with educational decision-making, a more interesting question would be whether *actively stimulating* self-development could have beneficial effects for the positivity and clarity of self-perceptions, and additionally, how these changes are reflected in the brain. As adolescence is particularly a period where both self-concept and the brain are highly susceptible to environmental influences, this can have considerable implications for treatment and intervention (Jolles & Crone, 2012). Consequently, creating positive circumstances for optimal self-concept development could have significant beneficial outcomes, especially during this sensitive developmental period. Therefore, I examine whether during (late) adolescence, self-concept can be fostered through training and which underlying neural mechanisms would drive these changes. And, most importantly, I test whether improvements in self-concept could in the end be predictive of better suited educational choices.

Outline of this thesis

In this thesis, I report the results of four empirical studies that I have conducted to investigate the development of self-concept during adolescence with a specific focus on the role of self-concept in the process of future-oriented educational decision-making. All studies are part of "The Leiden Self-concept Project". The main aim of this project was to longitudinally examine behavioral and neural correlates of self-concept development in typically – and atypically developing adolescents. The project consists of multiple samples, including a cross-sectional behavioral sample (*N* = 202, 9 – 25 years, 1 time point, behavioral measures), an adolescent sample (*N* = 160, 11 – 21 years, 3 time points, fMRI and behavioral measures), and a sample of adolescents/young adults who all experienced difficulties with future-oriented educational decision-making (*N* = 38, 16 – 24 years, 4 time points, fMRI and behavioral measures). The latter sample was recruited in collaboration with Foundation Gap Year (Dutch: Breekjaar), an organization in the Netherlands that provides self-concept training programs for adolescents who have dropped out of higher education and experience difficulties with making suitable academic and career choices. Studies with the longitudinal adolescent sample and Gap Year sample have been pre-registered on https://osf.io/8mspn/. In all studies reported here, a similar self-concept task was used (inside or outside the MRI scanner) where adolescents were asked about their evaluation of self-traits in different domains, and from different perspectives. Together, with these studies I aim to (1) shed light on the behavioral development of domain-specific self-concept across adolescence and its interaction with the social environment, and (2) investigate the role of various aspects of self-concept and its neural mechanisms in the context of future-oriented educational decision-making.

In **chapter 2** I present a new paradigm to examine the development of self-evaluations in different domains across adolescence, and to experimentally test how the development of these self-evaluations is altered by an explicit social comparison context. First, participants (*N* = 202, 9 – 25 years) were asked to evaluate themselves on trait-adjectives in academic, social, and physical domains, and to rate the certainty of their self-evaluations and subjective importance of possession of the traits. Second, participants were again presented with the same trait-adjectives but were now asked to evaluate themselves compared to an unknown peer. This shift in social context allowed me to disentangle the specific influence of social comparison outcomes within developmental patterns of self-evaluation.

Chapters 3 – 5 focus on the role of behavioral and neural indices of adolescents' self-concept in relation to educational decision-making. In **chapter 3**, I start out by examining the role of behavioral and neural indices of *academic* self-concept specifically, in relation to the orientation process leading up to the decision for a future study or career. For this purpose, I included a subsample of adolescents who were in the final years of high school (N = 48, 14 - 20 years). In addition to academic self-concept measures, I also tested whether other academic variables, such as academic performance and the subjective importance of academic traits, would relate in a similar or different way to the orientation process. This way, I aimed to investigate to what extent academic self-concept could be unique in its relation with future-oriented educational decision-making.

In **chapter 4**, I move from the general population to a specific sample of adolescents who all experience clear difficulties with future-oriented educational decision-making. That is, they started a major but dropped out of higher education or remained undecided after high school. This sample was recruited in collaboration with Foundation Gap Year. I focus on what characterizes these individuals (N = 38, 16 – 24 years) in terms of self-concept by comparing their self-esteem, self-concept clarity, and domain-specific self-evaluations to those of adolescents who already successfully transitioned into higher education (N = 46, 17 – 21 years). In addition, I examine group differences on a neural level and test whether brain activity during self-processing could be dependent upon individual differences in self-esteem and self-concept clarity.

In **chapter 5**, I follow the same adolescents who struggled with educational decision-making in chapter 4 throughout a naturalistic self-concept training program within a gap year context. Across three time points during this gap year (each 5 months apart), I investigate whether different aspects of their self-concept could be improved by training and examine the specific trajectories of these changes. In addition, I examine changes in the neural circuitry associated with self-processing and test whether these neural changes are related to co-occurring improvements in self-positivity. Lastly, I assess whether individual differences in self-concept changes during the gap year could be predictive of positive outcomes related to educational decision-making and indices of successful adjustment on a follow-up measurement 6 months later.

Finally, in **chapter 6** I summarize and discuss the findings of the empirical studies presented in this thesis and provide an overview of the implications of these results.


Wat zou je tegen je 2 jaar jongere zelf willen zeggen?
"KIJK NIET ZOVEEL NAAR ANDEREN, JE KOMT ER WEL." ☺
Julia, 17 jaar

Chapter 2

THE DEVELOPMENT OF SELF-VIEWS ACROSS ADOLESCENCE: INVESTIGATING SELF-DESCRIPTIONS WITH AND WITHOUT SOCIAL COMPARISON USING A NOVEL EXPERIMENTAL PARADIGM

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ABSTRACT

Adolescence has been described as a unique period for self-concept development, with an intensified alertness to social comparison as a mechanism for self-knowledge and self-evaluation. However, it remains difficult to disentangle the specific influence of these social comparisons on the development of self-descriptions in adolescence. Moreover, it is still unclear how social comparisons impact upon the development of self-views in different domains, such as physical, academic and social self-views. The goal of this study was therefore to examine the development of self-descriptions in different domains across adolescence, and to experimentally test how the development of these self-descriptions is altered by an explicit social comparison context. For this purpose, we developed two tasks which both asked participants (aged 9-25-years, N=202) for trait self-descriptions but differed in the salience of a social comparison. Results showed consistent age-differences with more positive self-views for children and adolescents in the age-range 9 – 14 years. The context of explicit social comparison yielded similar as well as additional age-differences that were more dependent upon valence and domain. Moreover, mid-adolescents (15-17 y) were most negatively affected by these social comparisons relative to other ages. Together, this study made a first step in disentangling the specific influence of social comparison outcomes within the development of general self-descriptions, and highlights the importance of social context in studying self-concept in adolescence.

INTRODUCTION

Adolescence can be described as a unique period in life marked by increases in self-exploration, which is accompanied by changes in the way adolescents view themselves (Erikson, 1968). It is thought that both cognitive and social influences may underlie these developmental changes in self-views. For example, prior research has demonstrated an increase in cognitive abilities, which allows for more abstract perspectives of the self (Selman, 1980; Elkind, 1967), that become more differentiated across different social contexts and domains (Harter, 2012). At the same time, the transition into adolescence highlights an important period of "social reorientation", indicating that adolescents become increasingly sensitive to their peer context (Moor, van Leijenhorst, Rombouts, Crone, & Van der Molen, 2010; Nelson, Leibenluft, McClure, & Pine, 2005; Pfeifer & Peake, 2012). They spend more time with peers, the feedback of peers becomes increasingly important, and peers also start to play a central part in the ability to shape self-views by the use of social comparisons (Sebastian, Burnett, & Blakemore, 2008). However, it remains difficult to disentangle the specific influence of these social comparisons on the development of self-descriptions in adolescence. Moreover, it is still unclear how social comparisons impact upon the development of self-views in different domains, such as physical, academic and social self-views. This study aims to examine the development of self-descriptions in different domains across adolescence, and to experimentally test how the development of these self-descriptions is altered by an explicit social comparison context.

Development of self-descriptions across domains

Self-views can be manifested as global self-esteem as well as domain specific self-concepts. Where global self-esteem refers to a more general evaluation of self-worth as a person, domain specific self-concepts point towards more distinct beliefs and evaluations about traits and competencies in different domains (Harter, 2012). For example, these domain-specific self-descriptions could refer to someone's abilities in a school context (academic self-concept), behavior in groups or social skills (social self-concept) or to an evaluation about one's appearance (physical self-concept). Research has suggested that self-descriptions become increasingly domain-specific with increasing age, with more differentiated self-evaluations for social, physical and academic domains (Marsh & Ayotte, 2003). This differentiation could also be related to the increasing set of social contexts adolescents find themselves in. They may view themselves differently in school (being a student), at home (being a child) or with peers (being a friend). Studies investigating the development of self-evaluations within these different domains across adolescence have yielded mixed results. For example, it appears that the academic domain is most sensitive to the period of school transition, when the positivity of self-descriptions in this domain shows a temporary dip in early adolescence (Cole et al., 2001; Eccles et al., 1993; Schaffhuser, Allemand, & Schwarz, 2017). However, other studies found this decrease extended even into the end of high school (Fraine, Damme, & Onghena, 2007; Shapka & Keating, 2005; van der Cruijsen, Peters, van der Aar, & Crone, 2018), or on the contrary, showed steady increases in the academic domain over the course of adolescence (Bolognini, Plancherel, Bettschart, & Halfon, 1996; Kuzucu, Bontempo, Hofer, Stallings, & Piccinin, 2014). With regard to the social domain, studies have shown that the positivity of self-descriptions in this domain could be temporarily negatively influenced by school transitions as well, as this marks a social challenge of adapting to a new environment with the corresponding new friends, classmates, and teachers (Cole et al., 2001). Finally, research has produced quite consistent results with regard to the development of self-views in the physical domain during adolescence. Here, influences of biological factors, such as the start of puberty with the associated bodily changes, have shown to negatively impact descriptions related to physical appearance, and this decrease persists across adolescence (Kuzucu et al., 2014; Schaffhuser et al., 2017).

Interestingly, and although most measures of self-concept contain positive as well as negative self-descriptions, studies have generally only examined these as mean scores, as if they would be part of one single dimension with one negative and one positive end (see for example studies that have made use of the Self Perception Profile by Harter (1985, 1988) such as Cole et al., 2001 and Schaffhuser et al., 2017). However, these two valences are not polar opposites, in which the presence of one implies absence of the other (Bukowski, Laursen, & Rubin, 2018). Namely, one could maintain positive as well as negative self-views within the same domain at the same time. For example, someone could think he/she gets good grades (academic positive), but still feel they need help in school (academic negative). Averaging these scores into an essentially neutral mean score can result in missing out on important nuances between the two valences. Therefore in this study we chose to examine this evaluative concept of the self as a two-dimensional structure, and analyzed domain and age-related differences of self-descriptions separately per valence.

Influence of social comparison on self-views

Within the development of more differentiated self-descriptions during adolescence, the sources of information used to gain more knowledge about the self undergo changes as well. Where young children often base their self-concept on increases or decreases in their performance or behavior over time (e.g. 'I am good at math because I am better than I was last year'), they start to rely more on feedback from the social environment as a means of self-evaluation as they grow into adolescents (Dijkstra, Kuyper, van der

Werf, Buunk, & van der Zee, 2008; Harter, 2012; Pfeifer & Peake, 2012). One way to use the social environment as a mechanism for self-evaluation is by comparing oneself to others. These social comparisons have been found to be a key way to evaluate one's abilities and characteristics, and to gain a more accurate self-concept (Festinger, 1954). Social comparisons have been examined in very different and diverse ways; varying in topic, measurement, and target (for a meta-analysis, see Gerber, Wheeler, & Suls, 2017). For example, studies have looked at comparisons with population norms, (online) media characters as well as direct peers. These measurements can be explicit (such as self-report) or implicit (inferred by experimental manipulation) and have been associated with self-evaluations in various topics such as body image (Myers & Crowther, 2009), school performance (Dijkstra et al., 2008), and self-esteem (Vogel et al., 2014).

With regard to specific domains of self-evaluation, research has generally focused on investigating the influence of social comparison in one domain at a time. For example, many studies have examined the effects of appearance-focused social comparisons on body-image or body dissatisfaction. These often included comparisons with images of fashion models on TV or in magazines, but increasingly focus on online comparisons with peers as well as celebrities on social network sites such as Facebook and Instagram (Brown & Tiggemann, 2016; Fardouly, Diedrichs, Vartanian, & Halliwell, 2015). Social comparisons have also been a topic of research in the domain of academic self-concept, as the classroom provides an extensive environment to compare oneself to the abilities of other classmates (Dijkstra et al., 2008).

Studies that examined the use of social comparison in childhood and adolescence have shown that children's self-evaluations are still little affected by social comparisons until the age of 8 (Cremeens, Eiser, & Blades, 2007; Ruble, Boggiano, Feldman, & Loebl, 1980). This changes as children enter adolescence, and make the transition into secondary school. Here, the use of social comparisons as a pervasive data source for assessing one's abilities and characteristics increases, and adolescents are more prone to build their self-concept upon the outcome of these comparisons (Harter, 2012). By the age of 9 and 10 years, around 40 % of children use social comparison information as a source for self-evaluation and this keeps increasing to around 80 % of 13 and 14 year olds (Dijkstra et al., 2008; Keil, McClintock, Kramer, & Platow, 1990).

The current study

Together, adolescence can be described as a unique period, with an intensified alertness to social comparison as a mechanism for self-knowledge and self-evaluation. To date however, even though prior studies have investigated developmental patterns in self-descriptions across domains, there is still little understanding of how these self-descriptions are altered by a social comparison context. A study comparing self-views with and without an explicit social context, focusing on how they interact across domains, valences and different ages in adolescence is still lacking. The goal of this study was therefore to compare self-descriptions with and without an explicit social comparison context, as well as age-related changes across adolescence and differences within domains and valence.

We focused on two main aims. First, we aimed to investigate the development of self-descriptions in a task without an explicit social comparison (termed 'Self-Attribution task' in this paper) in four age groups: late childhood (9 – 11 years), early adolescents (12 – 14 years), mid adolescents (15 – 17 years) and young adults (18 – 25 years), and across three domains (academic, social, and physical appearance). For this task, participants were asked to make judgements about how different trait adjectives applied to themselves. We expected more positive self-descriptions for the youngest age group, and greater variability across domains with increasing age, as an indication of a more fully differentiated self (Cole et al., 2001; Kuzucu et al., 2014; Marsh & Ayotte, 2003; Shapka & Keating, 2005).

Second, we aimed to experimentally test for developmental differences of self-descriptions within an explicit social-comparison context. For this purpose, participants completed a second self-other attribution task (termed 'Self-Other Attribution task' in this paper). This task consisted of different trait-adjectives and asked participants to judge based on first impression if they thought the trait would better fit themselves or an image of an unfamiliar peer in their age group. Adolescents have been found to become increasingly sensitive to the social peer context, which has often been associated with a decrease in self-evaluation (Dijkstra et al., 2008; Sebastian et al., 2008; Wehrens et al., 2010). Therefore, we predicted more pronounced developmental differences in this Self-Other Attribution task compared to the Self-Attribution task, with lower positive self-attributions in the early and middle adolescent age group.

In addition, we explored three supplementary aims related to individual differences in self-descriptions. First, we investigated the contributions of ratings of certainty and importance of self-descriptions. Earlier studies in adults have shown that people differ in the degree of confidence with which self-descriptions are held as well as the value they place upon these self-descriptions (D'Argembeau et al., 2012; Pelham, 1991). Investigating these two additional forms of investments in self-views may be especially relevant from a developmental perspective, as adolescence is a key period for exploring change and stability patterns in self-concept (Van Dijk et al., 2014). For example, possessing positive traits in the social domain might become more important during adolescence, as this could reflect the increased value of fitting in with the peer group in this period of social re-orientation.

Finally, we included gender in our analyses of self-descriptions, as gender has been found to be an essential variable when studying self-concept. A large body of research has focused on gender differences in general self-esteem, as well as domain specific self-perceptions (for reviews, see Gentile et al., 2009; Zuckerman, Li, & Hall, 2016). These studies have generally shown a small advantage for boys in general self-esteem, and in the domains of physical appearance and athletics. Girls tend to show more positive self-perceptions in the domain of behavioral conduct (i.e. viewing one's behavior as appropriate). It is unclear however, how these gender differences in domain specific self-descriptions hold in the context of a social comparison.

METHOD

Participants

The sample consisted of 202 participants, aged 9 – 25. They were evenly distributed over four continuous age groups: late childhood (9 – 11 years; M_{age} = 10.52; SD_{age} = .14; N = 54; 25 males; 29 females), early adolescents (12 – 14 years; M_{age} = 13.09; SD_{age} = .17; N = 34; 20 males; 14 females), mid adolescents (15 – 17 years; M_{age} = 16.00; SD_{age} = .14; N = 57; 21 males; 36 females) and young adults (18 – 25 years; M_{age} = 21.09; SD_{age} = .14; N = 57; 25 males; 32 females). A χ^2-test indicated no significant sex differences between age groups (χ^2 (3, N(202) = 4.23, p = .24). The background of the sample was 95,5 % Dutch, 1,5% Moroccan and 3% classified as "Other". Around 43 % of the participants reported that one or two parents were born outside of the Netherlands (mainly Morocco and Turkey). Participants were recruited from two primary schools (late childhood and early adolescents), and two secondary schools (early, and mid adolescents) in Leiden and Rotterdam, the Netherlands. Secondary schools included a variety of academic levels. The group of young adults was recruited through our own network. These participants were students at different educational institutions also including a variety of academic levels in the Netherlands. We excluded psychology students, as they may be familiar with the measurements. Written informed consent forms were provided by the participants themselves or by a parent for minors. The study and its procedures were approved by the Leiden University Ethics Committee.

Experimental Tasks

We designed two experimental tasks that investigated self-descriptions with and without an explicit social context (Self-Attribution task and Self-Other Attribution task). In both tasks, participants were presented with adjectives that described traits or competencies in the domains of academics (e.g. 'intelligent' or 'unmotivated'), social skills (e.g. 'friendly' or 'jealous') and physical appearance (e.g. 'attractive' or 'skinny'). A total of 90 adjectives were selected from a merged list, containing 240 trait adjectives developed by Anderson (1968). The stimuli have been translated into Dutch and checked for frequency of occurrence in the Dutch language, according to a database containing 44 million words from film and television subtitles (Keuleers, Brysbaert, & New, 2010). In order to determine how traits were generally perceived, we used the desirability scores of a French study of D'Argembeau et al., (2012). These scores ranged from 1 – 7. We selected traits that were generally perceived as highly desirable (M = 5,5) or not very desirable (M = 2,7) and labeled them as 'positive' or 'negative'. A paired t-test indicated a significant difference between these scores (t(21)= 13,75, $p < .001$). In addition, we asked a focus group of 8 students to categorize the traits as positive or negative as well. Finally, we equally divided the traits perceived as positive and negative over the domains. In total, each domain consisted of 30 stimuli, half with positive valence and half with a negative valence. Even though prior studies did not consistently distinguish between valences, we explored possible valence differences and domain x valence interactions in this study. Cronbach's alpha's for all domains ranged between .60 and .85 with an average of .75. Stimuli were presented electronically using the E-prime 2.0 software (Psychology Software Tools, Pittsburgh, PA).

Self-Attribution Task: For the Self-Attribution task, participants were asked to make three kinds of judgments for each trait using a Likert-type 4-point rating scale (1 = not at all, to 4 = completely): 1) self-descriptiveness (i.e., 'to what extent does this trait describe you?') and 2) certainty in the self-view (i.e., 'how certain are you of your answer?') To prevent participants from directly discounting a trait (e.g. labeling a positive trait described as inapplicable also as relatively unimportant to have) we presented the same trait adjectives as a second run apart from the first and asked participants for 3) the importance of the traits (i.e., 'how important is it for you to possess this trait?'; 1 = not at all important, 4 = very important). The stimuli and accompanying questions were presented in a random order and separated by a jittered black screen (500 to 1500 msec) and a white fixation cross (500 msec). To control for effects of attention, the second question about certainty of the self-view was displayed in a different color (blue) than the first question about self-descriptiveness (white). See **Figure 1A** for an example of the trial sequence.

Self-Other Attribution Task: In order to measure self-descriptions in a context with a more explicit social cue, all participants completed the task a second time during which they compared themselves on the same traits with pictures of unfamiliar peers in their age group. They were asked to decide on first impression whether they thought the presented trait adjective was most appropriate to describe either him/herself or the peer on the picture. For every age group, a total of 90 different photos (45 males, 45 females) were used (Moor et al., 2010). In advance, the individual pictures of every age group were randomized and assigned to one of the trait adjectives. Thus, within each age group every participant saw the same combination of trait and picture. Each of the 90 trials consisted of a jittered black screen for 500–1500 msec, followed by a white fixation cross for 500 msec. Thereafter, the stimulus was presented, consisting of a trait adjective in the middle of the screen, a frame (either left or right) containing an emoticon referring to the self with the word "myself", and a frame (either right or left) containing a picture showing an unfamiliar peer with the words "the other" written below it. Using the left or right key, the participant could choose whether they thought the attribute was most appropriate to describe the person displayed in the left or right frame. The positions of the emoticon (self) and the picture (peer) were counterbalanced across trials. See **Figure 1B** for an example of the trial sequence.

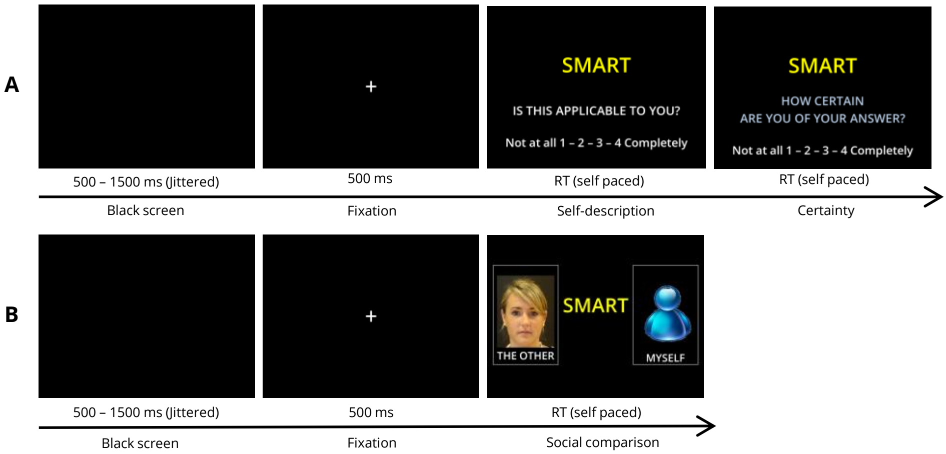

***Figure 1.** Example of a trial for the Self-Attribution Task **(A)** and Self-Other Attribution Task **(B)**. Each trial started with a black screen with a jittered duration between 500 and 1500ms. Subsequently, a fixation cross was shown for 500ms after which the stimulus appeared. In the Self-Attribution task, participants rated on a scale of 1 to 4 to what extent the traits fit themselves and how certain they were of their decision. In a separate run, participants were asked to for the importance of the traits. In the Self-Other Attribution Task, participants chose on first impression if they thought the trait was most appropriate to describe either him/herself or the peer on the picture, using the left or right key.*

Questionnaires

Self-Perception: In order to validate the domains of the new paradigms, we made use of Harter's Self-Perception Profile scales for children (SPPC; Harter, 1985) and adolescents (SPPA; Harter, 1988). These well-validated questionnaires give a measure of adolescents' self-rated traits and competencies in different domains as well as a measure of their global self-evaluation. The questionnaires have been translated to Dutch (CBSK; Veerman, ten Brink, Straathof, & Treffers, 1996; CBSA; Treffers et al., 2002) and contain multiple domain-specific questions, each with two opposing statements. The adolescent has to choose one statement (e.g. either 'some teenagers do very well at their class work', or 'other teenagers don't do very well at their class work') and decide for the chosen statement whether that statement is "somewhat true" (score 2 or 3) or "entirely true" (score 1 or 4). Items were scored on a 4-point scale and recoded so that higher numbers represent more positive self-perceptions. The CBSK consists of 36 questions divided over 6 subscales. The CBSA consists of 35 questions divided over 7 subscales. The 9 – 12 year olds were given the CBSK, the rest of the sample was given the CBSA. Only the subscales Scholastic Competence, Social Acceptance and Physical Appearance of the CBSK/A were used as a validation measure for the academic domain, social domain and physical appearance domain, respectively.

Self-Concept Clarity: Similarly, we used a Dutch translation of the Self-Concept Clarity Scale (Campbell, 1990; Van Dijk et al., 2014) as a validation measure for the description of certainty of the self-view in our experimental paradigm. This 12-item questionnaire measures the extent to which individuals describe their self-concept as clear, stable, and internally consistent. An example of an item is "My beliefs about myself often conflict with one another". Answers were given on a five point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").The scale is generally used for children and adolescents of 12 years and older, and was reliable according to a Cronbach's alpha of .86. Mean scores were computed so that higher scores indicate higher self-concept clarity.

Procedure

This study was part of a larger study and consisted of two parts: The experimental tasks and a series of questionnaires measuring different aspects of self-concept development. In advance, participants were divided in two groups. They could start with the experimental tasks or the questionnaires and switch halfway through the testing session. All participants were tested in a regular classroom and a computer room or media library at the participating schools or universities. Participants were seated with at least one empty seat in between, to ensure they performed the tasks individually. Before the testing session, an experimenter explained the procedure to the class emphasizing anonymity. Participants were encouraged to honestly describe how they thought about themselves and ask questions if they did not understand the meaning of a trait adjective. Before starting the experimental tasks, participants were provided with a number of examples to ensure all participants understood the tasks. Five trained research assistants were present at all times to provide help. In consultation with the schools, participants were given either a monetary reward of 5 Euros or a small present for their participation.

Statistical Analyses

To test for age group effects on self-descriptions, we conducted a Repeated Measures ANOVA with Domain (3) and Valence (2) as within subject-factors and Age group (4) as between-subjects factor. This repeated measures ANOVA was performed for the average scores on self-descriptions as well as certainty given to the self-descriptions and importance of possessing the trait. Unfortunately, participants, as was communicated to the experimenters during the testing session, did not all correctly understand the question about importance. For negative valence, participants differed in their interpretation of the question and whether their accompanying answer referred to the importance to have this trait (e.g. scoring a 1, indicating low importance of having this negative trait) or not to have this trait (e.g. scoring a 4, indicating high importance not having this trait). Therefore, we only used the importance scores for the positive traits for the analyses.

For the Self-Other Attribution task, we first computed scores per domain of how often in the social comparison someone chose for themselves (for positive and negative traits separately) and included these scores into another 3 (Domain) x 2 (Valence) within-subjects factors and 4 (Age group) between-subjects Repeated Measures ANOVA. All reported repeated measures analyses are Greenhouse-Geisser corrected and post-hoc analyses make use of a Tukey correction for multiple comparisons.

In order to examine age-related differences in self-differentiation, we first recoded the applicability scores for the negative traits and combined these scores with the positive traits into one score per domain. This way, we would only look at differences in the positivity of self-descriptions across domains and not between valences. Next, we computed a standard deviation score per person for their self-descriptions scores on all three domains, in which a higher standard deviation indicated more variability across domains. Finally, we examined age group differences in variability with an ANOVA with a Tukey correction for multiple comparisons.

In order to validate the new paradigms, correlations between the different domains of the experimental tasks (academic, social and physical) and the corresponding domains of the self-report questionnaires (CBSK/A) were computed as well as correlations between the self-concept clarity scale and certainty of the self-view.

RESULTS

Self-Attribution Task

Self-descriptions

In order to examine age group differences in self-descriptions, we started with a 3 (Domain: academic, social, physical) x 2 (Valence: positive, negative) within-subjects factors and 4 (Age group: late childhood, early adolescence, middle adolescence, young adulthood) between-subjects Repeated Measures ANOVA. This analysis yielded a significant Domain x Valence x Age group interaction, (F (6,394) = 2.85, p = .010, η_p^2 = .04). As a result of this significant interaction, we further investigated the relation between age group and domain per valence separately.

For positive valence, we found a significant between-subjects effect of age group (F (3,197) = 6.76, p < .001, η_p^2 = .09). Post-hoc analyses showed higher average scores for the two youngest age groups (late childhood and early adolescents) compared to the mid adolescents (p = .011, p = .045 respectively) and the young adults (p = .002, p = .012 respectively). See **Figure 2A** for a visualization of these results. Next to this between-subjects effect, we also found a main effect of domain (F (2,394) = 91.41, p < .001, η_p^2 = .32). Overall, participants rated their physical traits less positive compared to their academic traits (F (1,197) = 81.45, p < .001, η_p^2 = .29), and social traits (F (1,197) = 175.36, p < .001, η_p^2 = .47). Scores on the social domain were higher than for the academic domain (F (1,197) = 8.08, p = .005, η_p^2 = .04).

There was also a significant Domain x Age group interaction for positive traits (F (6,394) = 5.87, p < .001, η_p^2 = .08). Post-hoc ANOVAs showed significant between-group differences for the physical domain only (F (3,197) = 11.61, p < .001, η_p^2 = .15). The youngest age group scored higher on positive physical self-descriptions in comparison to the mid adolescents (p = .020) and young adults (p < .001). The early adolescence age group showed similar results with a higher average on positive physical self-descriptions in comparison to the mid adolescents (p = .001) and young adults (p < .001). See **Figure 2C** for a visualization of these results.

For negative valence, we found a significant between-subjects effect of age group (F (3,197) = 4.82, p = .003, η_p^2 = .07), but no significant effect of domain or a Domain x Age group interaction (F (6,394) = 1.21, p = .298). Regardless of domain, the late childhood age group showed lower scores for negative traits compared to the mid adolescents (p = .043). Again, early adolescents differed significantly from mid adolescents (p = .009) and young adults (p = .043), showing overall lower scores on the negative traits. See **Figure 3A.C**. for a visualization of these results.

Finally, we explored possible developmental differences in self-differentiation across domains with an ANOVA on variability scores. This analysis resulted in a significant effect of age group ($F(3,194) = 4.95, p = .002, \eta_p^2 = .07$). Post-hoc comparisons showed higher variability scores for the young adults compared to the late childhood group (p = .005) and the early adolescents (p = .012). In summary, the Self-Attribution task showed general age differences in positive as well as negative self-descriptions, with more positive and less negative self-descriptions in the two youngest age groups. For positive self-descriptions, these age related differences showed to be domain specific and are only present in the domain of physical appearance. In addition, scores on self-descriptions showed greater variability across domains with increasing age.

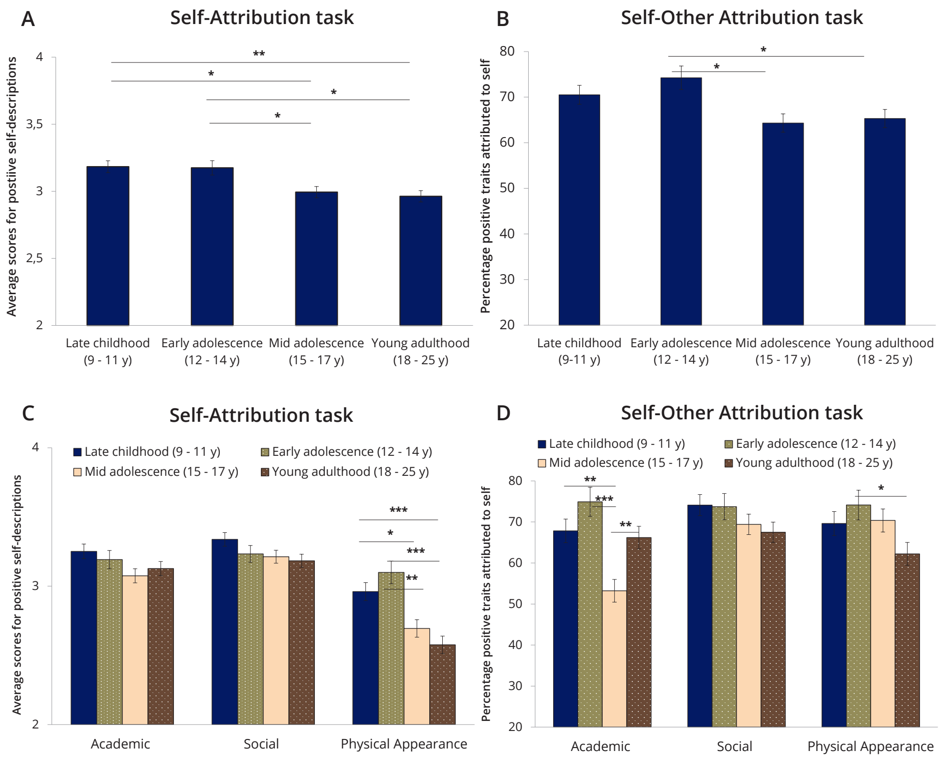

Figure 2. A. *Average scores for positive traits (range task = 1 – 4). Applicability scores were higher for late childhood and early adolescents compared to mid adolescents and young adults.* ***B.*** *Average percentages of positive traits attributed to self (range task = 0 – 100%). Early adolescents attributed more positive traits to themselves compared to mid adolescents and young adults.* ***C.*** *Scores for positive traits split out for domain. For the physical domain, applicability scores were higher for late childhood and early adolescents compared to mid adolescents and young adults.* ***D.*** *Average percentages of positive traits attributed to self, per domain. The academic and physical appearance domain yielded significant differences between age groups.*

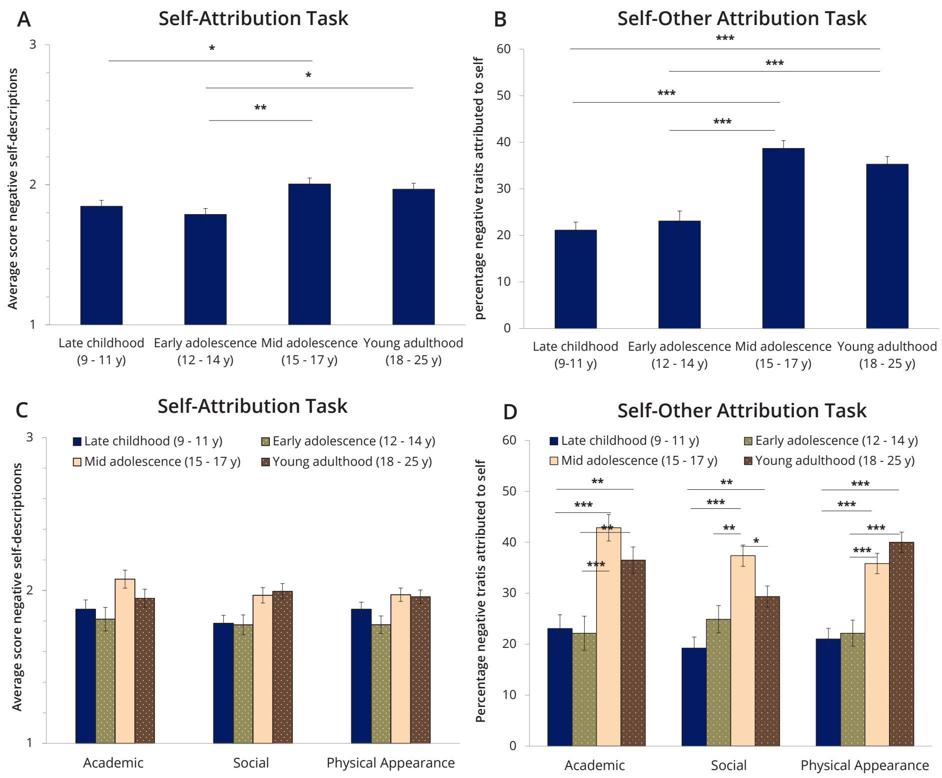

Figure 3. A. *Average scores for negative traits (range task = 1 – 4). Applicability scores were lower for late childhood and early adolescents compared to mid adolescents and young adults.* ***B.*** *Average percentages of negative traits attributed to self (range task = 0 – 100%). Late childhood and early adolescents attributed less negative traits to themselves compared to mid adolescents and young adults.* ***C.*** *Scores for negative traits split out for domain. Regardless of domain, applicability scores were lower for late childhood and early adolescents compared to mid adolescents and young adults.* ***D.*** *Average percentages of negative traits attributed to self, per domain. All domains yielded significant differences between age groups.*

Certainty

We investigated certainty of self-judgements using the same order of analyses as with the applicability of the self-descriptions. Results of the first Repeated Measures ANOVA yielded a significant Domain x Valence x Age group interaction, (F (6,394) = 2.40, p = .028, η_p^2 = .04). As a result of this significant interaction, we further investigated the relation between age group and domain per valence separately.

For positive valence, we found a significant between- subjects effect of age group (F (3,197) = 5.25, p = .002, η_p^2 = .07). Post-hoc analyses showed higher average certainty scores for the youngest age group (late childhood) compared to the mid adolescents (p = .005) and the young adults (p = .009). Next to this between-subjects effect, we also found a main effect of domain ($F(2,394) = 21.84$, $p < .001$, $\eta_p^2 = .10$). Overall, participants showed lower certainty scores for the physical domain compared to the academic domain ($F(1,197) = 26.77$, $p < .001$, $\eta_p^2 = .12$), and the social domain ($F(1,197) = 34.00$, $p < .001$, $\eta_p^2 = .15$). There was no Domain x Age group interaction for positive valence certainty.

For negative valence, we solely found a significant between-subjects effect of age group ($F(3,197) = 4.52$, $p = .004$, $\eta_p^2 = .06$). Early adolescents differed significantly from the other three age groups, showing lower average certainty scores for the negative self-descriptions compared to the late-childhood age group ($p = .008$), mid adolescents ($p = .038$), and young adults ($p = .005$). See **Figure 4** for a visualization of all certainty results.

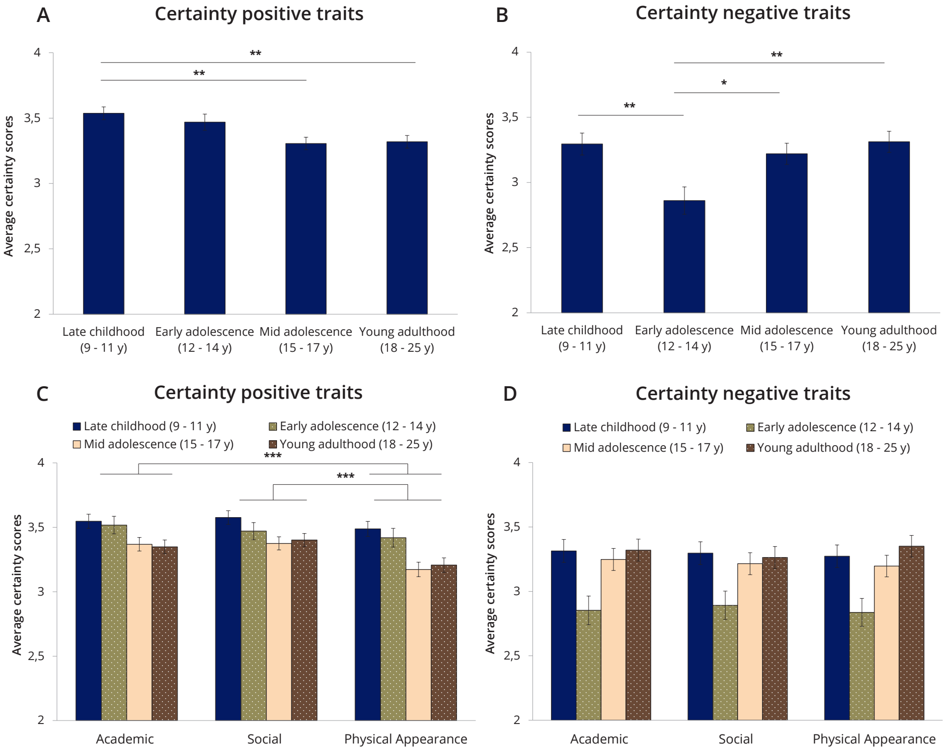

Figure 4. ***A.*** *Average certainty scores for positive traits (range task = 1 – 4). Certainty scores were higher for late childhood compared to mid adolescents, and young adults.* ***B.*** *Average certainty scores for negative traits. Certainty scores were lower for early adolescents compared to late childhood, mid adolescents, and young adults.* ***C.*** *Certainty cores for positive traits split out for domain. Participants were least certain about possessing positive physical traits.* ***D.*** *Certainty cores for negative traits split out for domain. Regardless of domain, certainty scores were lower for early adolescents compared to late childhood, mid adolescents, and young adults.*

Importance

Importance was only scored for positive traits (see methods section). A Repeated Measures ANOVA for the positive traits did not result in a significant between-subjects effect (F (3,193) = 1.31, p = .272, η_p^2 = .02). However, we did find a main effect of domain (F (2,386) = 125.26, p < .001, η_p^2 = .39). Overall, participants scored physical traits as less important to have compared to academic (F (1,193) = 111.51, p < .001, η_p^2 = .37), and social traits (F (1,193) = 191.31, p < .001, η_p^2 = .50). Social traits were thought to be most important to possess, as they were also scored higher compared to traits in the academic domain (F (1,193) = 16.78, p < .001, η_p^2 = .08).

There also was a significant Domain x Age group interaction (F (6,386) = 3.51, p = .004, η_p^2 = .05).). Post-hoc ANOVAs only showed significant between-group differences for the physical domain (F (3,197) = 3.99, p = .009, η_p^2 = .06). Early adolescents scored positive physical traits as more important in comparison to young adults (p = .009). See **Figure 5** for a visualization of these results.

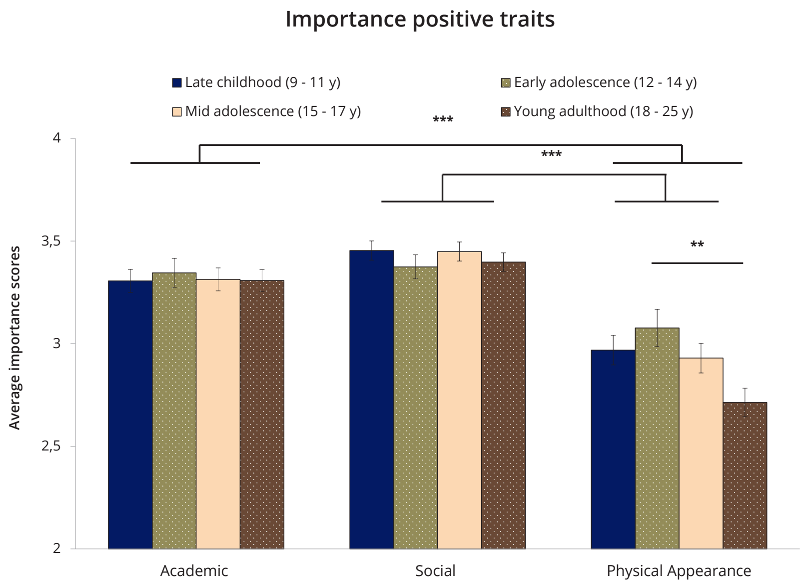

Figure 5. *Average importance scores for positive traits (range task = 1 – 4). Participants scored physical traits as least important, and social traits most important to possess. Early adolescents scored physical traits as more important in comparison to young adults.*

Self-Other Attribution Task

To examine age effects for the Self-Other Attribution task, we used the same order of analyses as for the Self-Attribution task. We first computed scores per domain of how often in the context of the social comparison someone chose for themselves (for positive and negative traits separately). These scores were transformed into percentages "chosen for self" and used as dependent variables. We started again with a 3 (Domain) x 2 (Valence) within-subjects factors and 4 (Age group) between-subjects Repeated Measures ANOVA. This analysis yielded a significant Domain x Valence x Age group interaction, (F (6,390) = 5.23, p < .001, η_p^2 = .07). As a result of this significant interaction, we further investigated the relation between age group and domain per valence separately.

For positive valence, we found a significant between- subjects effect of age group (F (3,195) = 4.19, p = .007, η_p^2 = .06). Post-hoc analyses showed that early adolescents attributed more positive traits to themselves compared to the mid adolescents (p = .014) and the young adults (p = .032). There was a main effect of domain as well (F (2,390) = 5.67, p = .005, η_p^2 = .03). Here, only the academic and social domain showed a significant difference, in which participants generally attributed more positive social traits to themselves, compared to positive academic traits (F (1,195) = 13.39, p < .001, η_p^2 = .06).

This analysis also yielded a significant Domain x Age group interaction (F (6,390) = 5.032, p < .001, η_p^2 = .07). Post-hoc ANOVAs showed significant between-group differences for the academic domain (F (3,195) = 8.98, p < .001, η_p^2 = .12) and the physical domain (F (3,195) = 2.684, p = .048, η_p^2 = .04). For the academic domain, mid adolescents scored lower on the positive academic self-descriptions in comparison to the late childhood age group (p = .002) early adolescents (p < .001) and young adults (p = .006), indicating they attributed fewer positive academic traits to themselves. For the physical domain, early adolescents differed significantly from the young adults (p = .048), showing more attribution of positive physical traits to themselves compared to this older age group. See **Figure 2B.D.** for a visualization of these results.

For negative valence, we again found a significant between-subjects effect of age group (F (3,195) = 24.14, p < .001, η_p^2 = .27). Post-hoc analyses showed that two youngest age groups attributed fewer negative traits to themselves compared to the mid adolescents (p < .001) and the young adults (p < .001). A main effect of domain was also present, with a significant difference between the academic and social domain. Participants generally attributed more negative academic traits to themselves, compared to negative social traits (F (2,390) = 3.02, p = .05, η_p^2 = .02).

There also was a significant Domain x Age interaction (F (6,390) = 3.30, p = .004, η_p^2 = .05)., indicating significant between-group differences for the academic domain (F (3,195) = 13.29, p < .001, η_p^2 = .17), the social domain (F (3,195) = 12.72, p < .001, η_p^2 = .16), as well as the physical domain (F (3,195) = 20.21, p < .001, η_p^2 = .24). With regard to the academic domain, the late childhood age group attributed fewer negative academic traits to themselves compared to the mid adolescents (p < .001) and the young adults (p = .002). The early adolescent age group showed similar results with fewer attributions to themselves compared to the mid adolescents (p < .001) and young adults (p = .005). Post-hoc analyses for the social domain illustrated a similar pattern. The late childhood age group attributed significantly fewer negative social traits to themselves compared to mid adolescents (p < .001) and young adults (p = .005). Mid adolescents continued to show a negative pattern in this social domain. Besides assigning significantly more negative social traits to themselves compared to the youngest age group, they also differed significantly compared to early adolescents (p = .002) and young adults (p = .035). Finally, post-hoc analyses for the physical domain revealed the same age group differences. The two youngest age groups attributed significantly fewer negative physical traits to themselves compared to mid adolescents (p < .001) and young adults (p < .001). See **Figure 3B.D.** for a visualization of these results.

In summary, the Self-Other Attribution task showed that the context of an explicit social comparison produces strong differences in self-attributions between age groups, valences and domains. Again, age differences were generally in favor of the two youngest age groups (i.e., positive traits for self rather than other, negative for other rather than self), although differences were largely dependent upon valence and domain specificity.

Gender differences

In order to examine the influence of gender in both tasks, we performed the Repeated Measures ANOVAs with gender included as an additional between-subjects factor. For the Self-Attribution Task, the first 3 (Domain) x 2 (Valence) within-subjects factors and 4 (Age group) x 2 (Gender) between-subjects Repeated Measures ANOVA yielded a significant Domain x Valence x Gender interaction, (F (2,386) = 8.36, p < .001, η_p^2 = .04). As a result of this significant interaction, we further investigated the relation between gender and domain per valence separately.

For positive valence, we found a significant Domain x Gender interaction (F (2,398) = 6.71, p = .002, η_p^2 = .03). Post hoc t-tests showed solely for the academic domain a significant gender difference, indicating that girls (M = 3.25, SD = 0.37) described themselves more positively than boys (M = 3.03, SD = 0.37), t (199) = -4.05, p < .001, d = .57). For negative valence, a Repeated Measures ANOVA resulted in a significant Domain x Gender interaction (F (2,398) = 6.19, p = .002, η_p^2 = .03). However, post hoc t-tests did not show any significant gender differences.

A Repeated Measures ANOVA for the Self-Other Attribution task, again with gender included as an additional between-subjects factor, resulted in a significant Domain x Valence x Gender interaction, (F (2,382) = 6.62, p = .001, η_p^2 = .03). When investigating the relation between gender and domain per valence separately however, positive valence did not show a significant Domain x Valence interaction. We did find a significant Domain x Valence interaction for negative valence ($F(2,394) = 4.43$, $p = .012$, $\eta_p^2 = .02$), however again post-hoc t-tests did not result in any significant gender differences.

Validation

The validity of the domains used in the new paradigms was judged on correlations with the corresponding scales of the self-report questionnaires CBSK/A. We computed Z-scores in order to combine the scores of both questionnaires. Results showed significant correlations between the academic domain and the Scholastic Competence scale for positive valence ($r = .21$, $p < .001$) as well as for negative valence ($r = -.29$, $p < .001$); between the social domain and the Social Acceptance scale ($r = .27$, $p < .001$ for positive valence, $r = -.32$, $p < .001$ for negative valence), and between the physical domain and the Physical Appearance scale ($r = .43$, $p < .001$ for positive valence, $r = -.35$, $p < .001$ for negative valence). For an overview see **Table 1.**

Similarly, the Self-Concept Clarity Scale (SCC; Campbell, 1990; Van Dijk et al., 2014) was used as a validation measure for the description of certainty of the self-view in the experimental paradigms. Results showed only significant correlations between the SCC and certainty in the positive task domains: academic ($r = .23$, $p < .001$), social ($r = .28$, $p < .001$) and physical ($r = .18$, $p < .05$).

Table 1.

Intercorrelations between task domains and corresponding CBSK/A scales

Scale	CBSK SC	CBSK SA	CBSK PA	CBSA SC	CBSA SA	CBSA PA	Zscores SC	Zscores SA	Zscores PA
Academic Positive	**.41****	.15	.18	**.14**	.01	.02	**.21****	.05	.07
Academic Negative	**-.52****	-.41**	-.21	**-.20***	-.22**	-.19*	**-.29****	-.28**	-.19**
Social Positive	.12	**.33***	.20	.02	**.26****	.15	.05	**.27****	.16*
Social Negative	-.32*	**-.34****	-.37**	-.17*	**-.32****	-.36**	-.22**	**-.32****	-.36**
Physical Positive	.21	.44**	**.32***	.16	.52**	**.51****	.17*	.47**	**.43****
Physical Negative	-.33*	-.29*	**-.39****	-.19*	-.42**	**-.34****	-.23**	-.28**	**-.35****

Note: SC = Scholastic Competence; SA = Social Acceptance; PA = Physical Appearance.
Highlighted in bold are correlations between corresponding domain and scale.
* = $p < .05$; ** = $p < .01$. CBSK (N = 60); CBSA (N = 137).

DISCUSSION

The main aim of this study was to examine the development of domain-specific self-descriptions with and without an explicit social context. To this end, we developed two tasks that both asked adolescents about trait self-descriptions but differed in the salience of the presence of a social comparison. The results of this study revealed general age differences in self-descriptions, with the two youngest age groups rating themselves more positively. Moreover, these age differences showed to be dependent upon valence and domain. Finally, the Self-Other Attribution task showed that the context of an explicit social comparison seems to enhance age-related differences in self-descriptions between age groups, valences and domains. The discussion is organized alongside the line of these findings.

Developmental changes in self-descriptions

First, we examined age-related changes in self-descriptions, without the emphasis of social context (Self-Attribution task). This task showed general age differences in which the two youngest age groups (late childhood and early adolescents) between the ages of 9 and 14 repeatedly showed more positive as well as less negative self-descriptions compared to the two older age groups. As has been previously described in the literature, over the course of childhood children tend to show typically very positive self-representations and overestimate their abilities, also referred to as a "positivity bias". This positivity bias generally declines as children become older and make the transition into adolescence (Harter, 2012; Pfeifer & Peake, 2012; Trzesniewski, Robins, Roberts, & Caspi, 2003), although there is still much debate whether self-evaluations actually decrease, stabilize, or even increase during the course of adolescence (Steiger, Allemand, Robins, & Fend, 2014). Some researchers have argued that self-perceptions become more negative as adolescents start to rely more on external feedback and outcomes of social comparisons as a basis for self-evaluation (Harter, 2012; Ruble et al., 1980; Sebastian et al., 2008). These changes give rise to more realistic information about the self and therefore more accurate self-perceptions. Also maturational changes associated with puberty and social changes such as the transition from elementary school to (junior) high school could result in a decrease of positive self-perceptions (Schaffhuser et al., 2017). Our results indicate that the positivity bias seen in childhood possibly extends into early adolescence, as the results of this age group (12-14) were similar to those of late childhood (9-11).

An alternative explanation for this relatively late decrease in positivity bias compared to other studies could be that our group of early adolescents in the age range of 12 – 14 years consisted of individuals in elementary school as well as adolescents in the second year of Dutch high school. As none of these adolescents were currently in – or recovering from the transition period into high school, this could partly explain why we did not find a dip in self-descriptions in this early adolescence age group. When looking at the two older age groups (mid adolescents and young adults) in this sample, results show a decrease for overall self-descriptions compared to the two youngest age groups. This is consistent with a large body of research that shows that the positivity of self-descriptions further declines across the adolescent years (Steiger et al., 2014; Trzesniewski et al., 2003).

Moreover, in this study we investigated the development of self-descriptions according to different domains. Most of the described studies have investigated the trajectories of global self-evaluations and gave less attention to trajectories concerning self-descriptions specific to domains. This focus on global rather than distinct aspects of self-concept could partly explain the inconsistency in findings in studies mapping the development of self-concept across adolescence. Indeed, earlier studies that have examined dimensional aspects of self-concept have found different self-descriptions according to different domains and that these distinctions become less correlated over time, suggesting a more differentiated self-concept from childhood to young adulthood (Marsh & Ayotte, 2003). Our results support this notion of domain specificity in two ways. First, we found that the overall age effects between the younger and older adolescents were most apparent in the domain of physical appearance. Self-descriptions for this domain showed a decrease across adolescence. This finding is consistent with other literature and has been related to changes in physical development (Kuzucu et al., 2014; Schaffhuser et al., 2017; Wigfield, Eccles, Reuman, & Midgley, 1991). Moreover, studies have suggested that the transition into adolescence often coincides with increased exposure to offline and online media images of ideal bodies. Together with the increased susceptibly to social comparisons, this could lead to an increased discrepancy between these ideal images and the own body, and result in more negative self-evaluations in the physical domain (Myers & Crowther, 2009). Notably, this effect was found for positive valence only. With regard to valence, most studies choose not to differentiate between positive and negative stated trait adjectives or average both into a mean score of the specific scale. Our results, however, suggest that valence is an important extra factor to take into account as developmental differences in self-descriptions vary across these factors. A second argumentation for increased domain specificity is related to our finding of increased variability across domains with age, which gives support to the idea of the development of a more differentiated self across adolescence (Marsh and Ayotte, 2003).

In addition to examining general age trends in self-descriptions, we investigated developmental changes in ratings of certainty and importance of self-descriptions. For the positive self-descriptions, results showed general higher certainty scores for the youngest age group compared to the two oldest age groups. Thus, besides rating themselves more positive on self-descriptions, the late childhood group is at the same time also more confident about their ratings. These results relate well to the idea that it is difficult to come to an extreme opinion about yourself without feeling extremely confident about this belief (Pelham, 1991), and fits with the more prevalent “all or none” thinking in childhood compared to adolescence (Harter, 2012). The lower certainty ratings of the mid adolescents support the notion of more confusion and unstable self-representations during this period of adolescence (Harter, 2012). With regard to the young adults, lower certainty ratings could be associated with the multiple important life experiences (such as changes in education, work and living conditions) that take place in this period, which could stimulate increased levels of exploration and uncertainty (Crocetti et al., 2016). Moreover, with increasing age, adolescents come across more opportunities and targets to compare themselves to; they are not limited to their direct environment (which includes an increasing amount of different contexts as well), but can also compare themselves to anyone they want online. These increases in comparison opportunities with possible conflicting outcomes could also result in increased uncertainty about the self. For the certainty ratings for the negative self-descriptions, a different pattern of age differences emerges. Our results suggest that the early adolescents show a dip in certainty of negative self-traits around age 12 - 14, but this needs to be confirmed in further studies.

Aside from age differences we also found a general effect of domain, showing that self-descriptions related to the physical domain were overall scored with less certainty compared to self-descriptions of the other domains. The physical domain has been described as qualitatively different from other self-concept domains, as physical appearance is always on display for others and ourselves to scrutinize and judge (Harter, 2012). At the same time however, we are often uncertain of the real opinions of others about the way we look, and the feedback we receive can be contradicting. Receiving contradicting feedback could also result from the more substantially varying opportunities for comparing one’s physical appearance, compared to the options for comparing academic competence or social skills. For example, comparing oneself to the physique of direct peers could result in thinking ‘I am attractive’, whereas in relation to media images this comparison could simultaneously result in thinking ‘I am far from attractive’. Together, this could lead to less confidence for the physical domain specifically. Interestingly, participants also judged traits of the physical domain as least important to possess, compared to academic competence or social skills. This is remarkable, as many studies have shown that how you evaluate your physical appearance is the number one predictor of general self-esteem (von Soest, Wichstrøm, & Kvalem, 2015). These results could be an example of self-protection where individuals choose to discount the importance of traits they think they do not possess, in order to protect self-esteem. Another possibility could be that these results illustrate a form of social desirability bias and reflect the societal norm not to appear as shallow.

Self-descriptions in the context of social comparison

As a second goal of this study, we focused on the development of self-descriptions within an explicit social-comparison context to examine how this influenced self-descriptions. This was achieved by asking participants to judge themselves relative to unknown peers. Again, we tested differences between age groups and domain. Compared to the Self-Attribution task, the Self-Other Attribution task with an explicit social comparison yielded similar as well as additional differences between age groups and domains. In general, age differences were again in favor of the two youngest age groups (more positive and less negative self-attributions), although age differences were largely dependent upon valence and domain specificity.

For positive valence, early adolescents (12-14) generally showed the highest scores, indicating that they attributed more positive self-descriptions to themselves compared to an unknown peer. This self-preference was most evident in the domains of academics and physical appearance. Thus, also within an explicit social comparison, this group continued to hold a more positive self-image. This is interesting, as most literature suggests that during this period of adolescence attention to social comparison information as a means of self-evaluation increases, generally leading to a decrease in self-evaluation (Dijkstra et al., 2008; Wehrens et al., 2010). The results from this study suggest that the transition to a less positive self-concept occurs later in mid- rather than early adolescence. Another notable result is the drop in positive self-evaluation for the mid adolescent group (15-17) in the academic domain specifically. The academic domain could be profoundly sensitive to social comparison, as the classroom is a highly evaluative environment where comparison of performance and grades with classmates is often emphasized (Wehrens et al., 2010). The more performance-focused character of the final years of high school could especially lead to increased social comparison and affect the self-concept for adolescents in this age group more negatively.

For negative valence, results showed similar general age-trends as for the self-attribution task. However, compared to the self-task, the context of a social comparison yielded more differences specific to domain. A finding that stands out mostly is the difference in age groups for the social domain specifically. This domain has not yielded any notable differences in the Self-Attribution task, but it shows that comparing self to peers for negative self-descriptions affects the mid adolescence group most negatively. Interestingly, this is the age group that appears to be most affected by the change in context by scoring themselves less positive and more negative on multiple domains. These results could possibly illustrate adolescent-specific transitions in social reorientation (Nelson et al., 2005; Sebastian et al., 2008).

Self-descriptions with and without explicit social comparison

Together, results on the development of self-descriptions with and without the context of an explicit social comparison showed similarities as well as differences. With regard to similarities, we found that the youngest age groups between 9 – 14 years old showed a robust and consistent 'positivity bias' across both task contexts and valences, which was reflected in more positive and less negative self-descriptions in the Self-Attribution task as well as more positive and less negative self-attributions in the Self-Other Attribution task. Differences between both tasks were most evident in the result of more pronounced age-differences that became more strongly dependent upon valence and domain. Here, the group of mid adolescents showed to be most affected by the addition of a social comparison, indicated by less positive self-attributions in the academic domain and more negative self-attributions in all domains. These results give support to the increased sensitivity to the social context for this specific age group, showing that regardless of domain, the context of explicit social comparison elicited greater uncertainties about own traits and competences.

Gender effects

Finally, we investigated whether gender contributed to differences in domain specific self-descriptions and whether the context of a social comparison could influence self-descriptions for boys and girls differently. Results showed significant differences for the academic domain only, where girls described themselves more positively than boys. This is consistent with the idea that girls perform better academically and receive higher grades than their male peers (Gentile et al., 2009). However, results regarding academic self-evaluation in favor of girls are mixed. It has been suggested that girls are more critical of their academic abilities and that performing well does not always affect how they view their academic traits. The lack of finding other gender differences is consistent with the review of Zuckerman and colleagues (2016) that states that gender differences in self-evaluation have been declining for the past 20 years. Interestingly, we did not find any gender differences in the Self-Other Attribution task. Previous research has demonstrated that girls compare themselves more to others than boys do, and more often make upward comparisons which is more likely to negatively affect self-evaluations (Dijkstra et al., 2008; Jones, 2001; Myers & Crowther, 2009). As our task limited participants to only compare themselves to unknown peers, instead of also comparing to celebrities or unrealistic media images for example, this could possibly explain why we did not find any gender differences with this task.

Limitations and future directions

This study has some limitations that should be addressed in future studies. First, the two tasks we used in order to investigate self-descriptions with or without an explicit social context differed in scale format. Whereas participants could rate themselves on a scale from 1 to 4 for the Self-Attribution task, results for the Self-Other Attribution task demonstrated a percentage score from 0 to 100 of 'chosen for self'. This discrepancy limited a direct comparison between the two tasks. Future studies should assess both aspects using tasks with similar scales.

For the Self-Other Attribution task, the social comparison was based on a simple social cue of an image of the face of an unknown peer, which limits participants to comparing themselves on the basis of first impressions only. However, the fact that we found significant results even with such a minimal social cue builds an even stronger case for adolescents' susceptibility to social comparison. With these results in mind, adding more information about the unknown peer would be an interesting new direction to investigate this susceptibility in more detail. In addition, because the comparison with the unknown peer was based on first impression, stereotypes (e.g. by gender) might have played a role as well. Although beyond the scope of this paper, it would be an interesting idea for future research to further examine the influence of these gender stereotypes on self-evaluation within a social comparison context.

Further, although internal consistency of the domains of the tasks was high (average .75), and we found consistent significant correlations with other measures of self-concept, the correlations with the questionnaires (CBSK/A and SCC) we used to validate the measures of applicability and certainty of self-descriptions were around .30. For both measures, this could be related to potential differences between the number and the framing of items in the questionnaires and in our tasks. For example, we included more trials per domain (30 instead of 6) and we used single traits instead of the sentences used in the CBSK/A. The SCC measures general stability and internal consistency of self-concept, which could be different from our measures of certainty related to specific domains.

Another limitation is related to the sample and recruitment process. We did not specifically select and group participants based on their school or grade level, therefore our sample did not include adolescents that were currently experiencing the transition period into high school. This could partly explain the relative positive results we found for adolescents in this age-range, as research has often found temporary drops in mean levels as well as stability of self-perceived competence during this transitional period (Cole et al., 2001; Schaffhuser et al., 2017). Future studies should take school transitions into account to give a more complete picture of the development of self-descriptions within these contextual influences.

Finally, this study was cross-sectional in nature. Future studies should make use of longitudinal designs to examine within-person developmental changes in self-descriptions.

Conclusions

Taken together, we investigated developmental changes in domain-specific self-descriptions with and without the context of explicit social comparison across adolescence. Results showed consistent age-differences with more positive self-views for children and adolescents in the age-range 9 – 14 years. The context of explicit social comparison yielded similar but more pronounced age-differences that were more strongly dependent upon valence and domain. Moreover, mid adolescents showed to be most negatively affected by these social comparisons relative to other ages. Together, this study made a first step in disentangling the specific influence of social comparison outcomes within the development of general self-descriptions, and highlights the importance of social context in studying self-concept in adolescence.


Welke droom zou je voor jezelf uit willen laten komen?
"REALISTISCH: EEN GOEDE STUDIEKEUZE MAKEN EN DAAR SUCCESVOL IN ZIJN.
ONREALISTISCH: EEN VETTE SUPERKRACHT! :) TELEPORTEREN OF TIJDMANIPULATIE."
Matthijs, 14 jaar

Chapter 3

THE NEURAL CORRELATES OF ACADEMIC SELF-CONCEPT IN ADOLESCENCE AND THE RELATION TO MAKING FUTURE-ORIENTED ACADEMIC CHOICES

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ABSTRACT

This study examined the role of brain regions involved in academic self-evaluation in relation to problems with study orientation. For this purpose, 48 participants between ages 14 - 20 years evaluated themselves on academic traits sentences in an fMRI session. In addition, participants completed an orientation to study choice questionnaire, evaluated the importance of academic traits, and completed a reading and shortened IQ test as an index of cognitive performance. Behavioral results showed that academic self-evaluations were a more important predictor for problems with study orientation compared to subjective academic importance or academic performance. On a neural level, we found that individual differences in the positivity of academic self-evaluations were reflected in increased precuneus activity. Moreover, precuneus activity mediated the relation between academic self positivity and problems with study orientation. Together, these findings support the importance of studying academic self-concept and its neural correlates in the educational decision-making process.

INTRODUCTION

Academic choices in adolescence

An important challenge for adolescents is to make future-oriented academic choices that fit with their identity, such as deciding about what courses to take in high school or choosing a study in higher education. Here, the final years of high school are especially an important time for adolescents, as they have to start to think beyond the borders of high school and puzzle over what future academic and/or vocational career they want to pursue after graduation (Rogers & Creed, 2011). This marks the start of an extensive period of planning, exploration and complex career decision-making. Orientation to a future study choice has been found to be one of the most important tasks in the total career decision-making process (Germeijs & Verschueren, 2006), as this includes the students' first awareness of the need to make this future-oriented decision and engage in relevant actions that contribute to a deliberate outcome.

To date, studies investigating orientation to a future study choice have focused on the role of various demographic variables, such that being older, being female and having a higher socio-economic background have been associated with more readiness and capacity to engage in the process of future career decision-making (Creed, Patton, & Prideaux, 2007). Also specific personality traits have been linked to career orientation and exploration, where higher levels of conscientiousness, extraversion and agreeableness have been shown to relate to more career planning and exploration (Klimstra, Luyckx, Germeijs, Meeus, & Goossens, 2012; Rogers, Creed, & Ian Glendon, 2008).

However, a topic that has been relatively understudied in relation to future orientation is how one sees and evaluates themselves and more specifically their competences in an academic or learning context, also known as academic self-concept (Bong & Skaalvik, 2003). Academic self-concept has been related to many educational outcome variables, such as students' school engagement and interests (Marsh & Martin, 2011), motivation (Valentine, Dubois, & Cooper, 2004), emotions (Goetz, Cronjaeger, Frenzel, Ludtke, & Hall, 2010), academic adjustment or wellbeing (Wouters, Germeijs, Colpin, & Verschueren, 2011), and school achievement or performance (Huang, 2011). However, much less is known about how academic self-concept is connected to making future-oriented academic decisions. It is important to examine the role of academic self-concept in the orientation to future academic choices, as the beliefs individuals have about their traits and competencies in the academic domain could significantly influence their awareness and motivation to engage in the career decision-making process.

A neuroscientific approach to the academic self

Recent studies in the field of neuroscience have shown that neural measures can provide unique additional variance in academic outcomes, over behavioral measures alone. For example, neural activity during a working memory task has shown to predict measures of school performance such as reading and mathematics two years later (Dumontheil & Klingberg, 2012; S. Peters, Van der Meulen, Zanolie, & Crone, 2017). To this end, understanding more about the neural underpinnings of academic self-concept could possibly also benefit our knowledge about the relation between academic self-concept and orientation to making future academic choices. To date, research on the neurological correlates of self-concept has mostly focused on brain areas related to general self-evaluations. These studies have consistently found that cortical midline structures such as the medial prefrontal cortex (mPFC) are involved in thinking about the self, compared to thinking about traits of others or baseline activation (Denny, Kober, Wager, & Ochsner, 2012; Murray, Schaer, & Debbané, 2012; Sebastian, Burnett, & Blakemore, 2008). Moreover, more specific parts of this brain region have been linked to differences in valence and self-relevance of traits, such that stronger activation in the ventral part of the mPFC (vmPFC) has been related to more positive as well as more self-relevant self-descriptions (for reviews, see Moran, Macrae, Heatherton, Wyland, & Kelley, 2006; van der Cruijsen, Peters, & Crone, 2017).

Although the neural correlates of general self-evaluations have been well studied, much less is known about what brain areas are involved in self-descriptions specific to different domains, even though it is well established that self-descriptions become increasingly differentiated upon domain (Marsh & Ayotte, 2003; van der Aar, Peters, & Crone, 2018). A few studies that have investigated domain-specific self-concept have shown that a broader network of brain regions is activated according to different domains of self-concept, including posterior cingulate cortex (PCC) related to more external, physical traits; and medial prefrontal cortex (mPFC) associated with more internal, character or competence traits (Ma, Wang, Yang, Feng, & Van Overwalle, 2016; Moran, Lee, & Gabrieli, 2011). For the domain of academic self-concept specifically, a study of van der Cruijsen and colleges (2017) found in an adult sample more activation in the precuneus and vmPFC when thinking about academic traits and competencies related to self, relative to evaluating own physical or prosocial traits. These results indicate that the precuneus and vmPFC could play an important role in the domain specificity of academic self-concept.

The current study

The main goal of this study was to examine the relation between behavioral and neural indices of academic self-concept, and orientation to future academic choice. For this purpose, we included a subsample of 48 adolescents that participated in the

Leiden Self-Concept study (van der Cruijsen, Peters, van der Aar, & Crone, 2018) and who reported they were in the final years of high school. In addition to academic self-concept measures, we also tested whether other academic variables, such as academic performance (measured by IQ and a reading fluency test) and the subjective importance of academic traits, would relate in a similar or different way to orientation to future academic choice. This way, we aimed to investigate to what extent academic self-concept could be unique in its relation with future career decision-making.

Behaviorally, we expected that a more positive academic self-concept would be related to having fewer problems with orientation to future academic choice, indicating early awareness and motivation to start the career decision-making process. This hypothesis was based on earlier established relations between academic self-concept and general motivation in school (Fenning & May, 2013; Valentine et al., 2004), but no prior study has linked this to orientation to future academic choice. On a neural level, we expected more activation in vmPFC and precuneus for evaluating academic traits compared to a control task (see also van der Cruijsen et al., 2018) for a report in the larger sample). We finally expected that brain activity related to evaluating academic traits could be informative for predicting orientation to future academic choice. We hypothesized that activity in these brain regions would be more pronounced for participants who evaluated themselves more positively on academic traits, and we examined whether these relations would be associated with orientation to future academic choice.

METHOD

Participants

The present study was part of a larger study (the Leiden Self-Concept study) with 150 participating adolescents in the age range 11 – 21 years. The subsample used in the current study comprised 48 participants in the age range 14 – 20 years (M_{age} = 16.62; SD = 1.33; 22 males; 26 females) who indicated to be in one of the final years of secondary education (grade 10, 11 or 12). Only these participants completed questionnaires related to study orientation, as this topic is not relevant yet for adolescents who are still in the first few grades of high school or for the ones who already continued with post-secondary education (college or vocational education). Participants were enrolled in different levels of educational programs: Pre-vocational education or “VMBO”, 17%; Higher general continued education or “HAVO”, 19%; or Pre-university education or “VWO”, 63%. As the duration of secondary education in the Netherlands is dependent upon the type of program, the final years of high school are differently defined for the different educational tracks. For the VMBO and HAVO program, the final years comprise the final two years (students aged 14 – 17 years), whereas for the VWO program these consist of the final three years of high school (students aged 15 – 18 years). All participants completed two subtests of the WISC-III or WAIS-III (Similarities and Block Design) in order to obtain an estimation of IQ. Estimated IQ scores fell between 82.5 and 137.5 (M = 109.58, SD = 9.64), and IQ did not correlate with age ($r(48) = .05$, $p = .758$). IQ did differ between school levels ($F(2,44) = 8.73$, $p = .001$) with lower IQ scores for participants following the VMBO program compared to participants following the HAVO program ($p = .006$) and VWO program ($p < .001$). Written informed consents were provided by the participants themselves or by a parent as well in the case of minors. All participants were screened for MRI contra indications, had normal (or corrected to normal) vision, were fluent in Dutch, and had no neurological or psychiatric impairments. The University Medical Ethics Committee approved the study and its procedures.

Experimental Task

Self-concept was measured with an fMRI task in which participants were presented with short sentences that described positively or negatively-valenced traits or competencies in the domains of academics, prosocial skills and physical appearance (for more information and validation of the traits, see (van der Cruijsen et al., 2018). For the current study, we focused on the academic domain specifically. In the self-condition, participants were asked to indicate for each trait sentence to what extent the trait applied to them, using a Likert-type 4-point rating scale (1 = not at all, to 4 = completely). Each domain consisted of 20 stimuli, half with positive valence and half with a negative valence, making a total of 60 trait sentences (e.g. 'I am smart' or 'I think school is hard'). For the control condition, participants were asked to categorize other traits relating to the same three domains (e.g. 'having a good memory') into one of four categories: (1) school, (2) social, (3) physical appearance, or (4) I don't know. This condition contained 20 traits in total, again equally divided in positive and negative valence.

The stimuli were presented in an optimized pseudorandomized order using Optseq (Dale, 1999) and were separated with a jittered black screen that varied between 0 and 4400ms. Each trial started with a 400ms fixation cross, after which the stimulus was presented for 4600ms, consisting of the trait sentence and response options (1 – 4) (see **Figure 1**). Participants could respond to the sentence within this timeframe by pressing buttons with the index to little finger of their right hand where after the number of their choice turned from white to yellow for the remaining stimulus time. If the participant failed to respond within the 4600ms, they were shown the phrase 'Too late!' for 1000ms. These trials were modeled separately and were not included in the analysis, and occurred on less than 0.7% of the trials in the self-condition and on less than 0.4 % in the control condition.

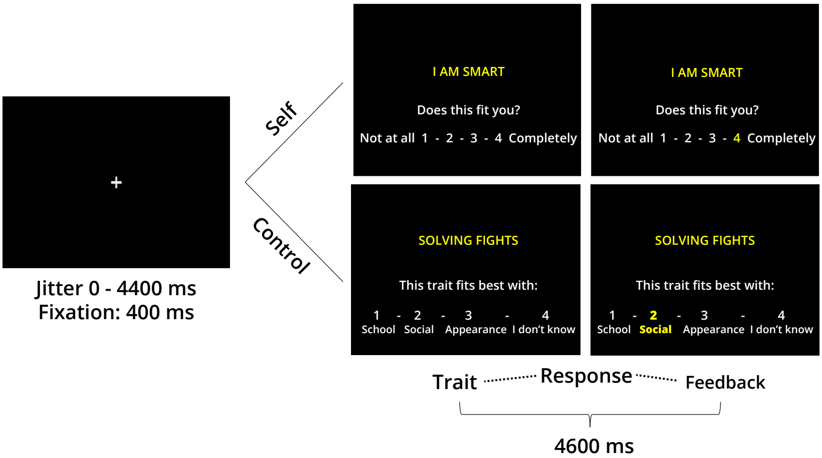

Figure 1. *Example of a trial in the Self and the Control condition. Each trial started with a black screen with a jittered duration between 0 and 4400ms. Subsequently, a fixation cross was shown for 400ms after which the stimulus was presented. In the self-condition, participants rated on a scale of 1 to 4 to what extent the traits fit themselves. In the control condition, participants categorized the trait sentences into one of four options. The stimulus was shown for 4600ms. If participants responded within this timeframe, the number of their choice would turn yellow. If participants failed to respond within this timeframe, a screen with the phrase 'Too Late!' was shown for an additional 100ms after which the next trial would start.*

Materials

Importance: After the scanning session, participants were asked to rate the same 60 trait sentences on importance of possessing these traits. They could indicate importance on a scale of 1 (It is very important to me to not have this trait) to 5 (It is very important to me to have this trait). Scores for the negative traits were recoded and merged with the positive traits, so that a higher combined score indicated a general positivity score for importance.

Orientation to study choice: We used the subscale 'orientation to choice' of the Study Choice Task Inventory (SCTI; (Germeijs, 2006). This 12-item questionnaire measures the extent to which adolescents are aware of the need to make a decision for a study in higher education and their motivation to do so. An example of an item is "I seldom think about what I will study". Answers were given on a 9-point Likert scale ranging from 1 ("does not describe me at all") to 9 ("describes me very well"). The scale was reliable according to a Cronbach's alpha of .89. Counter indicative items were recoded so that higher scores indicated more problems with orientation to study choice.

Reading: Reading skills were measured with a reading fluency task, called the "Three-Minute-Test"(Krom, Jongen, Verhelst, Kamphuis, & Kleintjes, 2010). In this task, participants received a list of Dutch words and were instructed to read the words aloud as clearly and quickly as possible in 1 min. The total score is defined as the number of correct words read minus the number of incorrect words. The Three-Minute-Test has good validity and reliability with a Cronbach's alpha of .96.

Procedure

Participants were given an extensive explanation and practice session in a mock scanner to familiarize them with the procedure of an MRI scan. Before scanning, participants received instructions about the self-concept tasks and performed 9 practice trials for each condition. Anonymity was emphasized and participants were encouraged to honestly describe how they thought about themselves and ask questions if they did not understand the meaning of a trait adjective.

MRI data acquisition

MRI scans were acquired on a Philips 3T MRI scanner, using a standard whole-head coil. Functional scans were collected in two runs with T2*-weighted echo-planar imaging (EPI) The first two volumes were discarded to allow for equilibration of T1 saturation effect. Volumes covered the whole-brain (TR = 2200 msec, TE = 30 msec, sequential acquisition, 37 slices of 2.75 mm, FOV = 220 x 220 x 111.65 mm). After the functional scans, a high-resolution 3D T1 scan was obtained as anatomical reference (TR = shortest msec, TE = 4.6 msec, 140 slices, voxel size = 0.875 mm, FOV = 224 x 178.5 x 168 mm). Sentences were projected on a screen behind the scanner and could be viewed through a mirror attached to the head coil. Head movement was restricted by placing foam inserts inside the coil.

MRI data analyses

MRI data were preprocessed and analyzed with SPM8 (Wellcome Department of Cognitive Neurology, London). Images were corrected for slice-timing acquisition and differences in rigid body motion. The normalization algorithm used a 12-parameter affine transformation together with a nonlinear transformation involving cosine basis functions and resampled the volumes to 3 mm cubic voxels. Templates were based on the MNI305 stereotaxic space (Cocosco, Kollokian, Kwan, Pike, & Evans, 1997). Functional volumes were spatially smoothed using a 6 mm FWHM isotropic Gaussian kernel.

Individual participants' data were analyzed using the general linear model in SPM8. The fMRI time series were modelled as a series of zero duration events convolved with the hemodynamic response function (HRF). Modelled events of interest for the self-task were: "Academic-Positive" and "Academic-Negative". For the control task, we used one event of interest ("Control") that was collapsed across domains and valences. Trials on which participants failed to respond were modelled as covariate of no interest and were excluded from further analyses. The events were used as covariates in a general linear model, along with a basic set of cosine functions that high-pass filtered the data. Six motion regressors were added to the model. The resulting contrast images, computed on a subject-by-subject basis, were submitted to group analyses.

At the group level, we compared academic trials (collapsed across valences) to the control trials using a one sample t-test for the contrast Academic-Self > Control. For all analyses, we applied FDR cluster level correction ($p < .05$) at an initial uncorrected threshold of $p < .001$, as implemented in SPM8. The general contrast Academic-Self > Control was also reported in van der Cruijsen et al. (2018) in the larger sample of the Self-Concept Study ($N = 150$). In addition, whole-brain regression analyses were performed to investigate whether stimulus-related activation in the academic trials was correlated with the individual responses in the task. Here, we recoded responses on the negative traits and merged them with the positive traits, such that higher average scores indicated more positive evaluations of the academic self. (academic self positivity). These regression analyses were also FDR cluster corrected at $p < .05$, at an initial uncorrected threshold of $p < .001$. In order to further examine the neural correlates of academic self-concept and the relation to orientation to study choice, functional ROIs were defined with the use of the MarsBar toolbox in SPM8 (Brett, Anton, Valabregue, & Poline, 2002). Outlier scores (z-value < −3.29 or > 3.29) were winsorized (Tabachnick & Fidell, 2013).

RESULTS

Behavioral measures

Table 1 shows the correlation between "self positivity scores of academic traits" ($M = 2.83$, $SD = .44$), "positivity scores on academic importance" ($M = 3.90$, $SD = .48$), and "problems with orientation to study choice" ($M = 3.56$, $SD = 1.70$). In addition, we report correlations with IQ ($M = 109.58$, $SD = 9.64$) and reading performance ($M = 98.19$, $SD = 12.60$) as indices of performance outcomes. Age was not significantly correlated with any of these key variables, therefore we did not include age in any further analyses.

As can be seen in **Table 1**, academic self positivity was significantly correlated with academic importance and problems with future orientation, but not with IQ and reading. In addition, academic importance was correlated with IQ and reading. IQ and reading were also inter-correlated. These findings suggest that there are partly overlapping, and partly separable relations between these measures of academic self-concept, performance and problems with future orientation to study choice. Next, we performed a multiple regression analysis including all academic variables as predictors and future orientation to study choice as dependent variable to test whether academic self-concept could be viewed as a more important predictor in this relationship. Results showed that only academic self-concept significantly predicted problems with future orientation (β = -.33, p = .042) thereby indicating that academic self-concept could be a more important predictor for future orientation to study choice compared to academic importance or performance.

To further examine these distinct relations, we checked whether the 5 academic variables could be encompassed by different factors using a Principal Component Analysis (PCA). Assumptions check for the PCA showed a Kaiser-Meyer-Olkin (KMO) value of 0.70, which indicated adequate sampling, and a significant Barlett's test of sphericity (χ 2 = 28.427, df = 10, p = .002), which indicated suitability of the data for PCA. To extract the suitable number of factors, an initial PCA analysis with varimax rotation was conducted. The parallel analysis indicated that two factors should be retained. The two factors together explained 61.68% of the total variance. The variables IQ, reading, and academic importance together loaded high on one factor, whereas academic self positivity and problems with orientation to study choice loaded on another factor. This suggests two separate academic constructs; one related more to academic performance and the other embodying academic self-concept and motivation. The specific factor loadings can be found in **Table 2**.

fMRI results

Whole-brain contrasts and regressions

To test for the neural correlates of academic self-concept, we first tested at the whole-brain level whether we could find similar results compared to the previous findings within the larger sample (N = 150; van der Cruijsen et al., (2018) in the current subsample (whole-brain contrast), and whether there were relations with academic self-concept ratings and problems with orientation to study choice (whole-brain regression).

First, we examined the brain regions that were involved in evaluating academic traits. Consistent with results reported in van der Cruijsen et al. (2018), in the current subsample of adolescents (N = 48), the contrast Academic-Self > Control resulted in increased activity in mPFC (see **Figure 2A** and **Table 3**). Next, we tested for additional relations with academic self positivity in the contrast Academic-Self > Control, by means of a whole-brain regression analysis. This resulted in positive correlations between academic self positivity and Academic-Self > Control in the precuneus (see **Figure 2B**) and right temporal lobe (see **Table 3**). As shown in **Figure 2B**, adolescents who rated their academic self-concept more positively showed greater activation in a posterior subsection of the precuneus. We conducted a similar whole-brain regression analysis with problems with orientation to study choice as regressor variable, but this did not result in significant clusters of activation.

Table 1.
Intercorrelations between academic variables

	Academic Importance	IQ	Reading	Problems with Orientation
Academic Self Positivity	**.38****	.27	.27	**-.35***
Academic Importance		**.32***	**.31***	-.15
IQ			**.37***	-.09
Reading				-.18

Note: * = p < .05; ** = p < .01.

3

Table 2.
Factor loadings for the Principal Component Analysis

	Factor 1	Factor 2
IQ	0.794	
Reading	0.714	
Academic Importance	0.658	
Problems with Orientation		-0.893
Academic Self Positivity		0.677

Note: Only factor loadings > 0.40 are printed in this table.

Table 3.
Regions activated during the target contrasts

	Region	BA	Coordinates			Cluster Size	T
(A) Academic > Control							
Frontal cortex	L Superior Medial Frontal (mPFC)	10	-9	59	7	121	4.68
(B) Academic > Control with academic self positivity as positive regressor							
Temporal cortex	R Middle Temporal	40	48	-28	22	156	4.87
	R Middle Temporal Gyrus	37	51	-55	10		4.22
Parietal cortex	R Supramarginal Gyrus	40	60	-25	19		4.09
	R Calcarine Gyrus / R Precuneus	23	9	-55	10	92	4.32
	L Precuneus	23	-3	-55	16		3.62

Note: Names were based on the Automatic Anatomical Labeling (AAL) atlas.

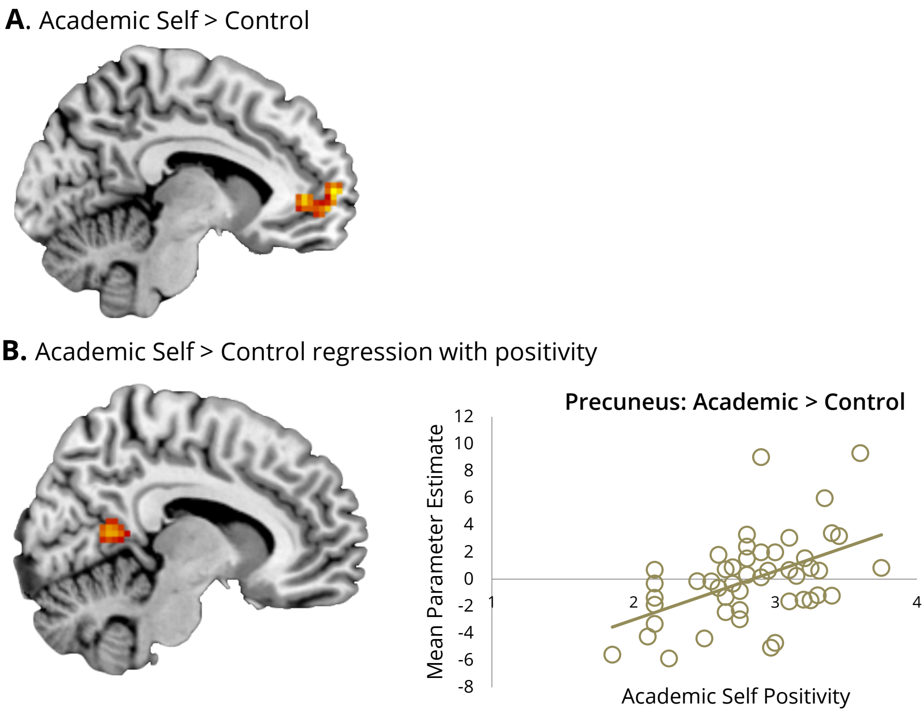

Figure 2. ***(A)*** *Main contrast Academic-Self > Control resulted in increased activity in mPFC, and* ***(B)*** *relation with academic self positivity (regression analysis Academic-Self > Control, positive relation with academic self positivity) shows stronger posterior precuneus activity for higher academic self positivity.*

Post hoc ROI analyses

To further explore how brain regions involved in academic self-concept were related to having problems with making future-oriented study choices, we extracted two ROIs of the mPFC and precuneus and related activity in these ROIs to the behavioral measures (see **Table 4**). To test whether any of these effects were valance specific, all correlation analyses were also performed for positive and negative academic items separately. The correlation between activity for positive and negative traits was .75 in mPFC and .82 in precuneus.

Next, we examined whether neural activity for academic self-concept could possibly mediate the relation between academic self positivity and problems with orientation to study choice, using the methods developed by Hayes (Hayes, 2013). As mPFC activity did not correlate with any of the behavioral measures, we only used precuneus activity for these mediation analyses.

We tested three mediation models with precuneus activity from the contrast Academic-Self (positive and negative together) > Control, as well as with the positive and negative traits separately as possible mediators between academic self positivity (X) and the outcome variable problems with orientation to study choice (Y). Based on 10.000 bootstrap resamples, the indirect path of academic self positivity to problems with orientation was only significant for precuneus activity within the negative traits (B = -.44, 95% CI= [-1.22 - -0.05]). Moreover, with the inclusion of precuneus activity in the model, the direct path from academic self positivity to problems with orientation was no longer significant (see **Figure 3**). Thus, a more positive academic self-concept was associated with more precuneus activity for the negative traits only, and more precuneus activity was in turn associated with fewer problems with future orientation. No significant mediation effects were found for precuneus activity for the positive traits (B = -.09, 95% CI= [-0.53 - 0.50]) or for the positive and negative traits combined (B = -.30, 95% CI= [-0.95 - 0.16]).

Table 4.
Intercorrelations between academic self-concept, performance, orientation and involved brain activity

	Academic Self Positivity	Academic Importance	IQ	Reading	Problems with Orientation
mPFC Acposneg > control	-.07	.09	.15	.16	-.01
mPFC Acpos > control	-.03	.08	.14	.17	.01
mPFC Acneg > control	-.12	.08	.14	.13	-.03
Precuneus Acposneg > control	-	**.28***	.25	.09	**- .29***
Precuneus Acpos > control	-	**.32***	.28	.06	- .20
Precuneus Acneg > control	-	.22	.21	.13	**-.35***

Note: * = p < .05; ** = p < .01.

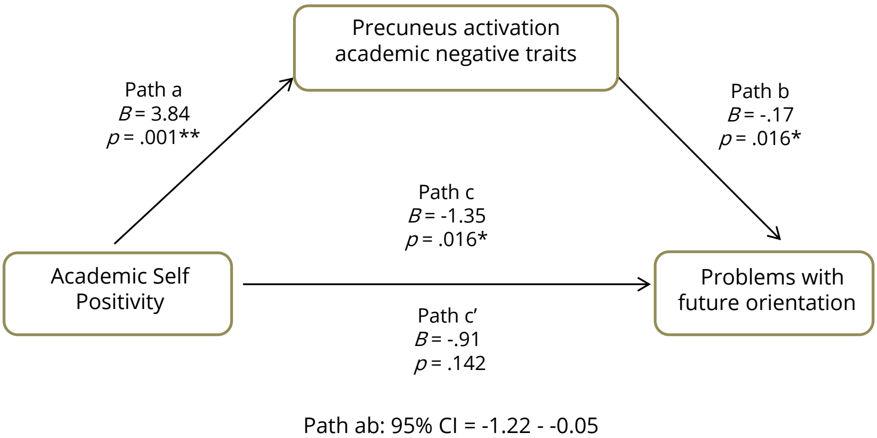

Figure 3. *Mediation analyses for the relation between Academic Self Positivity, Problems with future orientation, and precuneus activity for negative trials separately (academic negative traits).*

DISCUSSION

In this study, we combined behavioral indices and neural correlates of academic self-concept and related these outcomes to the awareness and motivation of adolescents to start engaging in the educational decision-making process. Results revealed three main findings. First, academic self-concept was a better predictor for orientation to future academic choice compared to subjective academic importance or performance. Specifically, this relation indicated that a more positive academic self-concept was associated with fewer problems with future orientation. Second, similar to prior research of van der Cruijsen et al. (2018) we showed increased activation in the mPFC for evaluating academic self-traits compared to a baseline task, in a smaller subsample. In addition, we found posterior precuneus activity in relation with more positive self-ratings. Third, precuneus activity specifically mediated the relation between academic self-concept and problems with orientation to future academic choice. The discussion is organized alongside the line of these findings.

The relation between academic predictors and future orientation

The choice of a postsecondary study can be described as a major educational decision with far- reaching consequences and implications for students' future careers (Pinxten, De Fraine, Van Damme, & D'Haenens, 2013). Many individual factors have been found to play an important role in the complex decision-making process, leading to this final choice. Here we tested the contribution of self-evaluations in the academic domain to problems adolescents can experience with the start of the orientation process, and how this contribution might differ from other academic and self-concept measures, such as academic performance and the subjective importance given to academic traits. Results showed that academic self-concept and academic performance can be viewed as two different, independent constructs with possible distinct relations with study orientation. As future orientation marks the start of the awareness and motivation of adolescents towards orienting themselves towards options after high school, this could also be viewed as a form of 'academic motivation for the future' or motivation based on the expectation of long-term rewards (Wong & Csikszentmihalyi, 1991). Research on academic motivation has shown relations with academic self-concept as well as academic performance (Bong & Skaalvik, 2003; Guay, Ratelle, Roy, & Litalien, 2010; Valentine et al., 2004). However, most studies investigated these relationships separately, focusing on academic performance as outcome variable. The few studies that focused on academic self-concept and motivation found the two to be strongly related, where motivation served as a mediator between academic self-concept and performance (Guay et al., 2010). In addition, studies investigating differences between academic self-concept and a related construct of self-beliefs, self-efficacy (the confidence in one's own abilities to perform a certain task successfully), showed that academic self-concept was a better predictor for motivation, whereas self-efficacy was a better predictor for academic performance (Fenning & May, 2013; Ferla, Valcke, & Cai, 2009). Our results fit with this line of research, showing that academic self-concept was a more important predictor for problems with study orientation than academic performance. In other words, the way adolescents evaluate their academic traits and skills in the past and the present is related to how they feel about engaging in orientation for a career in the future. However, to make definite conclusions regarding the sequential nature of self-evaluations involved in the process of orienting towards a study in higher education, longitudinal research is needed.

Interestingly, the subjective importance given to academic traits was not correlated to future orientation. This is surprising, as the extent to which a trait or self-view is considered to be important has been related to personal goals and motivation (D'Argembeau et al., 2012). In this light, one would expect that giving more emphasis to traits such as doing well in school, would also result in more motivation to start the orientation process for a suitable major in higher education. More research is needed in order to understand the relation between importance and future orientation. Possibly, academic importance ratings are less important than expected, or the current sample was too small to reveal this relation.

Together, these behavioral results emphasize academic self-concept as a key component with a unique contribution to the awareness and motivation to start the orientation process for a future study.

The relation between behavioral and neural correlates of academic self-concept

A second aim of this study was to examine the neural correlates of academic self-concept and relate these outcomes to individual differences in behavioral self-concept measures. We found mPFC involvement during the evaluations of academic traits compared to a control task. This is consistent with prior studies investigating internal, character or competence traits (Ma et al., 2016; Moran et al., 2011), and a study investigating academic self-concept in adults (van der Cruijsen et al., 2017). This effect was previously reported in van der Cruijsen et al. (2018) in a larger sample with a wide age range that included the current sample. These results add to the existing literature by showing the mPFC is a robust area for supporting judgments about the self in the academic domain as well.

Different from results of van der Cruijsen et al. (2017,2018), we did not find precuneus involvement for evaluating academic traits on the whole-brain level, possibly because our sample was smaller. However, posterior precuneus activity was observed when we related neural responses to individual differences in academic self-concept positivity. Specifically, we found that this section of the precuneus was more active when adolescents rated themselves more positively on academic traits and competences. This is interesting, as we did not find this dependency for the mPFC. Other studies that have examined general self-concept have mostly found ventral mPFC to be sensitive to signaling personal significance, showing increased activation when stimuli are more self-relevant (D'Argembeau, 2013). VMPFC responses have also been linked to positive valuation processes, which could be related to the idea that positive self-descriptions are often also simultaneously viewed as more self-relevant (Moran et al., 2006; J. Peters & Büchel, 2010; van der Cruijsen et al., 2018). This study suggests that for self-evaluations specific to the academic domain, posterior precuneus serves as an indicator for individual differences in the positivity with which adolescents describe their academic traits.

The precuneus has been found to be involved in the social brain network and activated during social cognitive processes, such as when one thinks about others and selves in social contexts (Cavanna, 2006). Interestingly, a study focusing on the neural correlates of social comparison as one of the most omnipresent mechanism of social cognition, found that precuneus in particular was highly involved when adult participants compared their intelligence to other individuals (Kedia, Lindner, Mussweiler, Ihssen, & Linden, 2013). In adolescence, the academic domain could be profoundly sensitive to social comparison, as the classroom is a highly evaluative environment where comparison of performance and grades with classmates is often emphasized (Wehrens et al., 2010). In previous studies, the exact location of precuneus activity differed between reports. In the current study, the precuneus region falls within the posterior part of the precuneus atlas, bordering but distinct from the lingual gyrus. An important direction for future research will be to examine the contribution of these different sections of the precuneus to individual differences in self-concept.

The role of neural correlates of academic self-concept in future orientation

An important goal of this study was to test the contribution of behavioral and neural correlates of academic self-concept to whether adolescents are aware and motivated to start the orientation process for a study in higher education. These analyses resulted in two important findings. First, we found a positive relation between activity in the posterior precuneus when participants were evaluating their academic traits and the problems they encounter with future orientation. Specifically, adolescents who reported to have fewer problems with future orientation showed more precuneus activation when evaluating their academic traits. Moreover, this relation was present for the evaluation of negative academic traits and the combination of positive and negative traits, but not for solely positive academic traits. Possibly, variance in precuneus activity is largest for academic traits with a negative valence, such as "I am dumb" or "I receive low grades". These self-evaluations may be more salient for individuals who are more focused on study orientation.

Second, precuneus activity during these evaluations of negative academic traits specifically, mediated the relation between behavioral outcomes of academic self-concept and problems with orientation to future academic choice. That is, adolescents who evaluated negative academic traits as less applicable to themselves indicated they experienced fewer problems with future orientation, and this relation was mediated by stronger precuneus activity. These findings suggest that the precuneus may be an important brain region that processes how adolescents evaluate negative academic traits, and subsequently influences how adolescents think about their future academic self through study orientation. It will be necessary to extent these findings using future longitudinal designs, but the findings fit with the presumed role of the precuneus in comparing self to others (Kedia et al., 2013; Swencionis & Fiske, 2014) and may in the current context also reflect the process of comparing current to future self.

Limitations and future directions

This study has several strengths, among them the inclusion of a diverse set of behavioral academic factors and neural measures of academic self-concept. However, there are some limitations that should be addressed in future studies. First, our measures of academic performance consisted of an estimation of IQ and scores on a reading fluency test, whereas academic performance is generally measured by specific school grades or GPA. Although IQ and GPA have been found to be moderately correlated, academic performance measured by GPA is influenced by many more variables than IQ alone (Duckworth & Seligman, 2005). In future studies, it should be considered to include both measures of IQ and school grades to give a more accurate estimate of academic performance.

Although beyond the scope of this paper, it should be noted that the Dutch school system stands out by distinguishing between multiple types or tracks of secondary education. These types differ in duration of the track as well as the academic level. Therefore, it is more difficult to compare grades into one GPA score, as a grade at a lower level does not evenly compare to a similar grade in a higher level. Moreover, because the duration of secondary education is dependent upon the type of program, students graduate at different ages. In this study, we did not select participants based on the educational track and therefore our sample was too small to include the type of educational program in the analyses. However, it would be an interesting direction for future research to incorporate the variety of scholastic tracks into the study design, thereby investigating the possible influences of these differences on the educational decision-making process.

A final limitation of this study concerns the cross-sectional design. Although this study contributes to the understanding of the relation between the behavioral and neural indices of academic self-concept and the motivation to make future oriented academic choices, we cannot firmly conclude that measures of academic self-concept play an antecedent role in this motivation for future orientation. Future research would benefit by testing these relations using longitudinal designs.

Conclusions

We investigated the role a diverse set of academic factors, including measures of academic performance and behavioral- and neural correlates of academic self-concept, in relation with problems adolescents can experience with starting the orientation process for a future study. In summary, we observed that self-ratings on academic traits were related to future study orientation. Moreover, neural activity during academic self-evaluations were observed in medial PFC and posterior precuneus, but only precuneus activity was correlated to rating the self positively on academic traits. Most importantly, precuneus activity mediated the relation between self-ratings and problems with study orientation, possibly reflecting a role of present and future self-comparison (Swencionis & Fiske, 2014). These findings have several important implications for future research on study orientation. First, academic self-evaluations were a more important predictor for study orientation than cognitive performance, showing the importance of a broader definition of factors influencing future orientation (Creed et al., 2007; Rogers & Creed, 2011). Second, an important question for future research will be to test the role of the precuneus in a longitudinal design to examine whether precuneus activity can predict future study orientation problems, and to test whether precuneus activity can be trained using self-concept training studies (O'Mara, Marsh, Craven, & Debus, 2006). Taken together, these results demonstrate the importance of studying academic self-concept and its neural correlates in the educational decision-making process.


Wat wens je jezelf toe voor je Breekjaar?
"MEER ZELFVERZEKERDHEID, ZELFSTANDIGER,
MEER VERTROUWEN EN EEN STUDIEKEUZE!"
Daniel, 18 jaar

Chapter 4

WHAT CHARACTERIZES ADOLESCENTS STRUGGLING WITH EDUCATIONAL DECISION-MAKING? THE ROLE OF BEHAVIORAL AND NEURAL CORRELATES OF SELF-CONCEPT AND SELF-ESTEEM

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ABSTRACT

Educational decision-making is a complex process where individual factors such as how adolescents think about and evaluate themselves could play an important role. In this study (N = 84), we combined behavioral and neural correlates of self-concept and self-esteem to examine what characterizes adolescents who struggle with educational decision-making. We included 38 adolescents (16 – 24 y, M = 18.7 y) from "the Gap Year program". This program focuses on personal development for adolescents who have dropped out of higher education or stay undecided after high school. We compared these adolescents prior to the start of the training with 46 peers (17 – 21 y, M = 19.4 y) who reported to have successfully chosen a major. The results showed that adolescents struggling with educational decision-making reported lower levels of self-esteem and self-concept clarity. Neurally, higher self-esteem was associated with more self-related activity in the mPFC. Together, these results suggest that healthy self-esteem levels are an important condition for the ability to make a well-suited educational choice.

INTRODUCTION

The transition from general education (e.g. high school) to higher education (e.g. college or vocational education) can be considered to be a major developmental milestone during the period of adolescence (Dietrich, Parker, & Salmela-Aro, 2012; Parker, Thoemmes, & Duineveld, 2015). This transitional period presents a number of challenges such as the need for exploring, selecting, and finally committing to a certain college major that fits with an individual's interests, abilities and career goals (Super, Savickas, & Super, 1996). As this process of educational decision-making can be complex, many adolescents experience difficulties when choosing a major in higher education. For example, these difficulties can be expressed in delaying the need to make a decision (e.g. by taking a gap year), not making a decision at all (career indecision), or making a wrong decision which can result in dropping out or changing programs. In the Netherlands, a growing number of individuals (from 6% in 2015 to 12% in 2017) do not enter higher education directly after high school, but instead take one or multiple gap years (Dutch Ministry of Education, 2018). Additionally, there has been a consistent pattern of about 33% of students who do not finish their first year, because they drop out or change programs (Dutch Ministry of Education, 2018). This is a high-stake societal issue as it has considerable consequences for the well-being of students and is associated with societal costs.

Together, these numbers reflect an alarming trend that highlights the need to understand more about these individuals who experience difficulties with educational decision-making. As adolescence is a phase in which the ability for self-reflection is still developing (Sebastian, Burnett, & Blakemore, 2008), how adolescents thinks about and evaluate themselves could play an important role in explaining why some adolescents encounter problems, drop out or remain indecisive whereas others do not (Lin, Wu, & Chen, 2015; Parker et al., 2012). Therefore, this study investigated behavioral and neural indicators of self-concept and self-esteem to examine what characterizes adolescents who experience difficulties with educational decision-making.

The importance of studying the self in educational decision-making

It has been well established that cognitive factors (e.g. IQ and prior academic achievement) are not the only variables of importance in the transition from high school to higher education (Guo, Marsh, Morin, Parker, & Kaur, 2015). Psychological factors such as motivation (Germeijs & Verschueren, 2007), personality (Klimstra, Luyckx, Germeijs, Meeus, & Goossens, 2012) and academic self-concept (Guo et al., 2015; Parker et al., 2012; Pinxten et al., 2015; Wouters, Germeijs, Colpin, & Verschueren, 2011) have also been found to predict academic adjustment or success after the first year of college. With regard to self-concept, these studies mostly focused on the academic domain specifically (i.e. how one evaluates their academic traits and abilities) and related this to achievement as a measure of academic progress or success (i.e. by GPA scores or completion of the first year). Both academic self-concept and achievement are associated with the (subjective or objective) evaluation of the cognitive abilities of an individual. However, successfully choosing and adjusting to a study program in higher education encompasses more than solely academic skills. For example, one should have a general idea of their traits, strengths and interests in order to find a major that they can enjoy and which fits their interests as well as their abilities (Pinxten et al., 2015). In the literature, less is known about how general descriptions and evaluations of the self contribute to successful educational decision-making. We hypothesize that having a clear, consistent and positive self-concept is crucial for the ability to choose a college major that matches your identity. Therefore, we adopt a dual approach where we investigate both domain-specific and domain-general self-evaluations in adolescents who experience difficulties with educational decision-making.

Two important self-related factors explaining problems with educational decision-making could be related to the structure and positivity of the self: self-concept clarity and self-esteem. Self-concept clarity (SCC) refers to the extent in which individuals generally perceive their self-beliefs to be clear, consistent and stable (Campbell, 1990). SCC increases gradually during adolescence, but shows a temporary dip between 17 – 18 years (Crocetti et al., 2016). Crucially, this is the time that many adolescents face the transition into higher education, but so far no prior research has related SCC to problems with educational decision-making. Self-esteem, on the other hand, has been linked to career decision-making in prior studies. These studies have consistently shown that lower self-esteem is related to career-indecision or low career decision self-efficacy, although they focus on college students rather than high-school students transitioning into higher education (Choi et al., 2012; Gati et al., 2011; Lin et al., 2015).

An important method to increase our understanding of how self-concept variables relate to problems with educational decision-making is by studying the underlying neural mechanisms of self-processing. Questionnaires are sensitive to response bias, and neuroscience research has consistently shown that the neural components of self-concept can be reliably assessed with functional MRI. This research has revealed that the medial prefrontal cortex (mPFC) is important for self-reflection in both adults and adolescents (Denny, Kober, Wager, 2012; Murray, Schaer, & Debbané, 2012; Pfeifer & Peake, 2012; Sebastian et al., 2008; van der Cruijsen, Peters, van der Aar, & Crone, 2018). Altered activity in the mPFC might consequently reflect self-processing deficits. For example, studies investigating self-processing in populations with clinical disorders such as autism or depression have shown atypical patterns of mPFC activity during self-evaluations (Quevedo, Martin, Scott, Smyda, & Pfeifer, 2016; Uddin, 2011). More recently, research has also started to examine brain regions related to self-evaluations in specific domains, such as the physical or academic domain. Although the mPFC is strongly activated for self-evaluations across all domains, these studies have shown that evaluating traits specific to different domains show additional unique activation patterns in the brain. For example, evaluating academic traits was shown to elicit specific activity in the posterior cingulate cortex (PCC) and precuneus which have often been related to memory processes, whereas evaluating physical traits activated regions in the inferior parietal lobe (IPL), which plays a role in mentalizing (Van der Aar, Peters, van der Cruijsen, & Crone, 2019; van der Cruijsen et al., 2018). However, it is still unclear whether atypical engagement of these brain areas could be related to problems with self-processing in these specific domains.

Finally, studies directly relating self-esteem or self-concept clarity to neural activity patterns have been surprisingly sparse. One study by d'Argembeau (2012) linked lower levels of self-certainty to decreased activity in dorsal mPFC, and Yang et al. (2012; 2016) showed that trait self-esteem was positively associated with activation during self-referential processing in orbitofrontal cortex (OFC), but negatively related to activation in dorsal anterior cingulate cortex (dACC). Both of these studies suggest that lower levels of self-concept clarity and self-esteem can be associated with altered activation patterns in different parts of the frontal cortex, but these relations have not yet been examined in adolescents and tested within an educational context.

The current study

The goal of this study was to investigate behavioral and neural correlates of self-evaluations in academic, physical and prosocial domains, and to link these to self-concept clarity, and self-esteem in individuals who experience difficulties with educational decision-making. Therefore, we recruited participants from the Gap Year Foundation. This organization provides structured gap year programs focusing on personal development for adolescents who have dropped out of higher education or stay undecided at the end of high school (www.breekjaar.nl). We compared these participants with adolescents who already successfully transitioned into higher education. Behaviorally, we expected lower scores for participants in the gap year group in the positivity of academic self-evaluations, self-esteem, and self-concept clarity. On a neural level, we expected the gap year group to show altered activity in mPFC during self-evaluations, especially for the academic domain as this domain would be most relevant to problems one could experience with educational decision-making. We additionally tested whether mPFC activity was correlated with individual differences in self-esteem and self-concept clarity. Possibly, continuous changes in these measures will be more valuable than group differences, as they also take into account individual differences within groups (Altman & Royston, 2006).

METHOD

Participants

In collaboration with Foundation Gap Year, we recruited 38 adolescents between 16 – 24 years (M_{age} = 18.73; *SD* = 1.47; 24 females) who were starting the 10-month training program named "the Gap Year Program". They were tested prior to the start of the program. All participants graduated from high school. 15 participants reported they had tried at least one college major, but dropped out; 23 participants took part in the program directly after high school. As educational decision-making problems are often comorbid with clinical problems (Gati et al., 2011; Scholtens, Rydell, & Yang-Wallentin, 2013), we chose to also include individuals with a clinical diagnosis (*N* = 7, **Table 1**), as long as they were not on medication at the time of testing. We included right-handed (*N* = 33) as well as left-handed participants (*N* = 5) with the criterion that they were able to use the button box with their right hand.

We compared these adolescents with 46 peers (17 – 21 years, M_{age} = 19.38; *SD* = 1.06; 24 females), who were part of a larger study (the Leiden Self-Concept study, *N* = 160, age 11 – 21 years; van der Cruijsen et al., 2018). They were selected from the larger sample based on the following criteria: between ages 16 and 21, and report of an already started major in higher education. This resulted in a sample of 46 participants who were directly comparable to the gap year participants. We assessed the level of commitment, questioning, and rethinking of their current education as an indication of satisfaction with their chosen program using the Utrecht-Management Identity of Commitments Scale (U-MICS; Crocetti, Rubini, Luyckx, & Meeus, 2008). On a 1 – 5 scale, this group scored relatively high on commitment (*M* = 3.73) and low on reconsideration (*M* = 1.83) and these scores differed significantly from the gap year group (commitment: $t(82) = -6.87$, $p < .001$; reconsideration: $t(82) = 4.53$, $p < .001$; **Table 1**).

All participants completed two subtests of the WISC-III or WAIS-III (Similarities and Block Design). Estimated IQ scores for the whole group fell between 85 and 132.5 (*M* = 106.99, *SD* = 11.1). The difference between IQ scores between the gap year group (*M* = 104.47) and the control group (*M* = 109.09) was not significant ($t(82) = -1.92$, $p = .058$). Age differed significantly between the groups ($t(82) = -2.34$, $p = .022$). To control for all possible age and IQ differences, these factors were included as covariates in the analyses. More information about both group characteristics and differences can be found in **Table 1**. Written informed consents were provided by the participants themselves or by both parents for minors. Participants were screened for MRI contra-indications, had normal (or corrected to normal) vision, were fluent in Dutch, had no neurological impairments, and were not taking psychotropic medication. The study was approved by the University Medical Ethics Committee.

Table 1.
Group characteristics

	Gap year (*N* = 38)			Control (*N* = 46)		
	Range	Mean	SD	Range	Mean	SD
Age (years)*	16.6 – 24.7	18.73	1.47	17.02 - 21	19.38	1.06
IQ	85 – 127.5	104.47	9.5	85 – 132.5	109.08	11.98
Commitment school**	1 - 5	2.52	.91	1 - 5	3.73	.71
Reconsideration school**	1 – 5	3.01	1.35	1 – 5	1.83	1.02
Clinical diagnoses		*N*			*N*	
ADHD		2			1	
ADD		3				
ASS		1				
Depression		1				

Note: * = $p < .05$; ** = $p < .001$.
Commitment and Reconsideration for school were measured with the U-MICS (Crocetti et al., 2008).

4

Experimental Task

All participants performed an fMRI task in which they were presented with short sentences that described positively or negatively-valenced traits or competencies in the domains of academics (e.g. 'I am smart'), prosocial skills ('I share with others'), and physical appearance (e.g. 'I am unattractive'). Each domain consisted of 20 stimuli, ten with positive valence and ten with a negative valence, making a total of 60 trait sentences (for more information and validation of the traits, see (van der Cruijsen et al., 2018) . In the Self condition, participants indicated to what extent the trait applied to them on a scale from 1 ('not at all') to 4 ('completely'). In the Control condition, participants categorized other traits relating to the same three domains (e.g. 'solving fights') into one of four categories: (1) school, (2) social, (3) physical appearance, or (4) I don't know. This condition contained 20 trait sentences in total, again equally divided in valence.

The Control and Self conditions were presented in separate runs and were counterbalanced across participants. The stimuli were presented in a optimized pseudorandomized order using Optseq (Dale, 1999) and were separated with a jittered black screen (0 - 4400ms). Each trial started with a 400ms fixation cross. Subsequently, the stimulus was presented for 4600ms, consisting of the trait sentence and response options (1 – 4) (**Figure 1**). Within this timeframe, participants could respond by pressing buttons with the index to little finger of their right hand after which the number of their choice turned from white to yellow for the remaining stimulus time. If the participant failed to respond within 4600ms, they were shown the phrase 'Too late!' for 1000ms. These trials were modeled separately and were not included in the analysis. They occurred in 0,5% of the Self condition and in 0,3% of the Control condition. To obtain one positivity score per domain in the Self condition, scores on negative traits were recoded and combined with scores on the positive traits.

Questionnaires

Self-esteem: Self-esteem was measured using a Dutch translation (Veldhuis, Konijn, & Seidell, 2014) of the well-validated Rosenberg self-esteem scale (Rosenberg, 1965). This 10-item questionnaire measures global self-worth by determining both positive and negative feelings about the self. Example of items are, 'On the whole I am satisfied with myself', and 'I certainly feel useless at times'. Answers were scored on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The scale had high internal consistency (Cronbach's alpha = .91). After recoding the five counter-indicative items, higher scores indicated higher self-esteem.

Self-concept clarity: Self-concept clarity was measured with a Dutch translation of the Self-Concept Clarity Scale (Campbell, 1990; Crocetti et al., 2008). This 12-item questionnaire measures the extent to which individuals describe their self-concept as clear, stable, and internally consistent. An example of an item is "My beliefs about myself often conflict with one another". Answers were given on a 5 point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"). The scale was reliable (Cronbach's alpha = .85). Mean scores were computed such that higher scores indicate higher self-concept clarity.

Procedure

Participants were familiarized with the MRI-procedure with a mock scanner. Before scanning, participants received instructions about the tasks and performed 9 practice trials for each condition. Anonymity was emphasized and participants were encouraged to honestly describe how they thought about themselves.

MRI data acquisition

MRI data were collected using a Philips 3T MRI scanner with a standard whole-head coil. Functional scans were collected in two runs with T2*-weighted echo-planar imaging (EPI). The first two volumes were discarded. Volumes covered the whole brain (TR = 2200 msec, TE = 30 msec, sequential acquisition, 37 slices of 2.75 mm, FOV = 220 x 220 x 111.65 mm). After the functional scans, a high-resolution 3D T1scan was obtained (TR = shortest msec, TE = 4.6 msec, 140 slices, voxel size = 0.875 mm, FOV = 224 x 178.5 x 168 mm). Sentences were projected on a screen behind the scanner and could be viewed through a mirror attached to the head coil. Head movement was restricted with foam inserts.

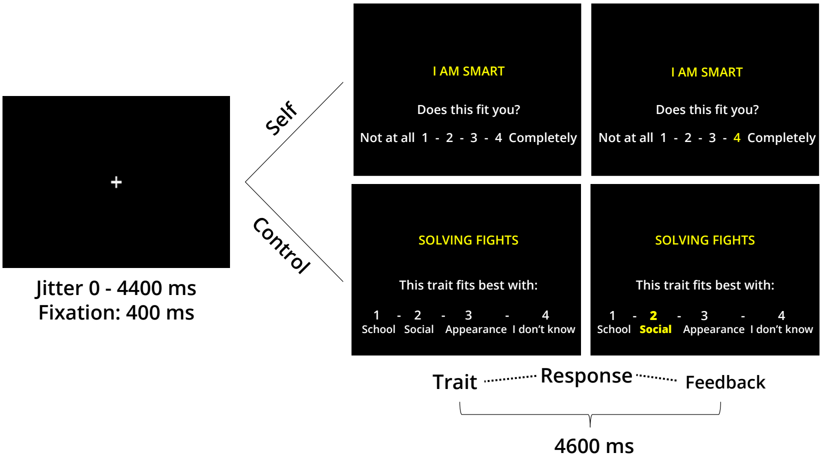

Figure 1. *Example of a trial in the Self and the Control condition. Each trial started with a black screen with a jittered duration between 0 and 4400ms. Subsequently, a fixation cross was shown for 400ms after which the stimulus was presented. In the Self condition, participants rated on a scale of 1 to 4 to what extent the traits fit themselves. In the Control condition, participants categorized the trait sentences into one of four options. The stimulus was shown for 4600ms. If participants responded within this timeframe, the number of their choice would turn yellow. If participants failed to respond within this timeframe, a screen with the phrase 'Too Late!' was shown for an additional 100ms after which the next trial would start.*

MRI data analyses

MRI data were preprocessed and analyzed with SPM8 (Wellcome Department of Cognitive Neurology, London). Images were corrected for slice-timing acquisition and differences in rigid body motion. All structural and functional volumes were spatially normalized to T1 templates. The normalization algorithm used a 12-parameter affine transformation together with a nonlinear transformation involving cosine basis functions, and resampled the volumes to 3 mm cubic voxels. Templates were based on the MNI305 stereotaxic space (Cocosco, Kollokian, Kwan, Pike, & Evans, 1997). Functional volumes were spatially smoothed with a 6 mm full-width at half-maximum (FWHM) isotropic Gaussian kernel.

Individual participants' data were analyzed using the general linear model in SPM8. The fMRI time series were modelled as a series of zero duration events convolved with the hemodynamic response function (HRF). Modelled events of interest for the Self condition were: "Academic-Positive", "Academic-Negative", "Physical-Positive", "Physical-Negative", "Prosocial-Positive", and "Prosocial-Negative". For the Control condition, we used one event of interest ("Control") that was collapsed across domains and valences. The events were used as covariates in a general linear model. Six motion regressors were added to the model. The resulting contrast images, computed on a subject-by-subject basis, were submitted to group analyses.

At the group level, we first performed whole-brain one sample *t*-tests for the contrasts Self > Control (collapsed across domains), Academic > Control, Physical > Control, and Prosocial > Control for both groups combined ($N = 84$). Next, we performed follow-up two-sample *t*-tests to compare activity in these four contrasts for the gap year group with the control group. In addition, we performed whole-brain regression analyses for the total sample to examine overall associations between self-related neural activation and individual differences in self-esteem and self-concept clarity. All analyses were FDR cluster-corrected at $p < .05$, at an initial uncorrected threshold of $p < .001$, as implemented in SPM8 (Woo, Krishnan, & Wager, 2014). Finally, we used the MarsBar toolbox to extract ROIs from the whole-brain contrasts to further illustrate individual differences in self-esteem and self-concept clarity.

RESULTS

Behavioral results

To investigate group differences in self-concept measures we performed a series of ANOVAs, corrected for age and IQ, on general self-evaluation positivity scores as well as per domain separately. These analyses yielded no group differences in positivity scores for self-evaluations per domain or across domains.

Additional ANOVAs for measures of self-esteem and self-concept clarity showed significant group differences for self-esteem ($F(1,80) = 27.00$, $p < .001$, $\eta_p^2 = .25$), and self-concept clarity ($F(1,80) = 13.06$, $p < .001$, $\eta_p^2 = .14$), with lower scores in the gap year group compared to the control group. Descriptive statistics can be found in **Table 2.**

Table 2.
Descriptive statistics of self-concept measures in the gap year group and control group

	Gap year (*N* = 38)			Control (*N* = 46)		
	Range	Mean	SD	Range	Mean	SD
Self positivity general	2.2 - 3.6	2.9	.36	2.5 – 3.6	3.1	.26
Academic positivity	1.7 - 4.0	2.6	.55	1.9 – 3.9	2.9	.46
Physical positivity	1.6 - 3.8	2.9	.56	2.2 – 3.8	3.0	.43
Prosocial positivity	2.3 – 4.0	3.2	.42	2.3 – 4.0	3.2	.37
Self-esteem**	1.3 – 4.3	2.8	.88	2.4 – 4.6	3.7	.61
Self-concept clarity**	1.7 – 4.1	2.7	.55	2.0 – 4.6	3.3	.70

Note: * = $p < .05$; ** = $p < .001$.

fMRI results

Whole-brain analyses

To examine which brain regions were generally involved in self-evaluations, we computed a whole-brain one-sample *t*-test for the contrast Self > Control for both groups combined. This resulted in significant clusters of activation in cortical midline structures; spanning from (ventral)mPFC, to the anterior-, middle-, and posterior cingulate cortex and bilateral precuneus. Additionally, the contrast Self > Control resulted in activation in right inferior frontal gyrus (IFG), bilateral SMA, and bilateral TPJ (**Figure 2** and **Table 3**). When examining the contrast Self > Control for the groups separately using a one-sample *t*-test, results for the control group showed increased activation in mPFC, ACC, right IFG, bilateral SMA and bilateral TPJ, and the gap year group showed activity in the ACC and vmPFC (see **Figure 2** and **Table 4**). To test for differences in the contrast Self > Control between the gap year- and control group, we conducted a two-sample *t*-test. There were no differences that survived FDR-cluster correction at $p < .05$.

We repeated these analyses for the domains separately. For the groups combined, the whole-brain contrast Academic > Control resulted in activation in vmPFC, PCC and precuneus, as well as in right IFG and right TPJ (**Figure 2**). The contrast Physical > Control resulted in similar activity in the mPFC, ACC, MCC, and PCC, as well as in right IFG, TPJ and bilateral SMA (**Figure 2**). Finally, the contrast Prosocial > Control resulted in activity in the mPFC, ACC and right TPJ (**Figure 2** and **Table 5**). When examining these contrasts for both groups separately, the gap year group only showed activity in mPFC and TPJ that survived FDR-cluster correction at $p < .05$ for the contrast Physical > Control (**Table 6**). However, two-sample *t*-tests for all three domain specific contrasts did not yield any significant differences in activation between groups.

Whole-brain regressions

Next, we examined relations with questionnaire self-concept measures by means of whole-brain regression analyses. For the whole-brain contrasts Self > Control, Academic > Control, and Physical > Control, higher self-esteem was associated with increased activation in the mPFC for evaluating self traits (**Table 3 and Table 5**). To further explore this relation for both groups, we extracted an ROI of this region activated in each whole-brain contrast. The results are visualized in **Figure 3** and indicate that individuals with higher self-esteem recruited the mPFC more during self-reflection than individuals with lower levels of self-esteem. As a follow-up analysis, we conducted an ANOVA for mPFC-activity with group as between-subjects factor and age and IQ as covariates. For the mPFC ROI extracted from the Self > Control contrast, we found a significant effect of group ($F(1,80) = 5.25$, $p = .025$, $\eta_p^2 = .06$), in which the gap year group showed lower averaged mPFC activity ($M = 0.65$) compared to the control group (M = 1.55). We found similar group effects for the mPFC ROI extracted from the Academic > Control contrast (F(1,80) = 8.26, p = .005, η_p^2 = .09; $M_{gap\ year}$ = 0.28, $M_{control}$ = 1.17) and the Physical > Control contrast (F(1,80) = 9.65, p = .003, η_p^2 =.11; $M_{gap\ year}$ = 0.79, $M_{control}$ = 2.08). However, it should be noted that these ROIs were extracted from the whole-brain contrasts with self-esteem as regressor, therefore results could be biased towards the behavioral findings of differences in self-esteem between groups.

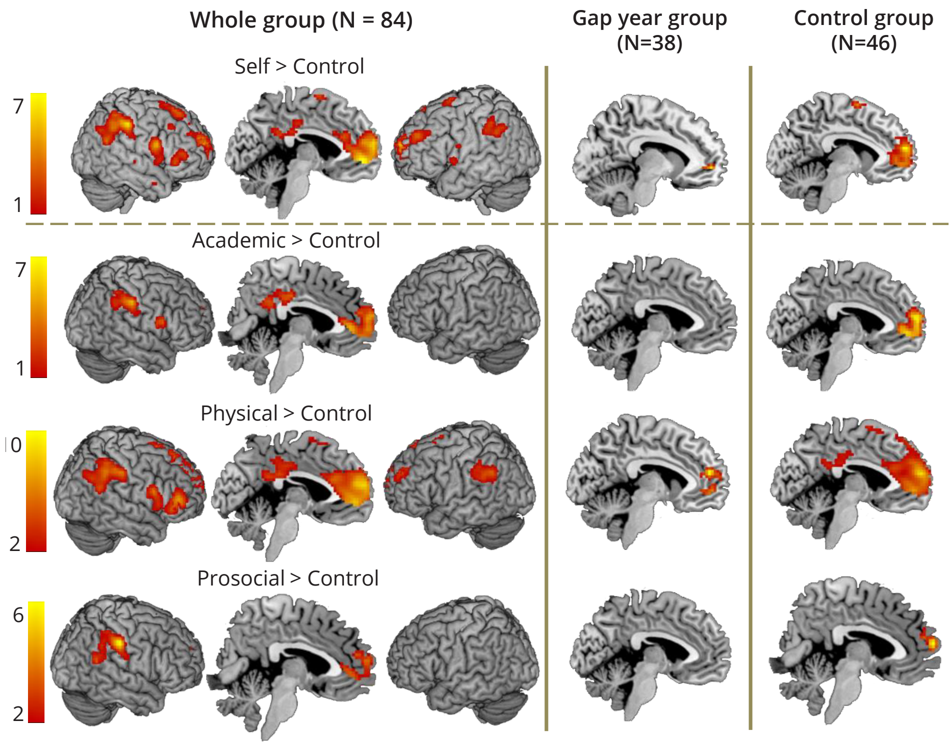

Figure 2*: Activity for the whole-brain contrasts Self > Control, Academic > Control, Physical > Control, and Prosocial > Control for both groups combined (N =84), and for the gap year group (N = 38) and the control group (N = 46) separately.*

To test whether the relation between self-esteem and mPFC activity was present in both groups, or was only found because self-esteem differs for the two groups, we calculated partial correlations between mPFC and self-esteem while controlling for group membership. This analysis showed that the relation between self-esteem and mPFC activity when thinking about self was still significant for all three contrasts (Self > Control: r = .36, p = .001; Academic > Control: r = .43, p < .001; Physical > Control: r = .33, p = .002), indicating a general relation between mPFC and self-esteem across participants in both groups.

Finally, we conducted similar whole-brain regression analyses with self-concept clarity as regressor variable, but this did not result in significant clusters of activation.

Table 3.
Regions activated for the contrast Self > Control for both groups combined (*N* = 84)

	Region	BA	Coordinates			Cluster Size	T
Self > Control							
Frontal cortex/	L Mid Orbital Gyrus (mPFC)	32	-3	50	-5	1025	7.09
subcortical	L Superior Medial gyrus	10	-6	59	13		6.61
	R Anterior Cingulate Cortex	32	3	41	4		6.09
	R Inferior Frontal Gyrus (IFG)	44	57	11	22	106	5.73
	R Inferior Frontal Gyrus	44	54	14	4		3.60
	R Inferior Frontal Gyrus	45	48	32	1	55	4.20
	R Inferior Frontal Gyrus	46	48	41	10		4.10
	L Suppl Motor Area (SMA)	6	-6	2	67	104	4.59
	R Superior Medial Gyrus	6	12	26	58		4.56
	R SMA	6	9	11	64		3.99
	R Middle Cingulate Cortex	23	3	-22	37	90	4.46
Parietal cortex	R SupraMarginal Gyrus (TPJ)	40	60	-25	46	353	6.68
	R Inferior Parietal Lobe	40	54	-46	40		4.89
	R Angular Gyrus	39	60	-52	25		4.75
	L SupraMarginal Gyrus (TPJ)	39	-60	-43	34	91	4.29
	L Inferior Parietal Lobe	40	-57	-37	46		4.19
	L Inferior Parietal Lobe	40	-54	-31	37		3.89
	L Posterior Cingulate Cortex (PCC)		0	-43	25	70	4.09
	R Precuneus	23	9	-52	31		4.09
	L Precuneus	31	-9	-55	31		3.55
Self > Control with self-esteem as positive regressor (N = 84)							
Frontal cortex	R Superior Medial Gyrus (mPFC)	10	6	59	7	66	4.37

Note: Names were based on Automatic Anatomical Labeling (AAL) atlas.

Table 4.
Regions activated for the contrast Self > Control for both groups separately

	Region	BA	Coordinates			Cluster Size	T
Self > Control							
Control group (N = 46)							
Frontal cortex/	L Superior Medial Gyrus (mPFC)	10	-6	59	16	927	7.57
subcortical	L Anterior Cingulate Cortex	32	-3	50	-2		6.59
	L Superior Medial Gyrus	10	-9	59	7		5.92
	R Inferior Frontal Gyrus (IFG)	44	57	11	22	167	5.77
	R Rolandic Opperculum	6	54	5	16		4.76
	R Inferior Frontal Gyrus	44	51	14	1		4.11
	L SMA	6	-6	2	67	106	5.42
	R Superior Medial Gyrus	8	12	29	55		4.21
	R SMA	6	9	11	64		4.19
Parietal cortex	L Inferior Parietal Lobe (TPJ)	39	-57	-46	37	90	4.81
	L Inferior Parietal Lobe	40	-57	-37	46		4.10
	L Supramarginal Gyrus	40	-57	-31	31		4.06
	R Inferior Parietal Lobe (TPJ)	40	57	-46	40	128	5.80
	R Angular Gyrus	39	60	-52	25		4.27
	R Angular Gyrus	39	42	-52	31		4.25
	R Supramarginal Gyrus (TPJ)	40	57	-28	46	57	5.81
Self > Control Gap year group (N = 38)							
Frontal cortex/	R Anterior Cingulate Cortex (ACC)	32	6	41	-2	59	5.18
subcortical	L Mid Orbital Gyrus	10	-9	53	-2		4.93

Note: Names were based on Automatic Anatomical Labeling (AAL) atlas.

Table 5.
Regions activated during the domain contrasts for both groups combined (*N* = 84)

	Region	BA	Coordinates			Cluster Size	T
Academic > Control							
Frontal cortex	L Mid Orbital Gyrus (vmPFC)	10	-9	56	-2	672	7.06
	L Superior Medial gyrus	10	-6	62	10		6.02
	R Anterior Cingulate Cortex	32	6	38	7		5.88
	R Inferior Frontal Gyrus (IFG)	44	57	11	22	70	5.08
Parietal cortex	R SupraMarginal Gyrus (TPJ)	40	60	-25	46	201	5.98
	R SupraMarginal Gyrus	40	48	-40	43		4.09
	R Inferior Parietal Lobe	40	51	-43	55		3.97

Table 5.
Continued

	Region	BA	Coordinates			Cluster Size	T
	L Posterior Cingulate Cortex	23	0	-46	31	246	4.77
	L Precuneus	23	-6	-55	25		4.65
	R Middle Cingulate Cortex	31	3	-22	37		4.58
Physical > Control							
Frontal cortex	L Superior Medial Gyrus (mPFC)	10	-6	56	16	1773	10.25
	L Anterior Cingulate Cortex	32	-3	50	-2		7.46
	L Superior Medial Gyrus	10	-9	59	1		7.14
	R Middle Frontal Gyrus	46	45	41	10	410	6.26
	R Inferior Frontal Gyrus	44	57	11	22		5.93
	R Inferior Frontal Gyrus	47	48	29	-2		4.82
	R Superior Medial Gyrus	8	12	29	55	176	4.84
	R SMA	6	6	17	61		4.79
	L SMA	6	-6	2	67		4.69
Parietal cortex	R Inferior Parietal Lobe (IPL)	40	57	-46	40	342	6.17
	R Supramarginal Gyrus	40	57	-28	46		5.61
	R Middle Cingulate Cortex (MCC)	23	6	-28	31	192	4.72
	L Posterior Cingulate Cortex		0	-40	25		4.23
	R Middle Cingulate Cortex	23	3	-22	37		4.17
Prosocial > Control							
Frontal cortex	L Anterior Cingulate Cortex	32	-3	50	-2	296	5.59
	R Superior Medial Gyrus	10	6	53	19		4.76
	L Superior Medial Gyrus	10	-12	56	13		4.65
Parietal cortex	R Supramarginal Gyrus (TPJ)	40	60	-25	46	239	6.63
	R Angular Gyrus	39	60	-52	25		4.36
	R Inferior Parietal Lobe	40	48	-40	46		4.05
Whole-brain regressions with self-esteem							
Academic > Control							
Frontal cortex	L Superior Frontal Gyrus (mPFC)	10	-18	65	16	95	4.90
	R Superior Medial Gyrus	10	6	59	7		4.12
	L Superior Medial Gyrus	10	-6	65	19		4.05
Parietal cortex	L Postcentral Gyrus	1	-48	-40	58	63	5.31
	L Postcentral Gyrus	1	-39	-43	64		4.70
	L Superior Parietal Lobe	7	-33	-55	64		3.33

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Table 5.
Continued

	Region	BA	Coordinates			Cluster Size	T
Physical > Control							
Frontal cortex	R Superior Medial Gyrus (mPFC)	10	3	59	10	113	4.60
	R Superior Medial Gyrus	10	12	50	4		3.68

Note: Names were based on Automatic Anatomical Labeling (AAL) atlas.

Table 6.
Regions activated during the domain contrasts for both groups separately

	Region	BA	Coordinates			Cluster Size	T
Control group (N = 46)							
Academic > Control							
Frontal cortex	L Mid Orbital Gyrus (vmPFC)	10	-9	59	-2	534	5.92
	L Superior Medial Gyrus	10	-6	59	16		5.87
	L Superior Medial Gyrus	10	-9	59	7		5.64
	L Superior Frontal Gyrus (dlPFC)	10	-21	53	28	72	5.29
	L Middle Frontal Gyrus	10	-30	47	31		4.11
	R Inferior Frontal Gyrus (IFG)	44	57	11	22	75	5.09
	R Rolandic Operculum	6	54	5	16		4.43
	R Rolandic Operculum	4	57	-4	16		3.58
Parietal cortex	L Inferior Parietal Lobe (IPL)	40	-54	-28	37	86	4.38
	L Inferior Parietal Lobe	39	-60	-46	37		4.15
	L Inferior Parietal Lobe	40	-57	-37	46		3.93
Physical > Control							
Frontal cortex	L Superior Medial Gyrus (mPFC)	10	-6	56	16	1773	10.25
	L Anterior Cingulate Cortex	32	-3	50	-2		7.46
	L Superior Medial Gyrus	10	-9	59	1		7.14
	R Middle Frontal Gyrus	46	45	41	10	410	6.26
	R Inferior Frontal Gyrus	44	57	11	22		5.93
	R Inferior Frontal Gyrus	47	48	29	-2		4,82
	Right Superior Medial Gyrus	8	12	29	55	176	4.84
	Right SMA	6	6	17	61		4.79
	Left SMA	6	-6	2	67		4.69
Parietal cortex	R Inferior Parietal Lobe (IPL)	40	57	-46	40	342	6.17
	R Supramarginal Gyrus	40	57	-28	46		5.61

Table 6.
Continued

	Region	BA	Coordinates			Cluster Size	T
	L IPC		-57	-55	40		5.85
	Left Inferior Parietal Lobe	39	-57	-46	37	149	5.47
	Left Supramarginal Gyrus	40	-57	-31	31		3.94
	Right Middle Cingulate Cortex	23	6	-28	31	192	4.72
	Left Posterior Cingulate Cortex		0	-40	25		4.23
	Right Middle Cingulate Cortex	23	3	-22	37		4.17
Prosocial > Control							
Frontal cortex	L Superior Medial Gyrus (mPFC)	10	3	62	13	135	5.19
	L Superior Medial Gyrus	10	-6	59	16		4.43
	R Superior Medial Gyrus	9	12	56	25		3.85
Gap year group (N = 38)							
Physical > Control							
Frontal cortex	L Superior Medial Gyrus (mPFC)	10	-6	50	16	195	5.67
	R Anterior Cingulate Cortex	32	6	41	-2		5.23
	L Mid Orbital Gyrus	10	-9	53	-2		4.76
Parietal cortex	R Supramarginal Gyrus (TPJ)	40	48	-43	43	66	4.61
	R Inferior Parietal Lobe	40	57	-37	52		3.90
	R Supramarginal Gyrus	40	63	-25	43		3.55

Note: Names were based on Automatic Anatomical Labeling (AAL) atlas.

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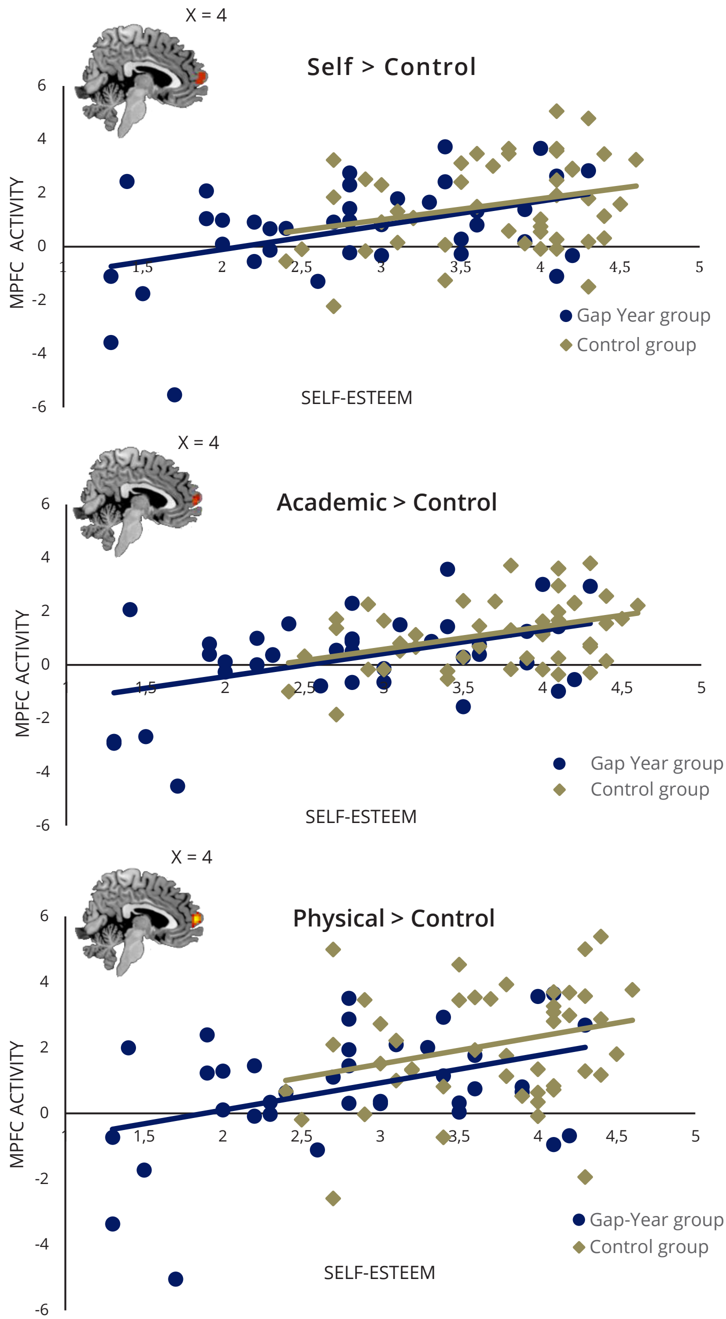

***Figure 3**: mPFC shows increased activity for increased self-esteem in the contrasts Self > Control, Academic > Control, and Physical > Control.*

DISCUSSION

In this study, we investigated behavioral and neural correlates of self-concept and self-esteem in individuals who experience problems with educational decision-making. We compared adolescents who were struggling with the educational decision-making process and were at the start of a structured gap year program (gap year group) to adolescents who already successfully transitioned into higher education (control group) on measures of domain specific self-evaluations, self-concept clarity and self-esteem. Results revealed two key findings. First, adolescents struggling with educational decision-making reported lower levels of self-esteem and self-concept clarity compared to a control group, but did not differ in their self-evaluations specific to domain. Second, lower self-esteem was associated with less self-related activity in the medial prefrontal cortex, especially for evaluating academic and physical traits. These findings will be described in more detail in the following paragraphs.

Differences in behavioral self-concept and self-esteem

Our first aim was to investigate characteristics related to self-evaluation in individuals who experience difficulties with educational decision-making compared to a control group. In line with our expectations, individuals who were struggling with educational decision-making scored significantly lower on self-concept clarity and self-esteem compared to their already-decided peers. Regarding self-esteem, these results are consistent with other studies relating self-esteem to career indecision and career decision-making self-efficacy (Choi et al., 2012; Creed, Prideaux, & Patton, 2005; Gati et al., 2011; Germeijs & De Boeck, 2002; Lin et al., 2015). Self-esteem could contribute to greater efficacy in decision-making as individuals with more self-esteem possess more positive attitudes, value the self more and therefore might engage more often in exploring and prioritizing their interests (Lin et al., 2015). Self-esteem could also function as a mechanism encouraging more goal-directed behavior (e.g. choosing a major based on own intrinsic interests and personal goals, not influenced by parental expectations) and could contribute to the confidence needed to make the final decision.

As predicted, we also found group differences in self-concept clarity. This is unsurprising as individuals with higher self-esteem are often also more confident in their self-judgments, and those self-judgments tend to be more stable and consistent (Campbell, 1990). These results could also be interpreted in the context of decision-making. For example, research has indicated that individuals who hold their self-beliefs with more certainty are also more likely to use self-knowledge to guide their decisions (Setterlund & Niedenthal, 1993; Story, 2004). Not having a clear sense of who you are could therefore also interfere in the process of deciding for a suitable major. For example, individuals with low self-concept clarity might be less confident that their strengths and weaknesses at the time of deciding for a college major will be the same in the future, and might anticipate regretting their decision. This could negatively influence their motivation to explore different options, and increase the chance of remaining undecided. Future studies should test these hypotheses in more detail using longitudinal designs to examine the temporal relation between self-esteem, self-concept clarity and educational decision-making.

Interestingly, we did not find any group differences in domain-specific self-evaluations. Contrary to our expectations, the gap year group did not evaluate themselves more negatively on academic traits. These results suggest that it is not necessarily their academic abilities that the gap year individuals are insecure or more negative about. Instead, their lack of a clear self-concept and low self-esteem are possibly a greater hindering factor for finding a future major that fits their identity. It is possible that they are confident that they have the academic potential to succeed in higher education, but lack the self-insight or self-esteem needed to choose a suitable major.

Differences in neural correlates of self-concept and self-esteem

An important way to clarify the underlying mechanisms of self-concept and educational decision making is by using neuroimaging measures as they may provide additional information about the networks underlying the process of making self-evaluations (Denny, Kober, Wager, 2012; Pfeifer & Peake, 2012). A second aim of this study was therefore to compare neural activity patterns in participants who struggle with educational decision-making to peers without such problems, and to examine whether activity was dependent upon individual differences in self-esteem and self-concept clarity. As anticipated, across all participants we found increased activity in cortical midline areas (such as mPFC) during self-evaluations across domains compared to a control task. This is consistent with studies investigating neural correlates of self-processing in adults as well as in adolescents (Flagan & Beer, 2013; Northoff & Bermpohl, 2004; Pfeifer & Berkman, 2018; Romund et al., 2017).

To examine how this neural activity differed between participants struggling with educational decision-making versus those who did not experience difficulties, we directly compared the groups to each other. In contrast to our expectations, a direct comparison did not result in neural differences between the groups for domain-general - nor for domain-specific self-evaluations. However, because the two groups differed in self-esteem, we also tested for self-related brain regions that co-varied with individual differences in self-esteem. Using self-esteem as a continuous measure could be more valuable than comparing at a group level, as this also takes into account individual differences within groups (Altman & Royston, 2006). We observed that individuals with higher levels of self-esteem recruited the mPFC more during self-reflection than did individuals with lower levels of self-esteem. This relationship was present for the evaluation of academic as well as physical traits. This indicates that self-esteem dependent individual differences in mPFC-recruitment are reflected in multiple domains. Thus, we found no whole-brain group differences in neural activity, but the groups differed on self-esteem and lower individual levels of self-esteem were associated with reduced self-related mPFC activity. These results highlight the importance of using an individual differences approach to examine the neural characteristics of individuals struggling with educational decision-making.

Prior studies have also observed relations between brain activity and self-esteem in comparable paradigms, such that individual differences in self-esteem were related to processing of self-referential items in dACC and OFC (Yang et al., 2012, 2016). This study, in contrast, observed that specifically the central part of the mPFC correlated with self-esteem. Differences between these results and our findings can possible be explained by the valence of the items as well as the choice of control condition. For example, Yang and colleagues (2016) reported a positive relation between OFC activity and self–esteem during self-evaluation of positive traits only, and these were contrasted against evaluation of traits of others, instead of the more basic semantic control condition used in our study. These design differences could have contributed to the relatively more ventral PFC regions being activated in Yang et al., which are regions known for supporting affective processing and have been related to more positive as well as more self-relevant self-descriptions (D'Argembeau, 2013; Moran, Lee, & Gabrieli, 2011), while in our study self-esteem was related to more central mPFC activation for thinking about the self in general compared to a more basic control task. In addition, Yang and colleagues (2016) did show a positive relation between mPFC activity and self–esteem, but only during evaluation of positive descriptions from others about the self. Together, these results suggest that self-esteem could serve as an important condition to help individuals in mentalizing about the self as well as about opinions of others about the self. Given that we found that individuals who struggled with educational decision-making scored lower on self-esteem, it would be an interesting future direction to investigate how self-esteem interventions could influence the content and valence of these self-appraisals and related neural activity.

The lower self-related mPFC activity which we found in individuals with lower self-esteem has also consistently been found in individuals with autism or alexithymia who are known for their deficits in self-awareness and impairments in mentalizing (Moriguchi et al., 2006; Pfeifer et al., 2013; Uddin, 2011). However, in our study it would be more likely to expect to find this relation with self-concept clarity, as this construct is more closely related to lower self-awareness. Interestingly, we did not find any neural activity related to individual differences in self-concept clarity, A prior study by

D' Argembeau did show that higher self-certainty was reflected in increased dmPFC activation (D'Argembeau et al., 2012). Possibly, these differences in findings are related to a difference in measures. Whereas self-certainty measures certainty of possessing traits related to specific domains, self-concept clarity reflects general stability and internal consistency of the self-concept (Campbell, 1990). Future studies are needed to unravel the interplay between self-certainty, self-concept clarity, self-esteem and self-processing on a behavioral and neural level.

Limitations, Future directions and Conclusions

In this study we compared a specific group of adolescents struggling with educational decision-making with adolescents who did not. Although this method increased our understanding of the behavioral and neural self-related characteristics of this specific group, results should be interpreted in light of several limitations. First, the experience of educational decision-making problems can be confounded with other difficulties (e.g. in the clinical range). Therefore it is inherently difficult to find a control group that precisely matches the gap year group, as they might differ in more areas than just educational decision-making. Larger samples in which various individual difference factors are controlled for can possibly provide more insight into these specificities.

Second, in this study we only investigated differences in self-concept measures between groups and did not test direct relations between self-concept and specific educational decision-making problems (e.g. differentiating between educational indecision or deciding but stopping in the first year). Therefore, we were not able to draw conclusions about what self-concept variables are better predictors for certain educational decision-making problems. Future studies should take these distinctions into account in order to increase our understanding of predictors of these various problems.

Additionally, future research would benefit from using larger samples and randomized control trials or longitudinal designs to separate cause and effect. For example, future studies should investigate whether individuals have lower self-esteem as a result of their difficulties with educational decision-making (perhaps by not conforming to the societal norm of pursuing a college degree, lacking structure or clear future life goals, or the feeling of lagging behind compared to their peers), or whether low self-esteem holds back self-exploration thereby hindering them from making an informed decision for a future major that fits their identity (Lin et al., 2015).

Despite these limitations, our results add to an increasing understanding of characteristics of individuals struggling with choosing a future major or career, and stress the importance of investigating non-cognitive, psychological factors in the decision-making process, as well as their underlying neural mechanisms. Moreover, as we did not find any differences in self-evaluations specific to domain, our results suggest that general factors relating to the structure and positivity of the self are possibly of greater relevance in the process of educational decision-making rather than domain-specific self-evaluations, such as how one evaluates their academic abilities. Our behavioral and neural results regarding differences in self-esteem especially highlight that healthy levels of self-esteem could be an important condition for the ability to make a well suited educational choice. These findings have important implications for future interventions, and emphasize the need for more attention to personal development in high-school in order to increase the possibilities for adolescents to find a major that fits their interests, abilities and goals.


Hoe heb jij je ontwikkeld in je Breekjaar?
"Ik ben zelfverzekerder geworden en twijfel een stuk minder aan alles.
Ik heb vertrouwen gekregen in mijzelf en in mijn toekomst."
Daniel, 19 jaar

Chapter 5

BETTER SELF-CONCEPT, BETTER FUTURE CHOICES? BEHAVIORAL AND NEURAL CHANGES AFTER A NATURALISTIC SELF-CONCEPT TRAINING PROGRAM FOR ADOLESCENTS

This chapter is under review as:
Van der Aar, L.P.E., Peters, S., Becht, A.I., & Crone, E.A. Better self-concept, better future choices? Behavioral and neural changes after a naturalistic self-concept training program for adolescents.

ABSTRACT

An emerging problem in our society is that young people experience difficulties matching their self-views to possible suitable programs in higher education, which can lead to high levels of drop-out and increasing number of gap years. This study addressed this issue by examining the effects of a naturalistic self-concept training within a gap year context on behavioral and neural correlates of self-evaluations, as well as the long-term effects for future educational decision-making. In total, 38 adolescents/ young adults (ages 16 – 24 years) participated in a 4-wave longitudinal study, with lab visits before, during, and after the training including behavioral assessments and fMRI. During fMRI-scanning, they rated themselves on positive and negative traits in academic, (pro)social, and physical domains, and additionally filled out questionnaires related to self-esteem and self-concept clarity. Results showed that the positivity of domain-specific self-evaluations, self-esteem and self-concept clarity increased during the training. Second, participants with lower medial PFC activity during self-evaluation before training showed larger self-esteem increases over the year. Moreover, mPFC activity increased after training for the evaluation of positive, but not negative traits. Furthermore, individual differences in the rate of change (slope) in self-concept clarity and social self-evaluations positively predicted social adjustment to college and academic performance 6 months after training. Together, these findings suggest that self-concept can be modulated in late adolescents, with an important role of the medial PFC in relation to enhanced positive self-evaluations, and self-concept clarity as a predictor of future educational outcomes.

INTRODUCTION

Adolescence is a period in life during which the ability for self-reflection is still developing (Sebastian, Burnett, & Blakemore, 2008). How adolescents view and evaluate themselves can play an important role in various life outcomes. For example, many studies have demonstrated positive relations between the positivity of self-evaluations and general well-being, mental health, as well as motivation and achievement in school (Marsh & Martin, 2011; Orth, Robins, & Widaman, 2012). Within this school domain, the transition into higher education is an important life change that almost all adolescents have to face but that remains relatively understudied. In this process, having a clear and coherent self-concept appears crucial in order to choose a suitable future educational or career path (Eccles, 2009), referred to as educational decision-making in this study. For example, in a recent study we showed that the overall evaluation of the self (self-esteem) and the clarity of self-beliefs (self-concept clarity) were significantly lower in adolescents who experienced difficulties with educational decision-making compared to peers who already successfully transitioned into higher education (van der Aar, Crone, & Peters, 2019)

The fact that educational decision-making can be challenging, especially at a relatively young age, is also reflected in an increasing number of adolescents who are postponing this choice by taking one or multiple gap years before starting a major in higher education. In the Netherlands, statistics show that one in ten students had taken a gap year before starting college education in 2017, an increase of almost 6 % over 10 years (Researchned, 2018a). The majority of adolescents who took a gap year indicated the main reason for their gap year was to gain more time to reflect upon themselves and their options in order to make a suitable choice for their future (Researchned, 2018a). This raises the question whether a gap year could also be used as a targeted intervention period explicitly focused on self-concept development, thereby increasing adolescents' chances of finding a suitable major. Therefore, the goal of this study was to examine the effects of a self-concept training within a gap year context to prepare for future educational decision-making.

A neuroscientific approach to self-concept and self-concept training

Adolescence is an especially interesting period to investigate self-concept development as decades of research have shown that this phase in life is particularly important for identity development, and a time where the structure and evaluation of the self are still highly changeable (Becht et al., 2016; von Soest, Wichstrøm, & Kvalem, 2016). Our understanding of adolescence as an inflection period has benefited from research on brain development, which demonstrated that the cortical midline regions of the brain, spanning from anterior cingulate cortex (ACC) to posterior cingulate cortex (PCC), but specifically the medial prefrontal cortex (mPFC), play an important role in self-evaluation (Pfeifer & Berkman, 2018; Romund et al., 2017; van der Cruijsen, Peters, van der Aar, & Crone, 2018). Prior studies showed that activity in these regions continue to develop during adolescence (Pfeifer et al., 2013; Pfeifer & Berkman, 2018) consistent with research showing that self-concept has a prolonged developmental trajectory (Van Doeselaar, Becht, Klimstra, & Meeus, 2018).

Recent studies have shown dissociable brain activity in regions related to a specific self-concept domain (e.g. self-evaluations in academic, social, or physical appearance domains) or valence of traits (e.g. positive versus negative self-evaluations). For example, evaluating academic traits such as “I am smart” was shown to elicit specific activity in the PCC/precuneus (Van der Aar, Peters, van der Cruijsen, & Crone, 2019; van der Cruijsen et al., 2018). Additionally, more specific parts of the mPFC have been linked to differences in valence and self-relevance of traits, such that stronger activation in the ventral part of the mPFC (vmPFC) has been related to more positive as well as more self-relevant self-descriptions (D’Argembeau, 2013; van der Cruijsen et al., 2018).

Furthermore, prior studies showed that self-concept can be dissociated in *direct* (how do I think about me?) and *reflected* self-concept (how do I think that others think about me?) (Jankowski, Moore, Merchant, Kahn, & Pfeifer, 2014; Pfeifer et al., 2009). Especially the temporal-parietal junction (TPJ), a region of the social brain network that is involved in perspective taking (Schurz, Radua, Aichhorn, Richlan, & Perner, 2014), plays an important role in both direct and reflected self-evaluations, in interaction with behavioral positivity ratings. For example, van der Cruijsen and colleagues (2019) showed that the TPJ was more strongly activated for reflected than direct self-evaluations when adolescents were less positive about themselves. Possibly, these results indicate that these adolescents are more concerned about the opinions of others compared to adolescents who are more positive about themselves.

Taken together, the neural processes underlying self-evaluation appear specifically targeted in the mPFC for positively-valenced self-evaluations (Van der Cruijsen et al., 2018), PCC/precuneus for academic self-evaluations (van der Aar et al., 2019) and TPJ for reflected self-evaluations (Jankowski et al., 2014; Van der Cruijsen et al., 2019), but these regions form part of a larger network with strong interconnections (Sebastian et al., 2008). It is not yet understood how these regions are sensitive to changes in (domain-specific) self-evaluations, self-esteem and self-concept clarity over time. It was previously suggested that the developing brain is influenced by cognitive and social experiences throughout adolescence, with considerable implications for treatment and intervention (Jolles & Crone, 2012). However, the transitional phase of late adolescence into young adulthood is relatively understudied, especially in brain research (Veroude, Jolles, Croiset, & Krabbendam, 2013). Consequently, we currently have little understanding of whether in late adolescents, self-concept can be fostered through training and which underlying neural mechanisms would drive these changes. Therefore, in this study we aimed to examine both the neural and behavioral effects of self-concept training in a gap year context.

Gap year and self-concept interventions

To our knowledge, no studies have investigated the effects of a transitional gap year that consists of a self-concept training. Existing research on self-concept training has mostly been performed within school contexts, targeting school-age populations (up to 18 years). Review studies have concluded that these intervention programs are generally successful in enhancing general self-esteem and domain-specific aspects of self-concept, such as improving self-perceptions within the academic domain (Haney & Durlak, 1998; O'Mara, Marsh, Craven, & Debus, 2006). Harter (2012), and Bos and colleagues (2006) suggested that important working mechanisms for self-concept interventions are related to the *cognitive* and *social* determinants of self-concept. That is, they argue that self-concept interventions should be aimed at changing both cognitive aspects (e.g. reframing dysfunctional self-beliefs), and social factors (e.g. increase of social support, internalization of positive opinions of others) in order to have a significant positive outcome.

These interventions however, are rarely only focused on changing self-concept but are often imbedded in larger intervention programs aimed at promoting social-emotional skills in young people. An example of a popular, worldwide used group of programs is SEL (Social Emotional Learning; Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011). SEL programs are school-based and aim to foster competencies related to the self (e.g. self-awareness and self-management, decision-making skills) and others (empathy, perspective-taking, relationship skills). These competencies, in turn, are expected to improve academic performance, adjustment, self-perceptions and positive social behaviors (Gutman & Schoon, 2013). Several meta-analyses have shown generally positive findings, with significantly improved social and emotional skills, increased self-confidence and academic performance compared to control participants (Durlak et al., 2011; Durlak, Weissberg, & Pachan, 2010).

The current study

The current study made use of an ecologically valid existing gap year program in the Netherlands, called "The Gap Year program" (www.breekjaar.nl). This program provides a 10- month training program for adolescents between 16 – 24 years who experience difficulties with making future academic and career choices. It is based on the concept of 'folk high schools' found in Scandinavian countries which promote lifelong learning; the idea that schools should educate for life. The Gap Year program has a large overlap with SEL programs; it focuses on fostering self-concept development within the larger context of training social competences (for more information on the content of the program, see method section: Training program).

For this pre-registered study (see https://osf.io/8mspn/), we examined changes in self-concept in terms of domain-specific self-evaluations (academic, physical, prosocial and social), as well as a more global evaluation of the self (self-esteem), and changes in the structure of the self (self-concept clarity). The main objectives were to (1) test whether self-concept training, as observed in a naturalistic setting within a gap year context, would be beneficial for the development of domain-specific self-evaluations, self-esteem and self-concept clarity, (2) examine the neural circuitry associated with self-processing before and after the training, and to test whether changes in activity in medial PFC, precuneus and TPJ were correlated with changes in the positivity of domain-specific self-evaluations and self-esteem, and (3) test the predictive value of changes in behavioral indices of self-concept for future educational decision-making.

To test for training effects, we examined the behavioral and neural correlates of self-concept before the start of the training program (baseline; time point 1 (T1)), and after the program (10 months; T3). For this purpose, participants completed a task that included evaluations of direct and reflected self traits across academic, (pro)social and physical trait domains (based on van der Cruijsen et al., 2018) during fMRI scanning. Furthermore, we additionally collected behavioral data halfway through the program (5 months; T2) and at follow up (18 months; T4) to follow the time course of changes, and the predictive value for the final time point (see **Figure 1** for a visualization of the study design).

Pre-registered hypotheses

Our pre-registered hypotheses were as follows: behaviorally (aim 1), we expected that that the focus the self during the training would result in a more positive self-concept after training (Bos et al., 2006), reflected in an increase in the positivity of all domain-specific self-evaluations (from both direct and reflective perspectives), self-esteem and enhanced self-concept clarity after training. For all variables, we expected linear increases across the training year. As the training takes place in a group, we expected that participants would benefit from the advantages of group counseling, such as peer acceptance and increased social skills (Forsyth, 2015; Hoag & Burlingame, 1997). Therefore we expected that the increase in the positivity of self-evaluations would be most significant for the social domain.

In terms of neural activity (aim 2), we focused on changes in the medial PFC, precuneus, and TPJ as three regions of interest that were previously shown to play an important role in self-evaluation (Pfeifer & Peake, 2012). First, we predicted that thinking about self (versus a control task) would be associated with increased activity in medial PFC. We previously demonstrated based on the data from the first time point (before training) that medial PFC activity was positively correlated with self-esteem ratings (van der Aar, Crone, et al., 2019). Therefore, we predicted that increases in self-esteem would be associated with increases in medial PFC activity during self-evaluation after training. Additionally, based on literature relating self-relevance of traits to increased (ventral) medial PFC activity, we expected that that more positive self-evaluations would be reflected in increased mPFC activation for evaluating positive versus negative self-traits after training (D'Argembeau, 2013). Second, we predicted that precuneus would show increased activity for evaluating academic traits specifically (versus a control task), and would be correlated with changes in behavioral positivity of self-evaluations in the academic domain (Van der Aar et al., 2019). Third, as a reflection of the internalization of positive opinions of others, we expected increases in right TPJ activity for direct versus reflected self-evaluations that would be associated with increases in behavioral positivity of self-evaluations (Van der Cruijsen, et al., 2019).

Finally, with regard to the predictive value of changes in self-concept for successful educational decision-making (aim 3), we expected that individual differences in changes in self-esteem and self-concept clarity during the year of training (T1, T2, T3) would be predictive of outcomes related to educational decision-making on T4. That is, we expected participants with higher starting levels of self-esteem/self-concept clarity and/or stronger increases in self-esteem/self-concept clarity levels to show more positive outcomes related to *general* outcomes (satisfaction with the chosen study or career path, and satisfaction with life) as well as more positive *academic* outcomes (related to study commitment, academic motivation, adjustment, engagement, and performance). For more information on the outcome measures, see method section. Additionally, we focused specifically on the predictive value of the social domain and academic domain for positive outcomes, because of the embedding of the program in social competence training and the focus on academic outcomes. For the social domain, we expected that participants with higher starting points and/or stronger increases in positivity scores would show increased life satisfaction as well as better social adjustment to college (Proctor, Linley, & Maltby, 2009). For the academic domain, we expected participants with higher starting points and/or stronger increases in positivity scores to show better academic motivation, academic adjustment to college and academic performance (Huang, 2011; Valentine, Dubois, & Cooper, 2004; Wouters, Germeijs, Colpin, & Verschueren, 2011).

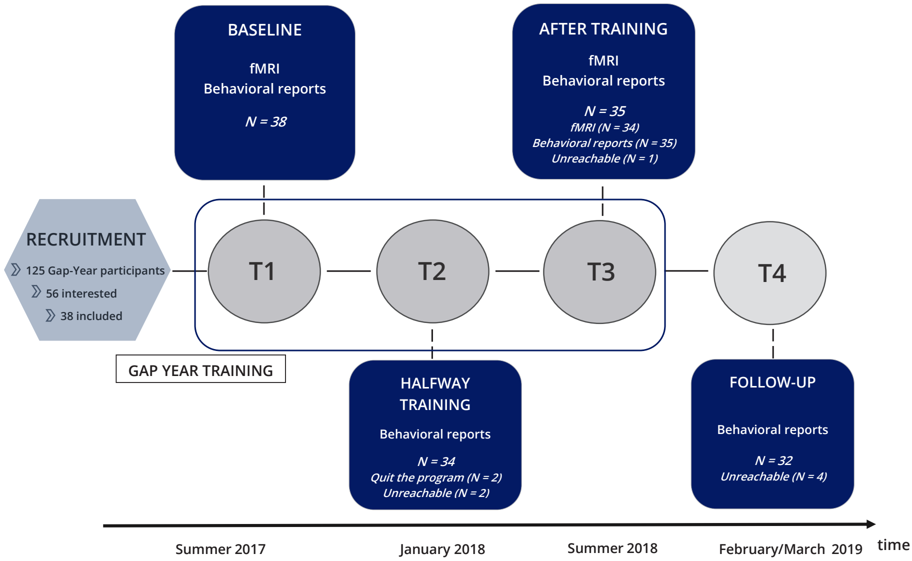

Figure 1: *Study design with timeline and overview of participants included at each wave.*

METHOD

Participants

A total of 38 late adolescents/young adults in the age range of 16 – 24 years (M_{age} = 18.73; *SD* = 1.47; 24 females) participated in this 4-wave longitudinal study. Results from the first data wave have been published previously (van der Aar et al., 2019). Participants were recruited in collaboration with Foundation Gap Year before they started their gap year training program in September 2017. For recruitment, we were dependent upon the number of places the Gap Year program has available per year and the application period for the program. For the year 2017-2018, the program had a capacity of 125 spaces. Adolescents were asked at their intake conversation with the program whether they were interested in participating in this study. If they showed interest, their contact information was sent to us. We started recruitment in June and continued recruitment and inclusion of participants until the program started at the beginning of September.

In total, 56 adolescents showed interest in our study (45% of the total number of applications). Of these 56, 38 adolescents were ultimately included in the study. Reasons for exclusion were MRI contraindications (*N* = 8) or current use of psychotropic medications (*N* = 2). Some adolescents withdrew (*N* = 3) or could not be reached before the start of the program (*N* = 5). We chose to include individuals with a clinical diagnosis (N = 7) as long as they were not on medication at the time of testing, as studies have shown that experiencing problems with educational decision making or career indecision is often confounded with other psychological problems (Gati et al., 2011; Scholtens, Rydell, & Yang-Wallentin, 2013). Diagnoses included ADHD (N = 2), ADD (N = 3), AD (N = 1), and depression (N = 1). We included right-handed (N = 33) as well as left-handed individuals (N = 5) with the criterion that they were able to use the button box with their right hand.

All 38 participants graduated from high school. Fifteen participants reported they started at least one college major, but dropped out; 23 participants took part in the program directly after high school. They all participated in an MRI session before the start of the program (T1). Behavioral data at T2 were collected from 34 participants (two dropped out of the program, two were unreachable). At the end of their gap year, all 36 remaining participants were invited for a second MRI session at T3. MRI data were collected from 34 participants, one participant only filled out questionnaires due to MRI contraindications. At T4, questionnaire data were collected from 32 participants (four were unreachable). See **Figure 1** for an overview of the inclusion numbers at each wave.

At T1, an estimation of IQ was obtained based on two subtests of the Wechsler Adult Intelligence Scale-III (Similarities and Block Design). Estimated IQ scores were in the normal range (M_{IQ} = 104.47, SD_{IQ} = 9.5, range = 85 – 127.50). At each time point, written informed consents were provided by the participants themselves or by both parents for minors. Participants were screened for MRI contraindications, had normal (or corrected to normal) vision, were fluent in Dutch, had no neurological impairments, and were not taking psychotropic medication. The study was approved by the University Medical Ethics Committee.

Training program

The Gap Year program is a Dutch nonprofit organization that provides training programs for adolescents who have dropped out of higher education and experience difficulties with making future academic and career choices. Their aim is to help adolescents gain confidence and more self-knowledge, and to guide them towards making a well suited future academic or career choice. They have locations in multiple cities in the Netherlands (Amsterdam, Utrecht and Eindhoven) and can place around 120 participants per year. Participants of this program follow a 10-month training (September – June) focused on personal development and start working on improving their self-esteem and decision-making abilities.

The training consists of multiple projects that are scheduled across the year, each with a focus on the self, as well as a travel period. Examples of these projects are “Project me”, where adolescents learn more about themselves (their traits, talents, goals) together with a coach; “Project me and the other”, where it is explored how participants relate to others (e.g. peers or society); "Project me and the world", where participants are challenged to come out of their comfort zone and learn more about themselves and their behaviors while exploring the world in a 6 week travel period; and "Project me and the future", which focuses on the process of decision-making with an emphasis on choosing a future study or career path. The training takes place three days per week in groups with a maximum of 30 adolescents. Each group is mentored by three coaches. In addition, participants can get help from a study advisor and the coaches for individual sessions.

fMRI Task

Self-processing was studied with an fMRI task in which short sentences were presented that described positively or negatively-valenced traits or competencies in four specific domains: academic (e.g. 'I am smart' or 'I find school difficult'), physical (e.g. 'I am attractive' or 'I am overweight'), prosocial (e.g. 'I like to help others' or 'I ignore other people's problems'), social (e.g. 'I am spontaneous' or 'I feel lonely'), and one global domain (e.g. 'I am happy with myself' or 'I am insecure'). Each domain contained 20 traits (10 positive and 10 negative), making a total of 100 trait sentences. This task is part of the Leiden Self-Concept Study where the academic, physical, and prosocial domain have already been used (for more information and validation of the traits in these domains see van der Cruijsen, Peters, van der Aar, & Crone, 2018). For the current study, the social and global domain were added to obtain a more complete representation of the development of self-evaluation in domains that are expected to be significant during the gap year training. However, as the content of the global domain had a large overlap with our measure of self-esteem (correlations between .81 and .88 at each time point), we decided to omit the global domain and only focus on the four specific domains.

The additional social domain showed good reliability measured with Cronbach's alpha at each time point (positive valence: $\alpha = .89$ (T1), $\alpha = .85$ (T2), and $\alpha = .81$ (T3); negative valence: $\alpha = .80$ (T1), $\alpha = .69$ (T2), $\alpha = .85$ (T3)). For validation purposes, we correlated the social domain at T1 with a similar validated subscale of the Self Perception Profile for Adolescents (SPPA; Harter, 2012). Scores on the social domain correlated significantly with the subscale social competence (positive valence $r = .70$, $p < .001$.; negative valence $r = -.67$, $p < .001$).

The task consisted of two experimental conditions (the direct self-evaluation condition, and the reflected self-evaluation condition), and a control condition (**Figure 2**). In the direct self-evaluation condition, participants indicated to what extent they thought the presented trait fit them on a scale from 1 (*not at all*) to 4 (*completely*). In the reflected self-evaluation condition, participants were asked on a same scale to indicate how they thought *same-aged peers* would rate their traits. They were presented with the same trait sentences that were now preceded with the words "my peers think that..". Morphed pictures of unknown same-aged peers were shown during these trials to remind participants to take their peers' perspective while evaluating their traits. In the control condition, participants were asked to categorize trait sentences instead of evaluating them. Response categories were (1) school, (2) social, (3) appearance, or (4) I don't know. Twenty trait sentences were shown in this condition, again equally divided per valence.

The three conditions appeared in separate runs and the order of conditions was counterbalanced across participants. The stimuli were presented in an optimized pseudorandomized order using Optseq (Dale, 1999) and were separated with a jittered black screen (0–4400 ms). Each trial started with a 400 ms fixation cross, followed by the stimulus that was presented for 4600 ms, consisting of the trait sentence and response options (1 – 4). Within this timeframe, participants could respond by pressing buttons with the index to little finger of their right hand after which the number of their choice turned from white to yellow for the remaining stimulus time. If the participant failed to respond within the 4600 ms, they were shown the phrase 'Too late!' for 1000 ms. These trials were modeled separately and were not included in the analysis. They occurred in 0.5% of the trials in the direct condition, 0.8% of trials in the reflected condition, and on 0.2% of trials in the control condition at T1. At T3, too late responses occurred in 0.4% of direct evaluation trials, 0.5% of reflected evaluation trials, and 0.1% of control trials.

To obtain one positivity score per domain in both the direct and reflected self-evaluation conditions, scores on negative traits were reversed coded and combined with scores on the positive traits.

Questionnaires

Questionnaires during training (T1, T2, T3)

Self-esteem: Self-esteem was assessed with a Dutch translation (Veldhuis, Konijn, & Seidell, 2014) of the well-validated Rosenberg self-esteem scale (Rosenberg, 1965). This 10-item questionnaire measures global self-worth by determining both positive and negative feelings about the self. Example of items are, 'On the whole I am satisfied with myself', and 'I certainly feel useless at times'. Answers were scored on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). After recoding the five counter-indicative items, higher scores indicated higher self-esteem. The scale had high internal consistency at each time point (Cronbach's alpha = .91 at T1, .87 at T2, and .84 at T3).

Self-concept clarity: Self-concept clarity was measured with a Dutch translation of the Self-Concept Clarity Scale (Campbell, 1990; Crocetti, Rubini, Luyckx, & Meeus, 2008). This 12-item questionnaire indicates the temporal stability, consistency and clarity of someone`s self-concept. An example of an item is "My beliefs about myself often conflict with one another". Answers were given on a 5 point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Mean scores were computed such that higher scores indicate higher self-concept clarity. The scale was reliable at each time point (Cronbach's alpha = .85 at T1, .73 at T2, and .87 at T3).

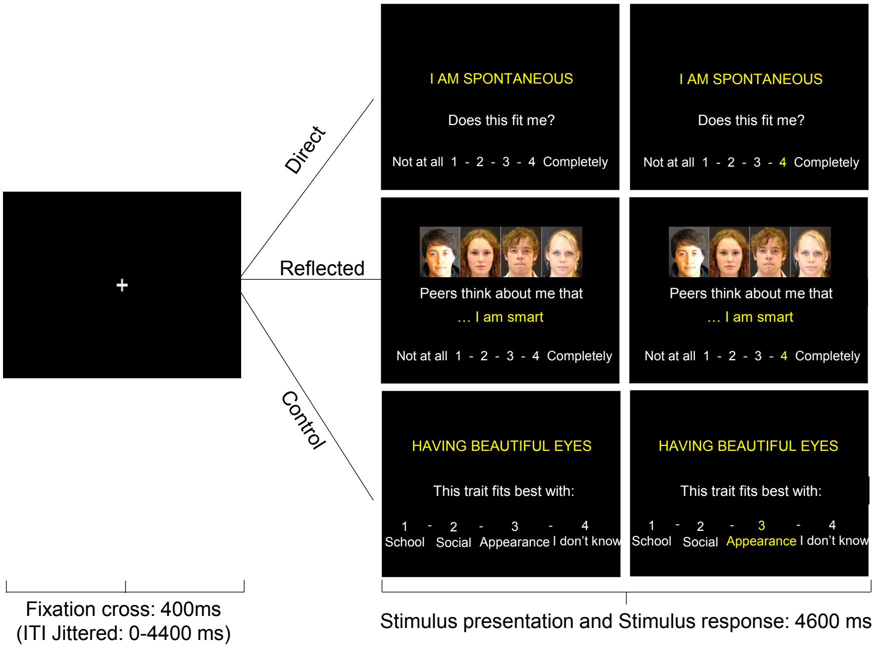

Figure 2*. Example a trial in the Direct, Reflected, and the Control condition. Each trial started with a black screen with a jittered duration between 0 and 4400 ms. Subsequently, a fixation cross was shown for 400 ms after which the stimulus appeared. In the Direct and Reflected conditions, participants rated on a scale of 1–4 to what extent the traits described themselves (from their own perspective or their perceived peers' perspective, respectively). In the Control condition, participants categorized the trait sentences into one of four options. The stimulus was shown for 4600 ms. If participants responded within this timeframe, the number of their choice would turn yellow. If participants failed to respond within this timeframe, a screen with the phrase 'Too Late!' was shown for an additional 1000 ms after which the next trial would start.*

Questionnaires as outcome measures (T4)

We collected a broad range of indices related to educational decision-making to provide a global index. In order to decrease the number of tests, we submitted the variables related to *academic* outcomes to a Principal Component Analysis (PCA) to determine whether these outcome variables could also be encompassed by one or two factors (see results section).

General:

Satisfaction with choice: Using one question, participants were asked how satisfied they were with the study or career choice they made on a scale from 1 (*not at all*) to 5 (*very much*).

Life satisfaction: The Satisfaction With Life Scale (SWLS; Diener, Emmons, Larsem, & Griffin, 1985) was used to measure global life satisfaction. The questionnaire consists of five statements concerning life satisfaction (e.g. 'The conditions of my life are excellent'), which can be answered with a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Higher scores indicated higher life satisfaction. The scale showed good reliability with Cronbach's alpha of .75.

Academic:

Identity commitment: Commitment in the domain of education was measured using the commitment scale of the Utrecht-Management of Identity Commitments Scale (U-MICS; Crocetti et al., 2008). With five items, participants can indicate on a scale from 1 (*completely untrue*) to 5 (*completely true*) to what extent they feel committed to their current chosen education. An example of an item is "My education makes me feel confident about myself". Higher scores indicate more commitment. The scale showed excellent reliability with Cronbach's alpha of .93.

Academic motivation: The Self-Regulation Questionnaire – Academic (SRQ-a; Vansteenkiste, Sierens, Soenens, Luyckx, & Lens, 2009) was used to assess participants' reasons for studying. The 16-item questionnaire differentiates between four types of motivation (four items per type) that can be combined into autonomous and controlled motivation behavior. For this study, we were only interested in autonomous motivation. This scale consists of identified regulation (e.g. 'I am studying because it is personally important to me') and intrinsic motivation (e.g. 'I am studying because I enjoy it'). Answers could be given on a scale from 1 (*not at all important*) to 5 (*very important*). Internal consistency of the scale was good (α = .86).

Student Adaptation to College: To examine to what extent participants were adjusted to their new study situation, we used a brief 20-item version (Beyers & Goossens, 2002) of the Student Adjustment to College Questionnaire (SACQ; Baker & Siryk, 1984). We focused on the scales academic adjustment (adaptation to educational demands of higher education, 10 items) and social adjustment (how well students deal with interpersonal experiences at their school environment, 10 items). Sample items are "I have been keeping up to date with my academic work" (Academic adjustment), and "I am meeting as many people and making as many friends as I would like at university" (Social adjustment). Answers could be given on a scale from 1 (*not at all*) to 5 (*very much*). Higher scores indicated better adjustment. Cronbach's alpha's were .87 and .93, respectively.

Academic Engagement: Study engagement was assessed with the shortened Dutch Utrecht Study Engagement Scale (UBES-S-9; Schaufeli, Martínez, Pinto, Salanova, & Barker, 2002). This 9-item questionnaire consists of three scales; vigor ("When I study, I feel full of energy"), dedication ("My study inspires me"), and 3 items to measure absorption ("Time flies when I`m studying"). Each scale comprised three items, these items were answered on a 7-point Likert-scale in a range from 1 (*Never*) to 7 (*Always*). Higher scores indicated more engagement. The internal consistency of the UBES-S-9 was excellent (α = .94).

Academic Performance: An indication of academic performance was obtained with one question that asked participants about their percentage of completed courses in their first year. They could answer on a scale from 1 (*0 %)* to 5 (*100 %).*

Procedure

Participants were scanned two times, before (T1) and right after their gap year training (T3) with an average 10-month interval (Δ in months T1–T3: M = 10.4, SD = 0.82; see **Figure 1**). Before scanning, the participants were familiarized with the scanning environment with a mock scanner. They received instructions about the tasks and performed nine practice trials for each condition. Anonymity was emphasized and participants were encouraged to honestly describe how they thought about themselves.

The questionnaires used in this study were programmed in Qualtrics (www.Qualtrics.com), sent to the participants via two e-mails, and completed at home. Participants received € 50 each time at T1 and T3 as compensation for the MRI scan and questionnaires. If participants could not participate in the second MRI session at T3 (e.g. because of MRI contraindications such as braces) they could still receive € 30 for filling out questionnaires. For participation at T2 and T4 (filling out questionnaires at home) participants received € 30 each time.

Behavioral training and prediction analyses

In order to examine changes in the positivity of domain-specific self-evaluations as well as self-esteem and self-concept clarity, we adopted a two-step procedure. First, we aimed to investigate the overall change in self-concept from the start (T1) to the end (T3) of the training year using Repeated Measures ANOVAs. Next, in order to get a better understanding of the developmental trajectory across the training year (T1, T2, T3), as well as individual differences in these trajectories, we conducted a series of latent growth curve models (LGM; Duncan & Susan C. Duncan, 2009) on all self-concept variables in M*plus* 8.2 (Muthén & Muthén, 2012). LGM is a highly flexible method to study longitudinal data, as it can capture both mean levels (fixed effects) of starting points (intercepts) and change (slopes), as well as individual differences around these intercept and slopes (referred to as random effects). Additionally, a benefit of LGM is that it can handle partially missing data. Concerning missing data, we conducted Little's missing completely at random (MCAR) test on all self-concept variables, which showed a chi-square (χ^2/df) of 0.75, indicating that it is unlikely that findings were biased as a result of missing values. Therefore, we included all participants with and without missing values in our LGM analyses and handled missing data using full information maximum likelihood (FIML).

For each self-concept variable, we examined whether linear or nonlinear, quadratic, growth curve models would best describe the data. In order to facilitate model convergence with three time points we only estimated fixed quadratic slopes and not random quadratic slopes. We compared the different models with the AIC (Akaike Information Criterion; Akaike, 1974) and BIC (Bayesian Information Criterion; Schwarz, 1978). The models with the lowest AIC and BIC values were preferred. If the AIC and BIC were inconsistent in their support for one model, we used the sample-size adjusted BIC (ssaBIC) as an additional fit indicator to select the best fitting model. All latent growth curve models were first performed with age at T1 as a covariate of intercept and slopes to control for possible age effects. If age was insignificant, it was trimmed from the model due to reasons of parsimony.

5

As a second aim, we investigated whether changes in self-concept variables during the year of training (T1, T2 and T3) could predict outcome measures related to successful educational decision-making on T4. For this purpose, we saved the intercept and slope parameters of each participant from the LGMs and used these intercept and slopes as predictors of general- and academic outcome measures in a set of multiple regression analyses in SPSS.

MRI data acquisition

MRI scans were acquired on a Philips 3.0 Tesla MRI scanner with a standard whole-head coil. Functional scans were acquired in two runs with T2*-weighted echo-planar imaging (EPI) sequence (TR = 2200 msec, TE = 30 msec, sequential acquisition, 37 slices of 2.75 mm, FOV = 220 × 220 × 111.65 mm). The first two volumes were discarded to account for T1 saturation. After the functional scans, a high-resolution 3D T1 scan for anatomical reference was obtained (TR = shortest msec, TE = 4.6 msec, 140 slices, voxel size = 0.875 mm, FOV = 224 x 178.5 x 168 mm). Stimuli were projected on a screen behind the scanner and could be viewed through a mirror attached to the head coil. Head movement was restricted by placing foam inserts inside the coil.

MRI data analyses

MRI data were preprocessed and analyzed with SPM8 (Wellcome Department of Cognitive Neurology, London, United Kingdom). Functional images were preprocessed using the following steps: realignment, slice-time correction, spatial normalization using segmentation parameters, and spatial smoothing with a 6-mm FWHM isotropic Gaussian kernel. The normalization algorithm used a 12-parameter affine transform with a nonlinear transformation involving cosine basis functions and resampled the volumes to 3-mm cubic voxels. Templates were based on MNI-305 stereotaxic space (Cocosco, Kollokian, Kwan, Pike, & Evans, 1997).

Individual participants' data were analyzed using the general linear model in SPM8. The fMRI time series were modelled as a series of zero duration events locked to stimulus onset convolved with the hemodynamic response function (HRF). Modelled events of interest for the direct self-evaluation condition were: "Academic-Positive", "Academic-Negative", "Physical-Positive", "Physical-Negative", "Prosocial-Positive", "Prosocial-Negative", "Social-Positive", Social-Negative". The same events were modelled for the reflected self-evaluation condition. For the control condition, we used one event of interest ("Control") that was collapsed across domains and valences. Trials for which participants failed to respond in time were modelled as events of no interest. The events were used as covariates in a general linear model. In addition, we included six motion parameters as nuisance regressors. The resulting first level contrast images, computed on a subject-by-subject basis, were calculated for both time points (T1 and T3) separately and submitted to second-level group analyses. We followed all analyses steps as detailed in our pre-registration on the Open ScienceFramework: https://osf.io/8mspn/.

Pre-registered Region of Interest (ROI) analyses

To investigate our pre-registered hypotheses regarding training effects on neural indices of self-concept, we used the Marsbar ROI toolbox (Brett, Anton, Valabregue, & Poline, 2002) to create ROIs of the mPFC (x = 6, y = 59, z = 13), precuneus (x = -9, y = -52, z = 28), and right TPJ (x = 60, y = -28, z = 46). These ROIs were pre-registered and based on the peaks of the clusters generated in the conjunction analysis of the contrasts direct > control and reflected > control, previously used in the larger self-concept study (Van der Cruijsen et al., 2019). This study by van der Cruijsen and colleagues used the same self-concept tasks, but in an independent sample of adolescents.

We extracted the parameter estimates of these ROIs for the time points before and after gap year (T1 and T3), and investigated possible differences using repeated measures ANOVAs in SPSS. To test whether the growth trajectory of a variable during training (e.g. increasing self-esteem) would influence the change in neural activity, we added the linear slope parameter of this variable used in the LGM as a covariate of interest to the repeated measures analyses. More specifically, we added the slope parameter of self-esteem to the repeated measures analysis of mPFC activity during the contrast self > control (for both task conditions) to test the relation between mPFC activity change and levels of self-esteem. Similarly, we added the slope parameter of academic positivity to the repeated measures analysis of precuneus activity during the contrast academic > control (thinking about academic traits from both direct and reflective perspective) to test if precuneus would show increased activity after training related to increased levels of academic positivity. Lastly, we added the slope parameter of a computed general behavioral positivity score (averaged across the positivity of self-evaluations of all four domains in both the direct and reflected task) to the repeated measures analysis of right TPJ activity during direct > reflected self-processing, to test whether behavioral increases in positivity was associated with increased right TPJ activity after training. Additionally, we explored whether training related differences in ROI mPFC and right TPJ activity differed between domains and valences. All analyses were corrected for age at T1.

Whole-brain analyses
In addition to our pre-registered ROI analyses, we explored changes in other brain regions on a whole-brain level using flexible factorial ANOVA in SPM8. We focused on three whole-brain contrasts; one valence-based contrast (evaluating Positive versus Negative traits), and two task-based contrasts (Direct > Control, and Reflected > Control). For all these whole-brain analyses, we applied FDR cluster level correction ($p < .05$) at an initial uncorrected threshold of $p < .001$, as implemented in SPM8 (Woo, Krishnan, & Wager, 2014). Results of these analyses can be found as supplementary material.

RESULTS

Behavioral training results
Means and standard deviations of the self-concept variables measured during training (T1, T2, T3) can be found as supplementary material **Table S.1**. Additionally, the observed group mean scores at each time point are illustrated in **Figures 3a, 3b, and 4.**

First, we tested for overall changes in self-concept variables before (T1) and after (T3) training for comparability with neural results. For the domain-specific self-evaluations collected during scanning, scores on negative traits were recoded and averaged with scores on the positive traits into one positivity score per domain, per task. These positivity scores were added to a 2 (Time; T1 and T3) x 2 (Task; direct and reflected) x 4 (Domain; academic, physical, pro-social, social) within-subjects Repeated Measures ANOVA. This analysis yielded a significant time x domain interaction (F (3, 102) = 7.96, $p < .01$, $\eta^2_p = .19$). The time x task x domain interaction was not significant ($p = .108$). Post-hoc tests to unpack the time x domain interaction showed that across tasks, the positivity of self-evaluations increased significantly in all domains, although the effect size differed: academic domain (F (1, 34) = 10.25, p = .003, η^2_p = .23), physical domain (F (1, 34) = 22.88, p < .001, η^2_p = .40), prosocial domain (F (1, 34) = 5.19, p = .029, η^2_p = .13) and social domain (F (1, 34) = 29.80, p < .001, η^2_p = .47) (see **Figure 3a and 3b**).

Finally, we computed two Repeated Measures ANOVAs with Time (T1, T3) as within-subjects factor to test overall changes in the questionnaires measuring self-esteem and self-concept clarity from T1 to T3. Results showed significant increases after training in both self-esteem (F (1, 34) = 29.59, p < .001, η^2_p = .47) and self-concept clarity (F (1, 34) = 13.71, p = .001, η^2_p = .29) (see **Figure 4**).

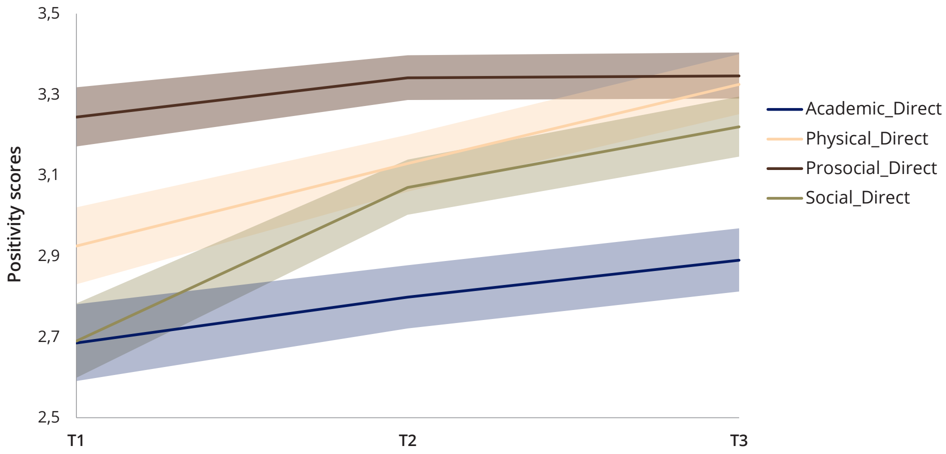

Figure 3a. *Average increase in positivity of direct self-evaluations on a scale from 1 - 4 across gap year.*

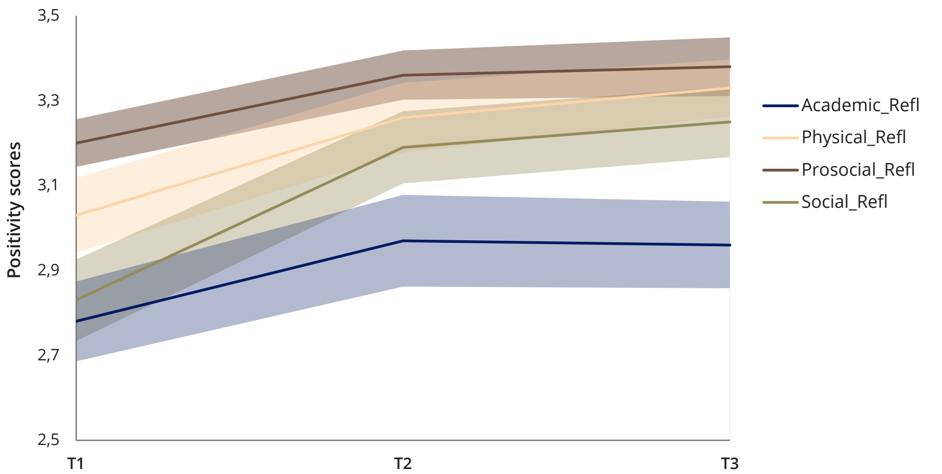

Figure 3b. *Average increase in positivity of reflected self-evaluations on a scale from 1 - 4 across gap year.*

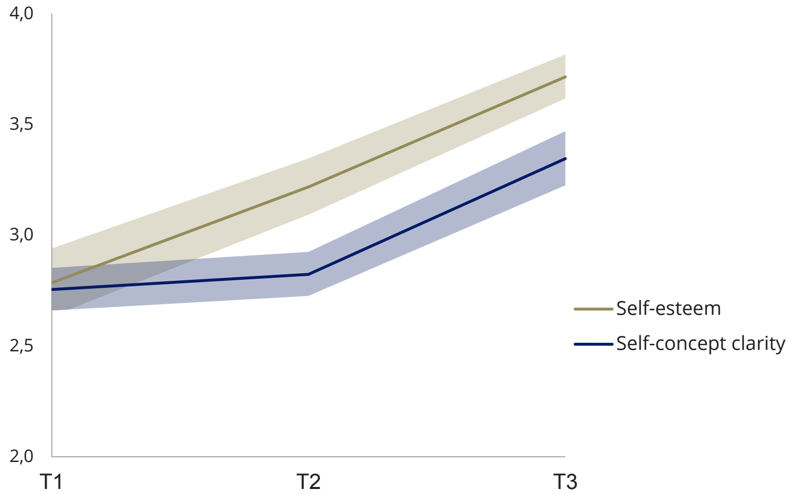

Figure 4. *Average increase in self-esteem and self-concept clarity on a scale from 1 - 5 across gap year.*

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Behavioral longitudinal results across three time points

We followed up the tests of overall change in self-concept from the start (T1) to the end (T3) of the training year by examining the specific shape of growth, as well as individual differences in these growth curves, through applying latent growth curve models on all three time points (T1, T2, T3). For every self-concept variable separately, we tested whether linear or quadratic growth curve models would best describe the growth trajectory during training. For all tested models, age at T1 rendered insignificant and was therefore trimmed from the models. **Table 1** shows the fit indices AIC and BIC for the different models. **Table 2** shows the mean level growth parameter estimates and the individual differences in intercept and slopes. **Figure 5a and 5b** show the raw individual trajectories and the mean developmental trajectories of each variable for the entire sample.

Mean level development of self-concept variables. We started out testing the trajectories of the positivity of the domain-specific self-evaluations from a *direct* perspective. For the academic domain and the physical domain, the linear model provided the best fit to the data. Only the physical domain showed a significant positive linear slope, indicating a linear increase in positivity for direct physical self-evaluations from T1 to T2 and T3. For the academic domain, the linear slope was not significant, indicating stable levels across the year. For the prosocial and social domain, quadratic growth models showed the best fit. However, similarly as for the academic domain, the model for prosocial self-evaluations did not show any significant slopes, indicating stable levels across the training year. The positivity of social self-evaluations revealed a linear increase that levelled off towards the end of training, as indicated by a positive linear and negative quadratic slope (**see Figure 3a and 5a**).

For all *reflected* self-evaluations, quadratic models showed the best fit. Significant linear slopes were revealed for the physical domain as well as for the prosocial domain (quadratic slopes were not significant). This indicates that the positivity of the reflected self-evaluations in these domains slightly increased in the first half of the training year. The positivity of reflected academic, and social self-evaluations both showed significant positive linear slopes and negative quadratic slopes indicating a linear increase that levelled off towards the end of training (**see Figure 3b and 5a**).

To test the hypothesis that the increase in the positivity of self-evaluations would be most prominent for the social domain, we saved the linear slope parameters of each participant for each domain from the LGMs, and computed a 4 (domain) x 2 (task) within-subjects factor Repeated Measures ANOVA on these estimated linear slopes. Results showed a significant interaction between domain and task (F (3, 111) = 13.74, p < .01, η^2_p = .27). Per task, a main effect of domain was found (direct condition (F (3, 111) = 88.86, p < .01, η^2_p = .71; reflected condition (F (3, 111) = 58.61, p < .01, η^2_p = .61)). Post-hoc tests using Bonferroni correction revealed that in both tasks, the increase in positivity in the social domain (direct: M = .43; reflected: M = .51) was significantly larger compared to the increase in the academic domain (direct: M = .10, reflected: M = .29, both at p < .001), the physical domain (direct: M = .20, reflected: M = .34, both at p < .001), as well as the prosocial domain (direct: M = .19, reflected: M = .26, both at p < .001).

For self-esteem, the linear model provided the best fit to the data. The positive slope indicated that self-esteem showed a linear increase over time for the whole sample. For self-concept clarity, the quadratic model revealed a better fit to the data. Self-concept clarity showed to be relatively stable until halfway through the training (T1-T2), where after it increased, as indicated by a significant positive quadratic slope (**see Figure 4 and 5b**).

Table 1.
Fit indices of the latent growth curve models for all self-concept variables

Self-concept	Linear model		Quadratic model	
Variable	AIC	BIC	AIC	BIC
Direct Academic Positivity	**77.362**	**90.463**	79.200	93.938
Reflected Academic Positivity	105.137	116.600	**102.945**	**116.046**
Direct Physical Positivity	**106.228**	**119.328**	108.223	122.961
Reflected Physical Positivity	111.207	124.307	**110.543**	**125.281**[1]
Direct Prosocial Positivity	65.508	78.608	**65.355**	**80.093**[1]
Reflected Prosocial Positivity	82.624	94.087	**81.862**	**94.962**[1]
Direct Social Positivity	123.825	136.925	**120.556**	**132.020**
Reflected Social Positivity	134.699	144.525	**130.151**	**141.614**
Self-esteem	**233.183**	**244.646**	235.016	248.117
Self-concept clarity	203.638	216.738	**199.292**	**214.030**

Note: Preferred final models are depicted in bold. AIC = Aikaike information criterion; BIC = Bayesian information criterion; [1] = In this case AIC and BIC were inconsistent in their support for one model. Therefore, we used the sample-size adjusted BIC (ssaBIC) as an additional criterion to select the best fitting model.

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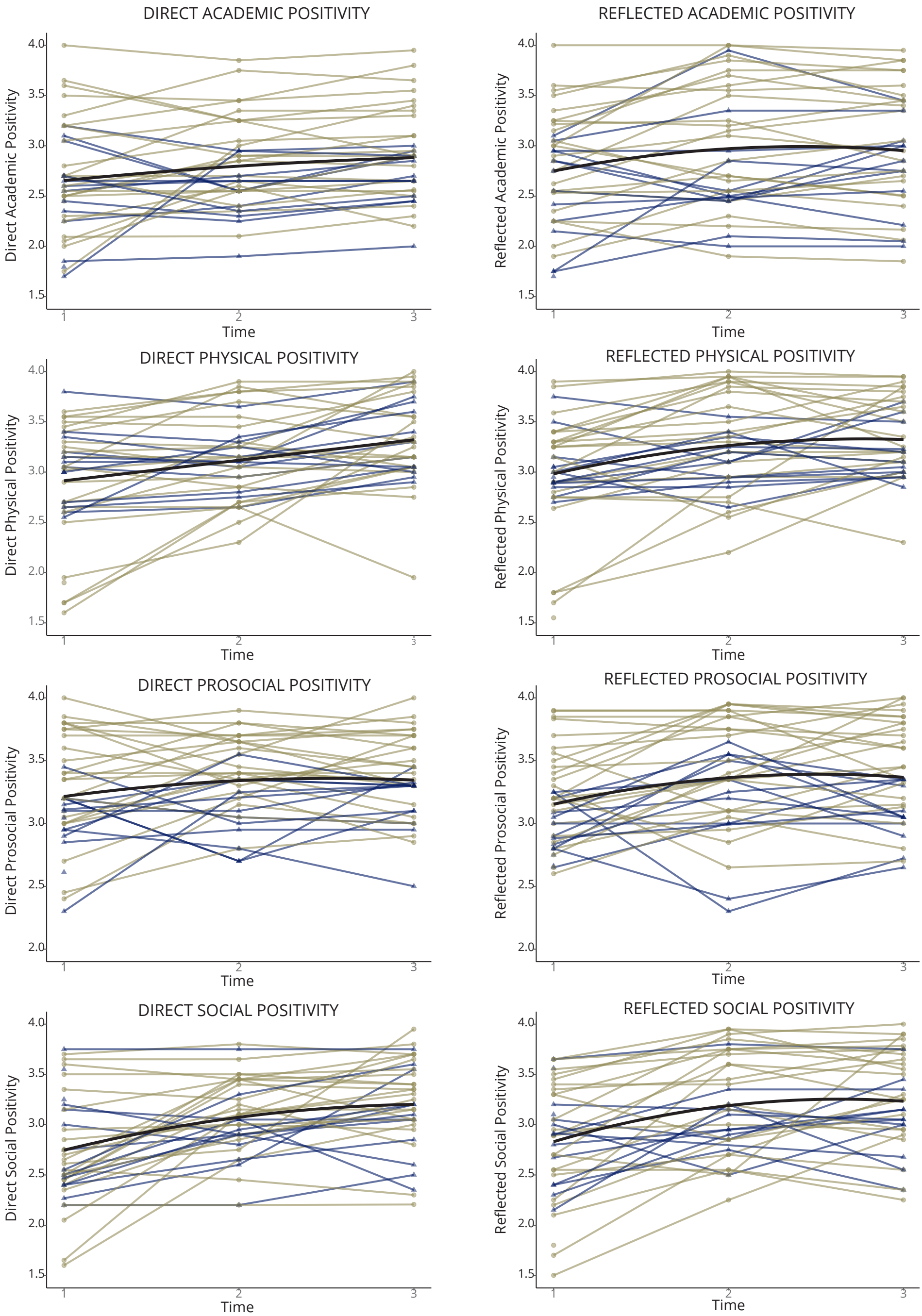

Figure 5a. *Observed individual trajectories for the positivity of domain specific direct – and reflected self-evaluations across the gap year. X-axis: time point (T1, T2, T3), Y-axis: positivity scores (1-4), yellow lines represent girls and blue lines represent boys. The black line shows the average intercept and slope.*

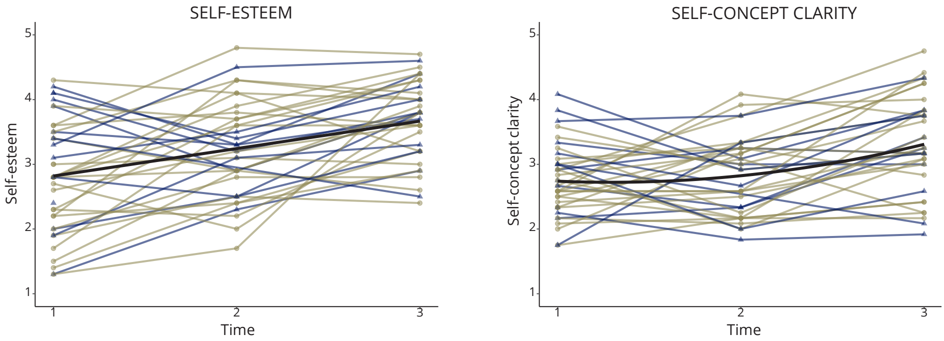

Figure 5b. *Observed individual trajectories for self-esteem and self-concept clarity across the gap year. X-axis: time point (T1, T2, T3), Y-axis: positivity scores (1-5), yellow lines represent girls and blue lines represent boys. The black line shows the average intercept and slope.*

Table 2.

Growth factor estimates of self-concept variables

	Growth Factors and Variance Components				
	Mean Int. (*SE*)	σ^2	Mean LS (*SE*)	σ^2	Mean QS (*SE*)
Dir Academic Positivity	2.67 (0.08)***	0.16**	0.10 (0.02)	0.01	
Refl Academic Positivity	2.75(0.09)***	0.24***	0.29 (0.11)*	0.01	-0.10 (0.05)*
Dir Physical Positivity	2.91 (0.09)***	0.23**	0.20 (0.04)***	0.02	
Refl Physical Positivity	2.98 (0.09)***	0.25**	0.34 (0.11)**	0.03	-0.09 (0.05)
Dir Prosocial Positivity	3.22 (0.07)***	0.08**	0.19 (0.10)	0.01	-0.06 (0.04)
Refl Prosocial Positivity	3.15 (0.06)***	0.09**	0.26 (0.11)*	0.02*	-0.08 (0.05)
Dir Social Positivity	2.75 (0.09)***	0.21***	0.43 (0.12)***	0.05**	-0.10 (0.05)*
Refl Social Positivity	2.83 (0.09)***	0.24**	0.51 (0.12)***	0.02	-0.15 (0.06)**
Self-esteem	2.82 (0.14)***	0.52*	0.43 (0.08)***	0.17*	
Self-concept clarity	2.74 (0.09)***	0.06	-0.16 (0.19)	0.13**	0.22 (0.08)**

Note: Dir = Direct; Refl = Reflected; Int = intercept; LS = Linear slope; QS = Quadratic slope; * = $p < .05$.; ** = $p < .01$.; *** = $p < .001$.

Neural training results

Pre-registered ROI analyses

To investigate how neural mechanisms underlying self-concept change after self-concept training, we started out by testing our pre-registered hypotheses focused on three *a priori* defined ROIs: the mPFC, Precuneus, and the right TPJ (see method section for ROI definition).

mPFC. First, we tested the hypothesis that increasing levels of self-esteem would be associated with larger mPFC changes, which should be evident by a time x self-esteem slope interaction. To test this effect, we performed a Repeated Measures ANOVA on the contrast self > control with Time (T1, T3) and Task (direct, reflected) as within subjects factors, the linear slope of self-esteem as covariate of interest, and age at T1 as covariate of no interest. Results showed no main effect of time (p = .400), nor an interaction between time and task (p = .237), time and self-esteem slope (p = .354), task and self-esteem slope (p = .066), or a time x task x self-esteem slope interaction (p = .973). There was however a main between-subjects effect of self-esteem slope on MPFC activity (F (1, 29) = 6.52 p = .016, η^2_p = .18). As the slope of self-esteem inherently contains an aspect of time (higher slopes indicate greater increases in self-esteem from T1 to T3) we checked the correlations between self-esteem slope and mPFC activity at each time point and plotted these relations for more clarity (see **Figure 6**). For mPFC activity at T1, the correlation with self-esteem slope was -.49 (p = .004), indicating that participants with lower mPFC activity during self-evaluation at T1 experienced greater increases in self-esteem during their gap year. For T3, the correlation was still negative, but not significant (-.26, p = .145). However, when comparing both correlation coefficients to each other using Fisher's Z transformation, they did not significantly differ from each other (z = -1.25 p = .105). It should be noted that the correlation at T3 is difficult to interpret, whereas the correlation at T1 shows that lower mPFC activity at the first time point predicts higher self-esteem slopes.

Next, we tested time x valence effects and examined whether changes in mPFC activity varied between the evaluation of positive and negative traits. We conducted a Repeated Measures ANOVA with Time (T1, T3), Task (Direct, Reflected) and Valence (positive, negative) as within subjects factors, and age at T1 as covariate of no interest. Results showed a significant time x valence interaction (F (1, 30) = 7.01 p = .013, η^2_p = .18). This analysis demonstrated that mPFC activity showed an increase for the evaluation of positive traits, whereas the activity for the evaluation of negative traits remained stable over time (see **Figure 7**). The time x task x valence interaction was not significant (p = .230), suggesting that these effects are similar for the direct and reflected task.

Lastly, we explored whether changes in mPFC activity during self-processing differed between domains with a Repeated Measures ANOVA with Time (T1, T3), Task

(Direct, Reflected) and Domain (academic, physical, prosocial, social) as within subjects factors, and age at T1 as covariate of no interest. This analysis did not yield a significant time x domain interaction (p = .529), nor a time x task x domain interaction (p = .286).

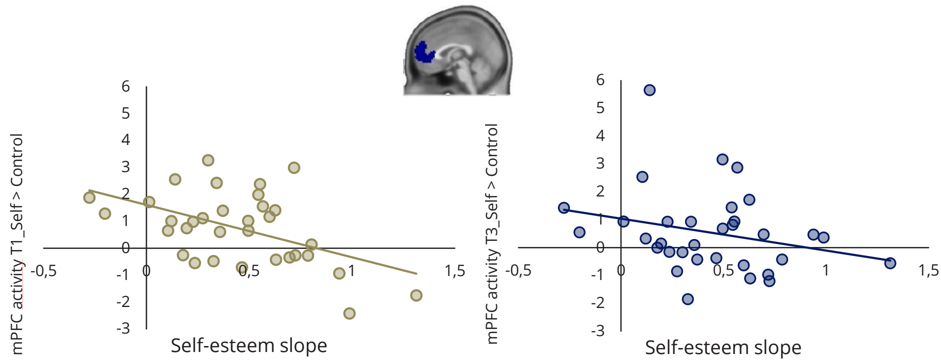

Figure 6. *Relations between self-esteem slope and mPFC activity for the contrast self > control at each time point.*

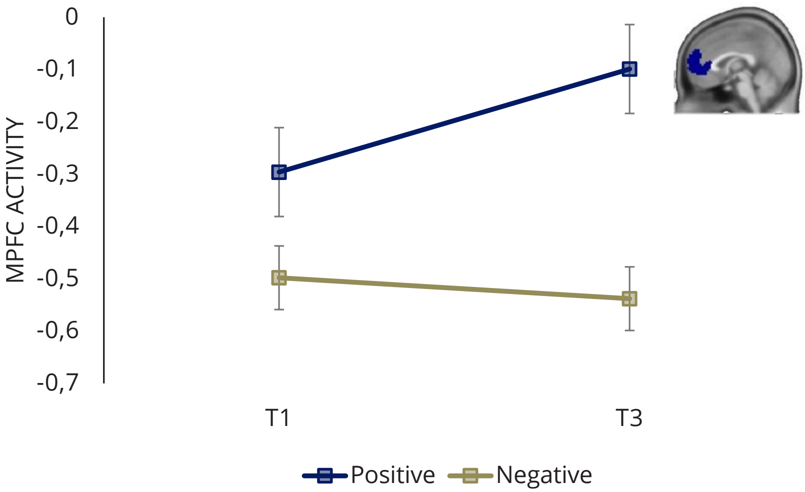

Figure 7. *mPFC activity for evaluation of positive and negative traits over time. mPFC activity showed an increase for the evaluation of positive traits, whereas the activity for the evaluation of negative traits remained stable over time.*

Precuneus. Next, we tested the hypothesis that the precuneus would show increased activity over time for the evaluation of academic traits specifically. A Repeated Measures ANOVA on the contrast academic > control with Time (T1, T3) and Task (Direct, Reflected) as within subjects factors, and age at T1 as covariate of no interest did not show a significant main effect of time (p = .745), or a time x task interaction (p = .736). The addition of the slope of academic positivity (averaged across tasks) did not have a significant main effect on precuneus activity (p = .721) or an interaction with time (p = .736).

Right TPJ. We first examined the hypothesis that training related behavioral increases in positivity would be associated with increased right TPJ activity for direct compared to reflected self-evaluations after training. We performed a Repeated Measures ANOVA on the contrast direct > reflected (both tested versus control condition) with Time (T1, T3) as within subjects factor, and the linear slope of a general behavioral positivity score (across domains and tasks) as covariate of interest and age at T1 as covariate of no interest. Results showed no main effect of time (p = .541), nor a main effect of the slope of overall positivity (p = .734), or an interaction between time and the slope of overall positivity (p = .725).

Next, we explored possible valence effects and tested whether training related changes in rTPJ activity varied between the evaluation of positive and negative traits. We conducted a Repeated Measures ANOVA with Time (T1, T3), Task (Direct, Reflected) and Valence (positive, negative) as within subjects factors, and age at T1 as covariate of no interest. Results showed no significant time x valence interaction (p = .818), or time x task x valence interaction (p = .346).

Finally, we explored whether training related changes in rTPJ activity during self-processing differed between domains with a Repeated Measures ANOVA with Time (T1, T3), Task (Direct, Reflected) and Domain (academic, physical, prosocial, social) as within subjects factors, and age at T1 as covariate of no interest. This analysis did not yield a significant time x domain interaction (p = .232), nor a time x task x domain interaction (p = .562).

Taken together, the results showed that change in mPFC activity was sensitive to valence, and increased more for the evaluation of positively-valenced trials than for negatively-valenced trials. Further, we partly confirmed our pre-registered hypothesis that mPFC activity would be associated with self-esteem slope, but this was only confirmed for the first time point and not for change-change. The pre-registered hypotheses for precuneus and rTPJ were not confirmed. Explorative whole-brain analyses for the valence-based and task-based contrasts are reported in the supplement.

Prediction results for academic and life outcomes

A final aim of this study was to examine whether individual differences in baseline and within-person changes in behavioral indices of self-concept during the gap year (T1, T2, T3) could predict outcomes related to future successful educational decision-making (T4). In line with our pre-registered hypotheses, we used the LGM estimated intercepts and linear slope parameters of the variables self-esteem, self-concept clarity, academic positivity, and social positivity as predictor variables. Outcome variables were separated into two categories: one related to more *general* outcomes (satisfaction with choice, and satisfaction with life), and one related to specific *academic* outcomes (commitment to study, academic intrinsic motivation, academic and social adjustment to college, academic engagement and academic performance). Means, SDs, and correlations between the outcome variables can be found as supplementary material **Table S.4**. As the questions regarding academic outcomes were only asked when participants had indicated to have enrolled in higher education, the N for these variables was smaller (N = 22) than for the general outcome variables (N = 32).

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In order to decrease the number of tests for the academic outcome variables, we first conducted a PCA with varimax rotation to examine whether they could also be encompassed by fewer underlying factors. Assumptions check for the PCA showed a Kaiser-Meyer-Olkin (KMO) value of 0.86, which indicated adequate sampling, and a significant Barlett's test of sphericity (χ^2 = 139.035, df = 36, p < .001), which indicated suitability of the data for PCA. The parallel analysis indicated that two factors should be retained. The two factors together explained 75.17% of the total variance. The first factor (63.37% variance explained) contained most of the variables: the three scales related to academic engagement (vigor, dedication, absorption), the two scales related to autonomous motivation (identified regulation and intrinsic motivation), commitment to chosen study, and academic adjustment to college. The second factor consisted of social adjustment to college and academic performance. The specific factor loadings can be found in **Table 4**. We labeled the first factor 'drive', as it contains variables related to intrinsic motivation, engagement, and commitment to a chosen study. The factor scores were saved for each participant so they could be used for regression analyses in SPSS. The second factor (social adjustment to college & academic performance) was more difficult to label, therefore we chose to name this factor "Factor 2".

Next, we performed a series of regression analyses in SPSS to test our pre-registered hypotheses regarding predictions of outcome measures related to successful educational decision-making.

Self-esteem. Self-esteem intercept and slope did not significantly predict any academic outcomes (factor "drive", p = .062; factor 2 (social adjustment & academic performance, p = .758)), or the general life outcomes: satisfaction of choice (p = .880) or life satisfaction (p = .657).

Table 4.
Factor loadings for the PCA on academic outcome variables

	Factor 1	Factor 2
Study dedication (UBES)	0.905	
Study absorption (UBES)	0.859	
Study vigor (UBES)	0.858	
Study commitment (U-MICS)	0.825	
Intrinsic motivation (SRQ)	0.743	
Academic adjustment (SACQ)	0.665	
Identified regulation (SRQ)	0.559	
Social adjustment (SACQ)		0.945
Academic performance		0.793

Note: Only factor loadings > 0.50 are printed in this table.

Self-concept clarity. Results revealed a significant model for Factor 2 (social adjustment and academic performance (F (2, 21) = 6.09, p <.001). The linear slope of self-concept clarity was positive and significant (: β_{slope} = .52, p < .001) indicating that individuals who showed a stronger increase in self-concept clarity over time reported better social adjustment to college and better academic performance relative to individuals with a lower SCC slope. No significant prediction models were found for other academic outcomes (factor "drive", p = .061), or the general life outcomes: satisfaction of choice (p = .833) or life satisfaction (p = .381).

Social positivity. As our pre-registered hypothesis regarding the social domain solely focused on predicting social adjustment to college and life satisfaction, we used social adjustment as a separate outcome variable for this analysis. Individual differences in the intercepts and slopes of the positivity of direct as well as reflected social self-evaluations were found to predict social adjustment to college (Direct: F (2, 21) = 4.28, p = .029; : $\beta_{intercept}$ = .54, p = .033; β_{slope} = .66, p = .011; Reflected: F (2, 21) = 7.41, p = .004; : $\beta_{intercept}$ = .67, p = .003; : β_{slope} = .64, p = .004). As both intercepts and slopes are positive, this indicates that individuals who started out with more positive social self-evaluations as well as show a stronger increase in the positivity of these self-evaluations report better social adjustment to college. No effects were found for life satisfaction (Direct: p = .156; Reflected p = .223).

Academic positivity. Following our pre-registered hypotheses regarding the influence of individual differences in starting points and trajectories of positivity in the academic domain, we only focused on academic motivation, academic adjustment, and academic performance as separate outcome variables. Intercept and slopes of the positivity of direct or reflected academic self-evaluations did not predict academic motivation (Direct: p = .240; Reflected p = .294) or academic adjustment (Direct:

p = .377; Reflected p = .307). For academic performance, the ANOVA model of both direct and reflected academic positivity was significant (Direct: $F(2, 22) = 4.89, p = .019$; Reflected $F(2, 22) = 6.37, p = .007$). However, for both models, the individual coefficients of both intercept and slope were not significant.

DISCUSSION

This study tested the effects of a naturalistic self-concept training within a gap year context on behavioral and neural correlates of self-evaluations, as well as the long-term effects for educational decision-making. The study resulted in four main findings. First, the one-year training period was associated with increases in self-esteem, self-concept clarity and positivity of domain-specific self-evaluations. Changes were largest for social self-evaluations, consistent with the notion that the social self is an important aspect of our identity (Pfeifer & Berkman, 2018). Second, participants with lower medial PFC activity before training showed larger self-esteem increases over the year. Third, brain activity in medial PFC, an important region for self-evaluation (Denny, Kober, Wager, & Ochsner, 2012) increased more for the evaluation of positive self-traits than for negative self-traits. Finally, individual differences in changes in self-concept clarity and social self-evaluations, but not self-esteem, positively predicted outcomes related to future-oriented educational choices. The discussion is organized along the lines of these four main findings.

Behavioral correlates of a naturalistic gap year program

An emerging problem in our society is that young people have difficulty choosing a fitting educational program, leading to high levels of drop-out and increasing number of gap years (Researchned, 2018a, 2018b). We addressed in this study whether a naturalistic self-concept training program targeting adolescents with educational decision-making difficulties would be associated with changes in domain-specific self-evaluations, self-esteem and self-concept clarity. These hypotheses were based on a recent study in which we showed that self-esteem and self-concept clarity were significantly lower in adolescents who experienced difficulties with educational decision-making compared to peers who already successfully transitioned into higher education (van der Aar et al., 2019). As predicted, participants who took part in this program showed increased levels of self-esteem, self-concept clarity and positivity of self-evaluations across all domains (academic, (pro)social and physical appearance) after the program. Notably, changes were most significant for social self-evaluations, suggesting that the difficulties within this group may be broader than academic decision-making and may reflect a general difficulty with fitting in (Di Fabio, Palazzeschi, Asulin-Peretz, & Gati, 2013).

To date, research on the effects of taking a gap year between high school and higher education have shown mixed results. For example, some studies have found positive effects with regard to personal development, such that gap year takers felt more confident, mature and independent after their gap year (King, 2011). Beneficial effects have also been found for academic outcomes, such as increased academic motivation for gap year takers (Martin, 2010). On the contrary, others have found negative outcomes for attainment (e.g. gap year students were less likely to start a major or more likely to drop out of a university degree) or showed no significant benefits in relation to goal engagement and self-confidence (Parker, Thoemmes, & Duineveld, 2015). The gap years examined in these studies were often unstructured (consisting of travelling or working) and it is unclear what the mechanisms were that ultimately would help adolescents with their decision-making process afterwards.

The current study evaluated changes in relation to a relatively structured gap year program in which participants followed specific modules targeted at improving self-esteem and self-concept clarity. The results seem promising regarding the malleability of self-concept during late adolescence. Moreover, they complement existing intervention programs which are mostly based on elementary - to high schools, by its focus on the transitional phase of late adolescence/emerging adulthood and specifically to the context of future educational decision-making. More specific analyses were conducted to examine time-related transitions by including an additional half-way time point. These analyses revealed that especially for *reflected* self-concept ("peers think about me that I am…"), changes occurred mostly in the first period of the program. In this period, the focus of the program was on 'me' and 'others', possibly indicating that these modules have a larger impact on self-evaluation from perspectives of others. Also the start of the training within a group setting with same-aged peers could have had a direct positive effect on these reflected self-evaluations (Forsyth, 2015). Interestingly, self-concept clarity showed a change only in the second half of the program, which had a stronger focus on 'travel' and 'world', suggesting that self-concept clarity increases more in interaction with new outside perspectives. Another reason for this relatively late increase in self-concept clarity could be that it takes more time for self-reflection and reconsideration in order to develop an increasingly clear and coherent self-concept. These patterns were different from changes in self-esteem, which as expected increased gradually over the course of the program.

A limitation of the current study was that it did not make use of a (quasi) experimental design, and there was no control group included. The reason for the absence of a control group is because waiting list participants often seek out alternatives in the intended gap year. The advantage of this program is that it made use of a naturalistic tailored design involving individuals who are intrinsically motivated to participate in the training. Tentative comparisons with existing longitudinal studies showed that changes in self-esteem and self-concept clarity were larger compared to what is usually reported in this age range. For example, in a 4-wave longitudinal study von Soest and colleagues (2016) reported an average increase (slope) in global self-esteem of .13 between the ages 13 – 31, compared to a linear increase of .43 in this sample. Similarly, self-concept clarity showed only minor increases in the period of late adolescence/early adulthood (slope of .03) according to a 6-wave longitudinal study of Crocetti et al., (2016), whereas our gap year participants showed an average increase of .22. However, future replications among different samples and across different age periods is warranted.

Neural correlates of a naturalistic gap year program

Several studies have demonstrated that a network of brain regions that is often implicated in social brain processing, including the medial PFC, PCC/precuneus and TPJ are also involved in self evaluations (Pfeifer & Berkman, 2018). Specifically, the medial PFC is often implicated as an important region for mentalizing about self and others (Denny et al., 2012). This study tested the changes in neural activity in these regions during the direct and reflected evaluations of self-traits that could be positive or negative, and that could be targeted to academic, (pro)social and physical appearance domains. Results from the first time point were previously published (Van der Aar et al., 2019). These findings showed that mPFC activity was correlated with self-esteem, such that individuals with higher self-esteem showed more activity in medial PFC during self-evaluation. The current study demonstrated that mPFC activity at the first time point predicted self-esteem *change*. That is, individuals who were already high in medial PFC activity during self-evaluation showed no large change in self-esteem, whereas participants who were low in medial PFC activity showed the largest increase in self-esteem. These findings extend our previous suggestion that self-esteem is an important prerequisite for self-evaluations and associated mPFC activity. It should be noted that we could not confirm the hypothesis of an mPFC change and self-esteem change correlation. Longitudinal studies including larger samples may unravel the time-related relations between mPFC activity during self-evaluations and self-esteem.

Previous findings also showed that mPFC is more strongly recruited for positive self-evaluations, possibly because these are often interpreted as more applicable to self (D'Argembeau, 2013; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006). Consistent with this finding, we demonstrated that mPFC activity was higher for the evaluation of positive than negative self-traits (see also Van der Cruijsen et al., 2018), but also that activity increased more for positive than negative self-traits after the training compared to before the training. These findings fit well with the general increase in behavioral positivity ratings, possibly reflecting that positive traits were considered more applicable to self (D'Argembeau, 2013).

In addition to the valence effects, we also pre-registered the predictions that PCC/precuneus activity associated with academic self traits would be correlated with increased positivity of academic self-evaluations (based on Van der Aar et al., 2019) and that right TPJ activity associated with reflected self-evaluations would be correlated with increased general positivity of self-traits (based on Van der Cruijsen et al, 2019). Both of these predictions were not confirmed. One possible explanation is that the variance for the behavioral positivity score of self-evaluations was relatively low to reveal correlations with neural activity. Adolescents showed significant individual differences in developmental trajectories of self-esteem and self-concept clarity while these individual differences were less pronounced for domain-specific self-evaluations. Thus, possibly the lack of individual differences together with the relatively small sample size did not allow us to detect the predicted brain-behavior correlations for self-evaluations in these regions.

Predicting educational decision-making

An important question in training research concerns whether changes related to training are predictive of future real-life outcomes. The educational outcomes in this study were separated in general positive outcomes (satisfaction with choice, and life satisfaction), and outcomes specifically related to an academic context (factors 'drive' and 'social adjustment/ academic performance'). These findings showed separable effects for self-esteem and self-concept clarity. That is, even though self-esteem increased gradually during the program, it did not significantly predict any of the outcome measures. In contrast, larger increases in self-concept clarity positively predicted social adjustment to college and academic performance. Interestingly, self-concept clarity increased relatively late in the program. Possibly, self-concept clarity change needs a longer investment but also shows larger long-term effects. An opportunity for future research is to further examine the direct or indirect role of self-concept clarity in the prediction of positive educational outcomes in higher education. For example, increases in self-concept clarity could lead to a better suited choice of education accompanied by meeting other students with similar interests, leading to better social adjustment. This social adjustment could subsequently improve academic performance through increased collaboration and help from others.

Consistent with our hypotheses, a second predictor for social adjustment to college was the intercept and change in the positivity of social self-evaluations. It is interesting to note that the predictions mostly concerned social adjustment to college and not academic outcomes related to commitment, motivation or adjustment ("drive"), suggesting that different factors might affect drive. Future studies could test, for example, whether "academic drive" is more strongly predicted by processes such as (growth) mind-sets rather than self-concept (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013).

Overall, the results emphasize that an important focus of the gap year training is related to "social factors", such as improving social skills, working together, giving and receiving feedback, and training within a group setting. This is consistent with the finding that the strongest increases were found for positivity scores in the social domain, and that predictions were mostly related to the social aspects of adjusting to the chosen college. Making successful future-oriented educational choices can be considered a process that should not only have a focus on academic skills, but includes an important role for social development as well.

Conclusion

Taken together, this study using a naturalistic program within a gap year context showed that training focused on the self enhanced multiple aspects of self-concept (self-esteem, self-concept clarity, and positivity of domain-specific self-evaluations) and associated activity in mPFC related to positive self-evaluations. This study aimed to speak to an emerging problem with an increasingly higher number of adolescents taking gap years before starting higher education. According to Researchned (2018), this increase could be a result of the introduction of the Dutch student loan system which increased the pressure for adolescents to make the "right" decision for their future straight away, as dropping out or switching between programs could lead to significantly high costs. As a consequence, many adolescents point out they suffer from choice overload and are afraid to make a wrong decision. However, this problem is not limited to the Netherlands, and reflects a broader tendency of students experiencing burnout due to various societal pressures (Lin & Huang, 2014). This study was conducted before the COVID-19 crisis, but this may be a new societal challenge that could affect adolescents' process of choosing a well suited future educational career path, although the long-term effects remain to be investigated.

In conclusion, this study showed that for late adolescents self-concept training can lead to increased positive domain-specific self-evaluations, self-esteem and self-concept clarity, and eventually better social adjustment to college and academic performance. Although these results were obtained within a gap year context, the positive outcomes point towards the implication of increasing the focus on self-concept development already early on in high school in order to help adolescents to get a better understanding of their traits, interests, abilities and goals, thereby increasing their chances of finding a suitable major.

SUPPLEMENTARY MATERIALS

Table S.1.
Means and Standard Deviations of all behavioral self-concept variables

Variable	*M*	*SD*
1.Dir Academic Positivity T1	2.69	.56
2.Dir Academic Positivity T2	2.80	.46
3.Dir Academic Positivity T3	2.89	.46
4.Refl Academic Positivity T1	2.75	.55
5.Refl Academic Positivity T2	3.36	.44
6.Refl Academic Positivity T3	2.95	.59
7.Dir Physical Positivity T1	2.93	.56
8.Dir Physical Positivity T2	3.13	.41
9.Dir Physical Positivity T3	3.32	.44
10.Refl Physical Positivity T1	2.98	.54
11.Refl Physical Positivity T2	3.26	.48
12.Refl Physical PositivityT3	3.33	.39
13.Dir Prosocial Positivity T1	3.24	.43
14.Dir Prosocial Positivity T2	3.34	.33
15.Dir Prosocial Positivity T3	3.35	.34
16.Refl Prosocial Positivity T1	3.15	.38
17.Refl Prosocial Positivity T2	3.36	.44
18.Refl Prosocial Positivity T3	3.37	.40
19.Dir Social Positivity T1	2.69	.54
20.Dir Social Positivity T2	3.07	.40
21.Dir Social Positivity T3	3.22	.44
22.Refl Social Positivity T1	2.83	.57
23.Refl Social Positivity T2	3.19	.49
24.Refl Social Positivity T3	3.23	.48
25.Dir Overall Positivity T1	2.88	.35
26.Dir Overall Positivity T2	3.08	.26
27.Dir Overall Positivity T3	3.19	.31
28.Refl Overall Positivity T1	2.93	.39
29.Refl Overall Positivity T2	3.20	.39
30.Refl Overall Positivity T3	3.22	.37
31.Self-esteem T1	2.83	.88
32.Self-esteem T2	3.22	.76
33.Self-esteem T3	3.69	.63

Table S.1.
Continued

Variable	*M*	*SD*
34.Self-concept clarity T1	2.74	.55
35.Self-concept clarity T2	2.82	.60
36.Self-concept clarity T3	3.31	.75

Note: Dir=Direct; Refl= Reflected.
Range of scores self-concept domains 1-4; self-esteem and self-concept clarity 1-5.

Whole-brain analyses

In addition to our pre-registered ROI analyses, we also examined the valence contrast positive > negative on a whole-brain level. One sample t-tests showed that at each time point and across tasks, evaluating positive versus negative traits resulted in activity in the mPFC, ACC, PCC/Precuneus, Hippocampus, and Angular Gyrus (**Figure S.1A, S.1B, Table S.2**). We conducted a Flexible Factorial ANOVA with time (T1, T3) and valence (positive, negative) to investigate possible increases in activation over time. The main effect of time (T3 > T1) revealed activation in the right putamen, right insula, and left superior temporal gyrus (**Figure S.1C, Table S.2**).

Finally, on a whole-brain level, we explored changes in task-based effects for both the direct and reflected task, tested versus the control condition. For the contrast Direct > Control on T1, activity was shown in the mPFC, ACC, and TPJ. On T3, activity was only observed in the SMA (see **Figure S.2A, S.2B and Table S.3**). No differences were found between time points. For the contrast Reflected > Control, activity was observed in the lingual gyrus on both time points. On T3, activity was also shown in the SMA (see Figure **S.3A, S.3B and Table S.3**). A Flexible Factorial ANOVA with time (T1, T3) and condition (reflected, control) revealed additional increases in the left middle- and posterior cingulate cortex (MCC and PCC). However, the extracted ROI of this cluster indicated that this effect was mostly driven by increases in activation for the control condition (Figure **S.3C. and Table S.3**).

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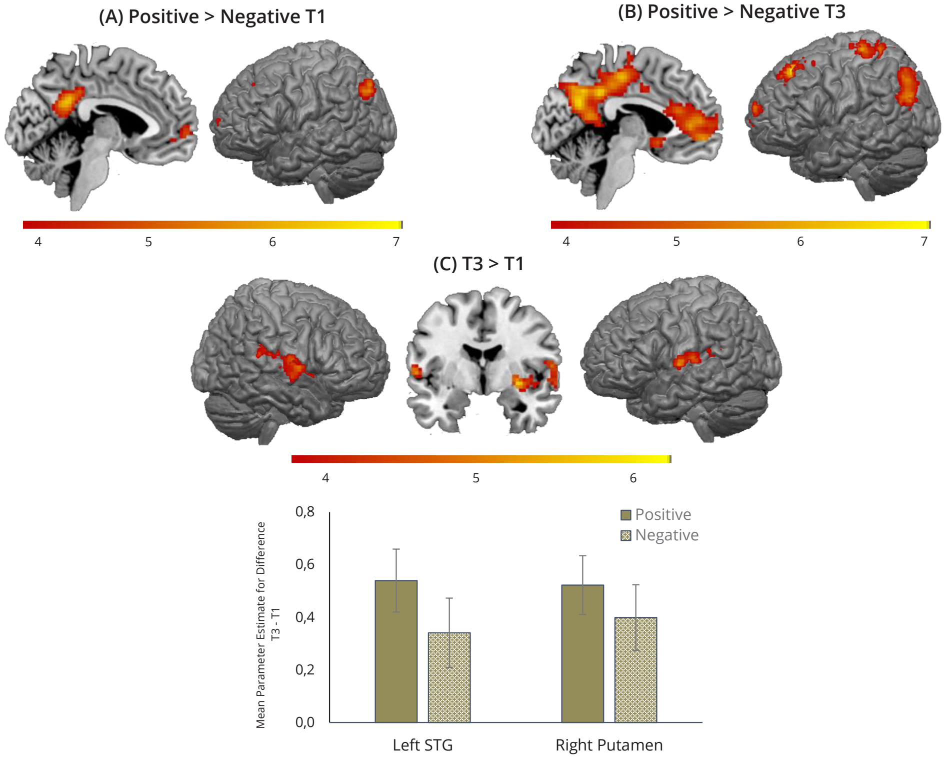

Figure S.1. *The contrast positive > negative (both tasks combined) resulted on both time points in activity in the mPFC, ACC, PCC/Precuneus, Hippocampus, and Angular Gyrus. A significant increase in activation for T3 > T1 was observed in right putamen and left superior temporal gyrus (STG). All regions survived FDR-cluster correction ($p < .05$) at an initial uncorrected threshold of $p < 0.001$.*

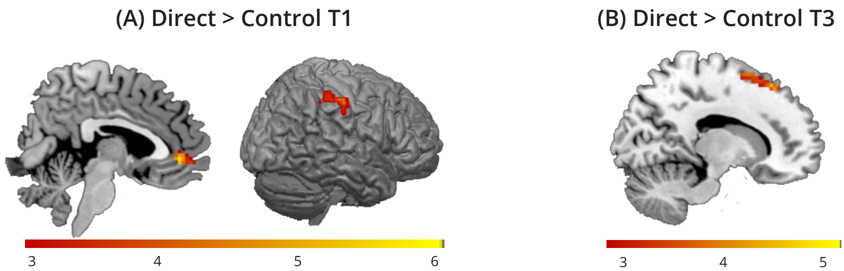

Figure S.2. *The task based whole-brain contrast direct > control resulted on T1 in activity in the mPFC, ACC, and TPJ. On T3 activity was only observed in the SMA. No differences between time points were observed. All regions survived FDR-cluster correction ($p < .05$) at an initial uncorrected threshold of $p < 0.001$.*

Table S.2.
Regions activated during the valence contrast positive > negative at each time point separately (T1, T3) and for T3 > T1

Region	BA	Coordinates			Cluster Size	T
Pos > Neg T1						
L Posterior Cingulate Cortex	23	-6	-49	25	333	6.90
R Precuneus	23	9	-52	28		5.43
L Middle Cingulate Cortex	23	0	-37	37		4.96
L Superior Medial Gyrus	10	-3	62	1	120	4.32
R Anterior Cingulate Cortex	10	6	47	7		4.18
L Mid Orbital Gyrus	32	0	50	-5		3.74
Hippocampus	36	-24	-22	-17	74	4.63
L Hippocampus	54	-36	-28	-14		4.33
L Parahippocampal Gyrus	36	-18	-34	-11		4.17
L Angular Gyrus	39	-39	-76	43	67	5.33
L Middle Occipital Gyrus	39	-45	-73	37		5.31
L Superior Frontal Gyrus	8	-18	26	46	38	4.73
L Middle Frontal Gyrus		-21	20	52		4.53
Pos > Neg T3						
L Superior Frontal Gyrus	8	-18	35	49	218	7.38
L Middle Frontal Gyrus	8	-30	20	49		3.88
L Precuneus	31	-15	-61	31	1678	7.07
L Middle Cingulate Cortex	23	0	-43	34		6.96
L Precuneus	31	0	-61	28		6.91
R Middle Orbital Gyrus	10	6	53	-2	813	6.45
R Anterior Cingulate Cortex	32	6	29	19		5.77
L Anterior Cingulate Cortex	32	-3	41	7		5.73
L Postcentral Gyrus	4	-36	-31	61	308	6.15
L Superior Parietal Lobe	7	-27	-46	67		5.02
L Postcentral Gyrus		-21	-28	64		4.62
L Angular Gyrus	39	-54	-70	25	289	5.78
L Middle Temporal Gyrus	39	-42	-61	22		5.42
L Angular Gyrus		-51	-67	40		5.33
L Parahippocampal Gyrus	37	-24	-31	-17	60	4.83
L Fusiform Gyrus	37	-30	-43	-20		4.28
L Cerrebellum		-18	-46	-17		3.53
L Caudate nucleus	48	-6	11	-8	65	4.78

Table S.2.
Continued

Region	BA	Coordinates			Cluster Size	T
PosNeg T3 > T1						
R Putamen	49	33	-13	-8	410	6.01
R Putamen	49	30	-4	-5		5.50
R Insula		33	-25	28		5.13
L Rolandic Operculum	1	-42	-22	19	201	5.17
L Superior Temporal Gyrus	6	-57	-4	4		4.73
L Superior Temporal Gyrus	22	-45	-40	16		4.55

Note: Names were based on the Automatic Anatomical Labeling (AAL) atlas.

Table S.3.

Regions activated during the task based contrasts self > control and reflected > control at each time point separately (T1, T3) and for T3 > T1

Region	BA	Coordinates			Cluster Size	T
Self > Control T1						
L Anterior Cingulate Cortex (ACC)	32	6	41	-2	80	5,78
L Mid Orbital Gyrus	10	-9	53	-2		4,78
L Middle Cingulate Cortex (MCC)	32	-9	44	-2		4,31
R Supramarginal Gyrus (TPJ)	40	63	-25	43	58	4,46
R Inferior Parietal Lobe (IPL)	40	45	-37	49		4,05
R Inferior Parietal Lobe (IPL)	40	57	-37	49		3,82
Self > Control T3						
R Superior Medial Gyrus	8	12	29	55	70	5,00
R SMA	6	15	11	64		4,13
R SMA	6	9	17	61		3,93
Reflected > Control T1						
L Lingual Gyrus	18	3	-79	-2	55	5,44
Reflected > Control T3						
L Lingual Gyrus	18	3	-79	-2	46	5,94
R SMA	6	12	17	61	67	4,85
R Superior Frontal Gyrus	6	15	26	55		4,16
Reflected Control T3 > T1						
L Middle Cingulate Cortex (MCC)	31	-6	-31	46	74	3,93
L Posterior Cingulate Cortex (PCC)	23	-6	-37	28		3,91
L Middle Cingulate Cortex (MCC)	31	-6	-37	52		3,62

Note: Names were based on the Automatic Anatomical Labeling (AAL) atlas.

Table S.4

Means, standard deviations, and correlations of all outcome variables

Variable	1	2	3	4
1.Satisfaction with choice				
2.Satisfaction with life	.27			
3.Study commitment (U-MICS)	.79**	.45*		
4.Intrinsic motivation (SRQ)	.60**	.60**	.78**	
5.Identified regulation (SRQ)	.44*	.27	.55**	.73**
6.Academic adjustment (SACQ)	.54**	.24	.63**	.62**
7.Social adjustment (SACQ)	.31	.14	.53*	.55**
8.Study dedication (UBES)	.78**	.20	.83**	.68**
9.Study absorption (UBES)	.75**	.37	.72**	.59**
10.Study vigor (UBES)	.72**	.26	.85**	.72**
11.Academic performance	.46*	.35	.63**	.47*
M	3.91	21.53	3.44	3.85
SD	1.03	5.72	.73	.60
Range	1 - 5	5 - 35	1 - 5	1 – 5

Note: * = p < .01.; ** = p < .001.

5	6	7	8	9	10	11
.46*						
.48*	.44*					
.56**	.49*	.26				
.41	.63**	.29	.73**			
.51*	.71**	.47*	.77**	.82**		
.38	.44*	.71**	.42	.50*	.62**	
4.17	3.34	3.63	5.00	4.00	4.14	4.39
.45	.73	.82	1.44	1.43	1.38	.78
1 - 5	1 - 5	1 - 5	1 - 7	1 - 7	1 - 7	1 - 5

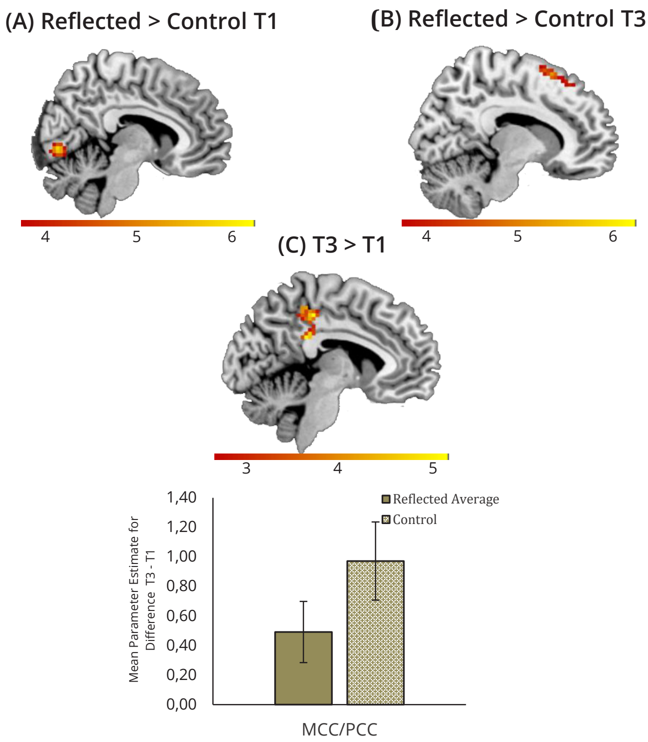

Figure S.3. *The task based whole-brain contrast reflected > control resulted on T1 in activity in the lingual gyrus. On T3 activity was additionally observed in the SMA. A significant increase in activation for T3 > T1 was shown in the left MCC and PCC. All regions survived FDR-cluster correction (p < .05) at an initial uncorrected threshold of p < 0.001.*

Hoe ben je veranderd sinds de eerste keer
dat je mee deed aan dit onderzoek?
"VEEL MEER ZELFVERTROUWEN, VEEL MEER DURVEN,
VEEL MINDER GEVEN OM DE MENINGEN VAN ANDEREN."
Maaike, 20 jaar

Chapter 6

SUMMARY AND GENERAL DISCUSSION

SUMMARY

The main goal of this thesis was to investigate the behavioral and neural processes involved in self-concept development in adolescence within the context of future-oriented educational decision-making. First, I examined the development of domain-specific self-evaluations across adolescence within a social context, by testing how the positivity of these self-evaluations is influenced by the use of social comparisons (**chapter 2**). Second, I focused on the role of behavioral and neural indices of adolescents' self-concept in relation to future-oriented educational decision-making (**chapter 3, 4,** and **5**). I studied this topic by focusing on the role of different aspects of self-concept (related to both its valence and structure, on behavioral and neural levels), including multiple samples of adolescents (differing in the problems they encounter with educational decision-making) and using various approaches (e.g. group comparison, training, and prediction). The current discussion starts out with a brief summary of the main findings of each chapter. This summary is followed by a general discussion, including recommendations for future research. Finally, I highlight the practical implications of the findings, and end the discussion with general conclusions.

Self-concept development and social comparison across adolescence

The first empirical chapter (**chapter 2**) describes developmental patterns of domain-specific self-evaluation across adolescence with and without the presence of an explicit social context. Prior research has indicated that adolescence is a unique period for self-concept development, with a heightened sensitivity for social comparison as a mechanism that can be used to evaluate the self (Sebastian, Burnett, & Blakemore, 2008). However, it remains unclear how these social comparisons impact the development of self-evaluations in different domains, and across different ages in adolescence. In order to disentangle the specific influence of social comparison outcomes within developmental patterns of self-evaluation, I developed two tasks that that both asked participants about trait self-descriptions (e.g. 'Am I spontaneous?'), but differed in the salience of the presence of a social comparison with an unknown peer (e.g. 'Am I more spontaneous than this peer?'). Traits could be either positive or negative and were categorized into three domains: academic (e.g. 'intelligent' or 'unmotivated'), social (e.g. 'friendly' or 'jealous') and physical appearance (e.g. 'attractive' or 'skinny'). As a first aim, I investigated the development of self-evaluations in a task *without* an explicit social comparison in four age groups: late childhood (9–11 years), early adolescents (12–14 years), mid adolescents (15–17 years) and young adults (18–25 years). Second, I focused on the development of self-evaluations *within* an explicit social-comparison to examine how this shift in context influenced the positivity of self-evaluations across domains and age groups.

Findings for the first task (without a social comparison context) indicated that children and adolescents in the younger age groups (9 – 14 years) consistently showed more positive as well as less negative self-evaluations compared to the two older age groups. These differences could be a reflection of a positivity bias (Harter, 2012), indicating that younger children and adolescents often hold favorable self-views and can overestimate their abilities. Compared to the first task, the second task with an explicit social comparison yielded similar as well as additional results. The youngest age groups continued to rate themselves more positively compared to the older adolescents. That is, they generally attributed positive traits to themselves, and negative traits to the peer. In addition to the findings for the first task, there were more pronounced age-differences that became more strongly dependent upon domain. Especially the mid adolescents (15-17-year olds) were negatively affected by the context of social comparison, attributing more negative and less positive traits to themselves. This effect was most apparent for the academic domain. Possibly, the academic school environment is characterized by a strong evaluative atmosphere where comparison of performance and grades with others is often emphasized (Wehrens et al., 2010). Particularly with an increased performance-focus during the final years of high-school, where most 15 – 17 years will find themselves in, this could increase the use of social comparisons and negatively influence the self-concept.

Together, these findings support the idea of a 'social reorientation' that takes place during mid-adolescence (Nelson, Leibenluft, McClure, & Pine, 2005) where greater sensitivity to the social context could affect the positivity of self-evaluations to a larger extent. In the next chapter, I further zoom in on the age group of mid-adolescence in their final years of high school, as I examine the role of behavioral and neural correlates of academic self-concept in the orientation process leading up to the decision for a future study.

Academic self-concept and future-oriented educational decision-making

In **chapter 3**, I started my investigation regarding the role of behavioral and neural indices of self-concept in future-oriented educational decision-making. Here, I focused on the orientation process towards a future study. This reflects students' first awareness of the need to make this future-oriented decision and consequently take relevant actions regarding planning and exploration of options (Germeijs & Verschueren, 2006). Within this process, I was specifically interested in the role of academic self-concept on both a behavioral and neural level. First, I examined how the positivity of academic self-concept and activity of brain regions involved in academic self-evaluations would relate to problems adolescents could experience with future orientation. Additionally, I tested whether academic self-concept could be unique in its relation to future orientation by also including other academic measures such as academic performance or the subjective importance of academic traits.

Participants were 48 adolescents between 14 – 20 years in the final years of high school, who therefore needed to start thinking about future academic or career options they would want to pursue after graduation. They evaluated themselves on positive and negative academic trait sentences (e.g. 'I am a fast learner' or 'I think school is hard') in an fMRI session. In addition, they evaluated the importance of these traits, completed a questionnaire on problems with future orientation, and performed a reading test and shortened IQ test as an index of cognitive performance. Behavioral findings indicated that a more positive academic self-concept was associated with fewer problems with future orientation. Moreover, academic self-concept was a better predictor for future orientation compared to academic performance or subjective importance of academic traits. These findings could be reflective of an underlying motivational component. That is, future orientation can be viewed as a 'motivation for the future', and academic self-concept is considered to be more closely related to motivation than performance (Guay, Ratelle, Roy, & Litalien, 2010). On a neural level, I found increased activation in mPFC for the evaluation of academic traits compared to a control task, which is consistent with prior studies (Ma, Wang, Yang, Feng, & Van Overwalle, 2016; Moran, Lee, & Gabrieli, 2011). Interestingly, the precuneus was sensitive to individual differences in academic positivity. That is, individuals who rated themselves more positively on academic traits also showed increased activity in the precuneus. This region is part of the cortical midline structures and is engaged in perspective taking through mental imagery, such as imagining oneself in multiple social contexts (Cavanna, 2006; Schurz, Radua, Aichhorn, Richlan, & Perner, 2014). This precuneus activity additionally mediated the relation between academic self-concept and problems with future orientation. These findings suggest that the precuneus is an important brain region that processes how adolescents evaluate academic traits, and subsequently influences how adolescents think about their future academic self through future orientation. After studying the relation between self-concept and educational decision-making in the general population, I now turn to a more specific group of adolescents who all experience serious problems with future educational decision-making in chapter 4.

Self-concept in adolescents struggling with educational decision-making

The main aim of **chapter 4** was to examine self-concept characteristics in a specific group of adolescents who reported difficulties with choosing a suitable major in higher education. In the Netherlands, there is an increasing number of adolescents who delay the need to make this future-oriented decision by taking one or multiple gap years (from 6% in 2015 to 12% in 2017). Many others appear to make a wrong decision which can result in dropping out or changing programs (33% drop out in their first year, Dutch Ministry of Education, 2018). To understand more about various aspects of the self-concept of these individuals and how these might differ from individuals who do not experience these difficulties, I recruited a sample of 38 adolescents (16 – 24 years) in collaboration with Foundation Gap Year. This is an organization in the Netherlands that provides structured one-year self-concept training programs for adolescents who have dropped out of higher education or remain undecided after high school. Before the start of their training, I tested these adolescents on behavioral measures of self-esteem, domain-specific self-evaluations, self-concept clarity and neural mechanisms underlying self-processing. I compared these measures to those of individuals who reported to have already successfully chosen a major (*N* = 46, 17 – 21 years), and additionally tested for brain regions that co-varied with individual differences in self-concept measures across both groups.

Behavioral findings showed that adolescents struggling with educational decision-making reported lower levels of self-esteem and self-concept clarity compared to their peers. Interestingly, groups did not differ on domain-specific evaluations. For example, the gap year individuals did not evaluate themselves more negatively on academic traits. These results possibly indicate that self-insight and self-esteem are important factors needed to successfully choose a suitable major. Neurally, both groups recruited cortical midline regions such as the mPFC and ACC during self-processing, but there were no group differences in brain activity. However, the strength of mPFC activity was related to individual differences in self-esteem. That is, individuals with lower self-esteem recruited the mPFC to a lesser extent compared to individuals with higher levels of self-esteem, especially for the evaluation of academic and physical traits. These results suggest that self-esteem could serve as an important condition to help individuals mentalize about the self (for further reading see Lieberman, Straccia, Meyer, Du, & Tan, 2019). Together, these findings contribute to our understanding what characterizes individuals struggling with educational decision-making. Given that differences were most pronounced for self-esteem, an important next step was to test whether training self-esteem could help adolescents to make a well-suited educational choice. I investigated this question in chapter 5.

Self-concept training and better future educational choices

Chapter 5 aimed to speak to the societal problem concerning the large number of adolescents who experience difficulties in choosing a suitable program in higher education which matches their self-views. Possibly, stimulating self-concept development could help adolescents to increase their chances of finding a suitable major. Therefore in this chapter, I examined the effects of a naturalistic self-concept training within a gap year context on behavioral and neural correlates of self-evaluations. Additionally, I examined the predictive value of changes in behavioral indices of self-concept during this gap year for successful future educational decision-making. I followed the same individuals who started their training with Foundation Gap Year in chapter 4 across four time points. Participants were tested on levels of self-esteem, domain-specific self-evaluations and self-concept clarity before, during, and after the training (each 5 months apart). There were two fMRI sessions before and after training to examine changes in the underlying mechanisms of self-processing. At an additional follow-up measurement (6 months later) participants filled out questionnaires related to their current academic situation, in order to examine long-term consequences of the training for educational decision-making.

This study resulted in four main findings. First, the one-year training period was associated with increases in all self-concept measures (self-esteem, self-concept clarity and positivity of domain-specific self-evaluations). However, the specific trajectories of these variables differed. For example, self-esteem showed linear increases across the year, whereas self-concept clarity only improved in the second half of the year. With regard to the domain-specific self-evaluations, changes were most significant for the social domain, which suggests that the difficulties this group experiences may be broader than academic decision-making and may reflect a general difficulty with fitting in. Together, these behavioral results seem promising for the malleability of self-concept during late adolescence. As a second main finding, neural results demonstrated that mPFC activity during self-evaluation pre-training predicted self-esteem change across the gap year. That is, participants with lower mPFC activity before training showed larger self-esteem increases over the year. These findings extend the cross-sectional association between self-esteem and mPFC activity previously reported in chapter 4, and indicate that mPFC activity not only correlates with, but also predicts self-esteem change. Third, mPFC also showed a time-related effect of valence, as activity increased after training for the evaluation of positive, but not negative traits. These findings fit well with the general increase in behavioral positivity ratings, as research has shown that mPFC activity is modulated by self-relevance. Therefore these results could possibly reflect that positive traits are considered more applicable to the self. Finally, individual differences in changes in self-concept clarity and social self-evaluations, but not self-esteem, positively predicted outcomes related to future-oriented educational choices, such as better social adjustment to college and academic performance. Overall, the results emphasize that a naturalistic gap year program focused on the self can increase positivity as well as clarity of the self-concept and associated activity in the mPFC, and in turn, can help adolescents with their adjustment in higher education.

GENERAL DISCUSSION

The studies presented in this thesis all highlight that self-concept is a multifaceted and complex construct that not only develops in *interaction* with the social environment, but can also have an *impact* on someone's future environment. For example, results from **chapter 2** indicated that the social environment, expressed in the outcomes of social comparisons, can affect the positivity of the self to a different extent across multiple domains and different stages of adolescence. **Chapter 3** showed how adolescents' academic self-concept can influence their motivation to stay committed to goals important for their future educational environment, whereas **chapter 4** illustrated differences in self-esteem and self-concept clarity in individuals who differed in their experienced problems with choosing this future educational environment. Finally, **chapter 5** demonstrated that in late adolescence, sensitivity to outside influences can be used to stimulate self-concept development through training which can ultimately help adolescents in their educational decision-making and adjustment in higher education. Together, these studies provide a comprehensive view on self-concept development in adolescence that takes place within a broader social, and educational context. In the following sections, I discuss several main findings that stand out across these different studies, and provide recommendations for future research and practical implications.

Self-concept within an educational context

A first finding that emerges from this thesis is related to the academic domain of self-concept in the specific period of mid-adolescence (14 – 17 years; Harter, 2012). In the Netherlands, most adolescents in this developmental stage are still in (one of the final years of) high school, working towards final examinations and possibly preparing for future educational decision-making. I studied the academic self-concept of this group of mid-adolescents in two separate samples in **chapter 2** and **chapter 3**. In **chapter 2**, I showed that for mid-adolescents, the positivity of academic self-evaluations was most negatively influenced by social comparisons compared to other age groups. This finding extends the result from a separate adolescent sample of the Leiden Self-Concept Study (van der Cruijsen, Peters, van der Aar, & Crone, 2018) where it was found that the academic domain showed a dip in positivity during mid-adolescence, whereas the physical or social domain did not show any age-related changes in positivity across adolescence. Research has suggested that academic self-concept is profoundly formed by actively comparing one's own achievements to those of peers in the same classroom, also known as the "Big-Fish, Little-Pond" effect (Marsh & Hau, 2003). The use of these comparisons is triggered even more as there is an increased emphasis on grades during (the final years of) high school, and through additional teacher practices such as giving verbal feedback in front of other classmates. Together with the heightened sensitivity to social influences on the self, this can make mid-adolescents more vulnerable to negative outcomes of these social comparisons and may therefore temporarily decrease the positivity of their academic self-evaluations.

Critically, having a positive academic self-concept could be especially relevant during mid-adolescence as it can not only influence adolescents' current academic goals, motivation or achievement, but could also affect processes involved in their orientation to future academic goals, a topic I focused on in **chapter 3**. Here I showed that in a separate sample of mid-adolescents in their final years of high school, a more positive academic self-concept was related to the experience of fewer problems with future orientation. That is, adolescents who evaluated their current academic motivation, interests and achievement more positively, also displayed more awareness and motivation to start their orientation and planning towards a suitable future educational choice. This process is an important first step towards successful educational decision-making and with a timely start could increase adolescents' chances of finding a suitable major in higher education. A large body of research has already indicated strong links between adolescents' academic self-perceptions and their motivation concerning short-term goals that take place within the walls of high school (Bong & Skaalvik, 2003; Guay et al., 2010). The current finding extends this relationship by showing that the positivity of these perceptions can be beneficial for the motivation regarding future, long-term academic goals as well.

Together these results indicate that mid-adolescence is a developmental phase where positive academic self-evaluations could be an important motivator in the orientation process for their academic future, but that at the same time it can be difficult to maintain these positive self-evaluations due to a concurrent heightened sensitivity to social influences on the self. This is underscored by a recent national report from UNICEF, that examined mental health, stress, and happiness in a large sample of Dutch adolescents between 10 – 18 years (UNICEF, 2020). Here, more than 50 % of mid-adolescents reported that their main source of stress was related to the school environment. Causes of this stress that were cited were, amongst others, high expectations from others and themselves, feeling pressured to perform well, a high degree of social comparison, and worries about their future.

Interestingly, a proposed protective factor against these feelings of stress and worries put forward by the participating adolescents themselves was having a strong sense of an own identity, with overall feelings of self-acceptance and self-worth (UNICEF, 2020). These aspects of self-concept could not only function as a buffer against stress during high school, but also help adolescents later in the process of educational decision-making, a topic I focused on in **chapter 4** and **5**. Here I examined self-concept in a sample of slightly older adolescents (*M* = 18-19 years) who had just finished high school and therefore urgently needed to make a decision regarding their academic future. I showed that both self-esteem and self-concept clarity were significantly lower in adolescents who visibly struggled with finding a suitable educational major (e.g. they had dropped out or took a gap year) compared to adolescents who reported to have successfully made the transition into higher education (**chapter 4**). Additionally, both self-esteem and self-concept clarity showed large improvements during a year of self-concept training in a gap year context (**chapter 5**). Finally, self-concept clarity was revealed as a possible key self-concept variable in the process of successful educational-decision making, as increases in self-concept clarity were predictive of positive outcomes such as better social adjustment and academic performance in higher education (**chapter 5**). Interestingly, within these late adolescents, academic self-concept did not differ in positivity between groups, nor were changes in academic positivity predictive of positive academic outcomes in higher education, such as better motivation, performance or adjustment. Together, these findings suggest that multiple aspects of self-concept could have different roles within the context of future educational decision-making. That is, the positivity of self-evaluations in the academic domain could be related to the more (intrinsic) motivational aspects of the start of the educational decision-making process, but it may not be the most decisive factor later on in the process. Furthermore, although self-esteem and self-concept clarity differentiated between adolescents with or without problems with educational decision-making and both these aspects were sensitive to improvement, only self-concept clarity was predictive of positive educational outcomes in higher education. These findings are in line with earlier studies indicating that self-esteem and self-concept clarity are separate constructs with unique associations with adjustment (Campbell, 1990; Findley & Ojanen, 2013). With regard to self-esteem, relationships with academic variables have been inconsistent or unclear, and it has been questioned whether boosting self-esteem always has a positive effect, since it may also lead to overconfidence which has been associated with underperformance and decreased motivation (Baumeister, Campbell, Krueger, & Vohs, 2003). On the contrary, self-concept clarity has generally been linked to positive outcomes only (Findley & Ojanen, 2013). The current findings add to this research by suggesting that having a clear understanding of the self is needed and possibly most important in the process of successful educational decision-making and adjustment in higher education.

Neural signature of self-concept and future-oriented educational decision-making

In order to increase our understanding of mechanisms underlying self-processing, I additionally examined self-concept and its relation with future-oriented educational decision-making on a neural level. Across the studies in this thesis, these brain imaging data highlighted two main findings. First, on a group level, thinking and evaluating the self during (mid and late) adolescence was associated with activation in the cortical midline structures such as the mPFC and precuneus, which is consistent with earlier studies examining self-processing in both adults and adolescents (Denny, Kober, Wager, & Ochsner, 2012; Pfeifer & Berkman, 2018). However, with regard to the context of future-oriented educational decision-making, the most interesting results were found in relation to brain regions sensitive to *individual differences* in self-concept. First, in mid-adolescence, precuneus was more active for adolescents with more positive academic self-evaluations and this increased activation was related to the experience of fewer problems with future orientation (**chapter 3**). Second, during late adolescence, I found that mPFC-activity was reduced for individuals with lower levels of self-esteem, a characteristic of adolescents struggling with educational decision-making (**chapter 4**). Together, these findings suggest that activity in these cortical midline structures during self-processing may be dependent on individual characteristics. Intriguingly, these brain-behavior relations were only observed for valence aspects of the self-concept (on a domain-specific or a more general level), but not structural aspects of the self (self-concept clarity). Possibly, self-positivity is coded by both anterior and posterior regions of the CMS as more salient, which is in agreement with studies suggesting that positive affect may be a central component of the mental representation of the self (Chavez, Heatherton, & Wagner, 2017; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006). Conversely, differences in self-concept clarity could correspond to a lesser extent to salience coding in the brain as it represents an indication of overall stability and consistency of the self-concept instead of a direct self-relevant response (e.g. "Yes, this trait describes me"). Together, these findings emphasize that including individual differences is a useful approach to better understand the underlying neural mechanisms of self-processing within the context of future-oriented educational decision-making.

Second, findings from **chapter 5** further suggest that activity in these cortical midline structures may change when creating positive circumstances for optimal self-concept development, as was demonstrated with the Gap Year program. Here, I observed on a group level that participating in a structured self-concept training was associated with increased activity in mPFC for the evaluation of positive-valenced traits specifically. That is to say, mPFC activity increased over time when evaluating oneself on positive-valenced traits but not on negative-valenced traits. This is consistent with the general increase in behavioral positivity ratings and the notion that the ventral part of the mPFC responds more strongly to stimuli that have a larger personal significance (D'Argembeau, 2013). This hypothesis was further reinforced by the finding that at the individual level lower mPFC activity prior to the Gap Year program was associated with lower self-esteem at the first measurement, but larger self-esteem change over time, possibly reflecting room for development. This latter finding is important because it shows that low mPFC activity should not be taken as a fixed state, as in the context of environmental enrichment it can predict who are the individuals who show potential for change. These findings provide the first steps in unraveling experience-related changes in neural activity in a naturalistic training environment. The current design should be followed up in a structured randomized-control design, including multiple age groups. Nonetheless, it provides a proof of concept to build future larger scale programs examining the role of social and personal enrichment on self-concept development and educational outcomes.

Recommendations for future research

The studies in this thesis made a first important step in the investigation of the role of multiple aspects of self-concept in the context of future educational decision-making, and provide a starting point for future studies to address several outstanding questions. In this section, I discuss ideas for extending the current research methods and introduce new research approaches that could help to increase our understanding of adolescents' self-concept in relation to future-oriented educational decision-making.

Extending current research methods

First, although I demonstrated differences in self-concept in relation to future-oriented educational decision-making on both the individual level (by including individual differences) and group level (by examining a specific group struggling with this process), the samples were too small to test for possible additional important differences between categorical variables such as gender, educational track, or social economic status (SES). For example, the report by UNICEF (2020) indicated that girls, adolescents with a migration background, and adolescents in a higher academic track were all more vulnerable to experiencing increased levels of stress due to school. Additionally, these Dutch educational tracks do not only differ in their academic level, but also in their duration and number of possible future options after graduation, which could all have a significant influence on later experienced problems with educational decision-making. Future studies would benefit by including these additional variables and testing relations with educational decision-making in larger samples, using longitudinal designs.

Second, with regard to the multifaceted and complex structure of self-concept, it is important to note that the studies in this thesis examined the behavioral and neural correlates of only a selection of all possible self-concept domains. The focus on self-evaluations within academic, (pro)social, and physical domains was chosen because these domains have been shown to be of particular relevance to the lives of adolescents (e.g. resembling traits needed in a school or social context with peers) and are similar to what other studies examining adolescent self-concept development have focused on (Pfeifer & Peake, 2012). However, within an educational context not all examined domains are as relevant for future-oriented educational decision-making and important aspects might have been overlooked. For example, the academic domain consists of trait words that are mostly focused on cognitive skills; they ask adolescents about an evaluation of their intelligence, grades or work attitude. However, this approach can be limited as it does not attend to adolescents' evaluation of aspects such as creativity or practical skills that can be important for someone's view of "being intelligent" (Henry, Sternberg, & Grigorenko, 2005; Nusbaum & Silvia, 2011) and could be helpful in dealing with the complex task of choosing a suitable future education. Therefore, future studies may address this issue by incorporating these traits to the academic domain or including an additional domain on creative self-concept (Karwowski, 2017). Similarly, self-concept research could be extended to include the investigation of adolescents' interests, as research has shown that someone's self-concept can affect their interests (e.g. 'I am good at math, I like math'; Denissen, Zarrett, & Eccles, 2007) and these interests, in turn, play an important role in adolescents' process of deciding which program to pursue in higher education (Vulperhorst, van der Rijst, & Akkerman, 2020).

Theoretical advancements

In this thesis, I examined the relation between self-concept and future-oriented educational decision-making by focusing on adolescents' evaluations about their *current* self and how this relates to (difficulties with) achieving their future academic goals. However, these future goals indirectly reflect a clear vision of a *future self*. Research has indicated that there are large individual differences in the degree to which people identify and feel connected to their future self, also known as future self-continuity (Chishima & Wilson, 2020). Importantly, research has also shown that people with more future self-continuity are more likely to make decisions in the present that will benefit their future outcomes (Ersner-Hershfield, Garton, Ballard, Samanez-Larkin, & Knutson, 2009). Therefore, an important next step would be to foster adolescents' future self-continuity, which could in turn benefit their planning and decision-making towards a suitable educational choice. The use of novel technology such as virtual reality (VR) could be a fruitful new research approach to increase the vividness of the future self, thereby possibly strengthening the relation between the current and future self and foster adaptive future-oriented behavior (van Gelder, Otte, & Luciano, 2014). Additionally, an interesting future direction would be to test whether the effect of an increased future self-continuity can be detected on a neural level. For example, earlier studies have shown that reflecting on representations of future selves elicited less activity in mPFC and ACC compared to thinking about the present self, which has been interpreted as a process of perceived degree of self-relatedness (D'Argembeau et al., 2010; Ersner-Hershfield, Wimmer, & Knutson, 2009). Therefore, increased activity in these brain regions when adopting a future perspective of the self could be an indication of the future self being viewed as less distant, and more closely connected to the present self.

Finally, in this thesis I studied the underlying neural correlates of self-evaluation as separate brain regions of the CMS. However, it is well known that brain regions do not operate in isolation, but that brain function depends on a large-scale network of interacting neural regions (Stevens, 2016). Research on task-based functional connectivity related to self-evaluation is limited, although one recent study in emerging adults suggested that reduced connectivity between anterior CMS regions such as the mPFC and the more posterior region IPL (involved in mentalizing and perspective taking), possibly indicating more efficiency, could be an indication of having easier access to self-representations (Davey et al., 2019). Following this approach, it would be an interesting next step to examine how task-based functional connectivity differs in individuals who experience different levels of self-concept clarity and struggle with matching their self-views to a suitable future education.

Implications for practice

The findings in this thesis provide important practical implications on the individual as well as societal level. First, the results highlight that during late adolescence, various aspects of self-concept such as self-esteem, self-concept clarity and social self-evaluations can be enhanced through training and, in turn, can help adolescents with their social adjustment and academic performance in higher education. These results were obtained with an existing structured self-concept training program (the Gap Year program) which takes place within a gap year context after high school. Although the Gap Year program has beneficial effects for adolescents' self-concept development and future orientation, which was recently confirmed in a report of the independent research institute Noorda & Co (2019), participation in such a program that operates independently from high school can be very expensive (e.g. costs for the 10-month program are € 9000). To avoid these costs and make the benefits of a program such as the Gap Year program more easily accessible to a larger group of adolescents and at an earlier stage, I recommend schools to invest more in the self-concept development of students already within the high school years. This idea resonates well with suggestions from other educational researchers who indicate that within the high school curriculum there is currently a lack of attention to "advanced skills". These are skills, attitudes or knowledge that can contribute to personal wellbeing and are important for students' futures (e.g. social competence, planning, problem solving, self-esteem and self insight;(Chatterjee Singh & Duraiappah, 2020; Dutch Ministry of Education, 2016). In the Brain & Development Research center, we already took a first step in broadening the knowledge and skills of young people by developing course material for elementary and secondary education that targets topics that are not normally covered within the normal school curriculum, such as self-concept development (see http://breinkennisleiden.nl/onderwijs .With these course materials, we aim to increase adolescents' awareness of their own self-concept. This is achieved by, for example, stimulating adolescents to explore together with their classmates how others can influence their self-concept and think about which domains of self-concept matter most to them and why. Ultimately, this attention to self-concept development together with other advanced skills such as future-oriented planning could be incorporated within the curriculum such that it becomes a structural element within high school education. Together, stimulating adolescents to actively reflect on both who they are now and who they aspire to be could help to increase adolescents' self-insight and thereby their chances of finding a suitable major in higher education.

Lastly, it is important to note that in this thesis "making the wrong choice for a future education" is approached as something that should be avoided, as findings showed that experiencing difficulties with this decision-making process or failing to find a suitable major was associated with unfavorable measures such as low self-esteem or self-concept clarity. However, is choosing a major that turns out to not be the right fit something that should necessarily be perceived as bad? With adolescence being a phase of uncertainty and exploration (Becht et al., 2016), it could be argued that trying multiple options and sometimes failing them is part of normative adolescent development and these experiences can function as a learning opportunity and are important for informing and updating someone's self-concept. Currently however, the Dutch educational system is not set up to support this kind of explorative behavior. For example, adolescents are expected to make important educational choices with long-term consequences already in an early stage of high school, as by the third grade of secondary education 14-year-olds already need to decide on a selection of subjects that exclude the option of some study programs later on. In addition, the current Dutch student loan system discourages the possibility to explore options or switch between programs in higher education. Instead, it increases the pressure for adolescents to make the "right" decision for their future straight away, as dropping out or switching between programs can come with significant financial costs. Indeed, a recent study from the research institute Motivaction examining the relation between the student loan system and students wellbeing indicated that the loan system increased students feelings of stress, worry, and pressure to achieve and finish their study in time (van Vreden & Thijssen, 2019). Together, these educational policies pressure adolescents into making the right decision about their academic future from a very young age on, without much room to change paths. This limits further exploration and could increase stress around the process of future educational-decision making which both can go hand in hand with negative outcomes such as low self-esteem and self-concept clarity. Changing these systems by giving adolescents more time and tools to develop their self-concept and make it more acceptable and feasible to explore or switch between programs could possibly help to reduce these negative outcomes.

Concluding remarks

In conclusion, this thesis generates novel insights into the role of self-concept as a complex and multifaceted construct within the context of future-oriented educational decision-making. The findings highlight that adolescence is an important period for self-concept development, that is characterized by an increased sensitivity to the social environment. Although this sensitivity can lead to more negative self-evaluations, it importantly can also function as an *opportunity* to stimulate adolescents' self-concept development. Ultimately, this may help adolescents to accomplish their future educational goals, or, in other terms, find their "*future me*".


wat zou je tegen jezelf willen zeggen voor over 2 jaar?
"GENIET MAXIMAAL VAN HET LEVEN,
MAAR VERLIES JEZELF DAARBIJ NIET UIT HET OOG."
Jochem, 18 jaar

Addendum

NEDERLANDSE SAMENVATTING
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NEDERLANDSE SAMENVATTING

"Beschrijf jezelf in drie woorden." Waarschijnlijk heb je deze vraag wel eens gehad, bijvoorbeeld voor een schoolopdracht of sollicitatiegesprek. Om hier goed antwoord op te kunnen geven, is het nodig om na te denken over welke eigenschappen je bezit en jezelf vragen te stellen zoals: "Wie ben ik?" en "Wat past goed bij mij?"

Zelfbeeld is, zoals de naam al aangeeft, het beeld dat iemand van zichzelf heeft. Het geeft aan hoe iemand naar zichzelf kijkt en zichzelf beoordeelt. Al eeuwenlang is het zelfbeeld een onderwerp van interesse. Dat is niet gek, gezien ons zelfbeeld een grote invloed heeft op onze gedachtes, gevoelens, gedragingen en de keuzes die we dagelijks maken (Orth, Robins, & Widaman, 2012). De gevolgen van deze keuzes kunnen klein zijn. Bijvoorbeeld: ik zie mijzelf als een sociaal en extravert persoon, dus mocht ik een uitnodiging krijgen voor een feestje dan zal ik deze eerder aannemen dan afslaan. Daarentegen ben ik absoluut niet avontuurlijk aangelegd (behalve die ene keer toen ik er op mijn 21^{e} voor koos om vrijwillig uit een vliegtuig te springen, wel met parachute..). Dus mocht ik voor een leuke vakantie moeten kiezen tussen backpacken door de jungle of een stedentrip naar Parijs dan kies ik zeer waarschijnlijk voor het laatste.

Ons zelfbeeld heeft niet alleen invloed op dit soort keuzes met uitkomsten op de korte termijn, zoals hoe we onze avonden of vakanties besteden. Het speelt ook een belangrijke rol bij het maken van grotere keuzes met langetermijnuitkomsten. Denk bijvoorbeeld aan het kiezen van een toekomstige studie- of baanrichting. Een ontwikkelingsfase waarin veel van dit soort belangrijke keuzes worden gemaakt is tijdens de adolescentie, de periode tussen de kindertijd en volwassenheid die ongeveer de leeftijd tussen de 10 en 25 jaar beslaat (Crone & Dahl, 2012). De adolescentie wordt gezien als een belangrijke periode voor zelfexploratie en het ontwikkelen van een eigen identiteit (Erikson, 1968). Vergeleken met kinderen zijn adolescenten veel meer bezig met het nadenken over- en ontdekken wie zij zijn. Ze experimenteren met verschillende identiteiten, zijn erg gefocust op hoe anderen over hen denken en worden in toenemende mate zelfbewust. Deze versterkte focus op 'het zelf' wordt ook gestimuleerd door de schoolomgeving waar wordt verwacht dat adolescenten al vanaf een jonge leeftijd toekomstkeuzes maken die om een hoge mate van zelfreflectie vragen (bijvoorbeeld: Wat voor vakkenpakket past bij mij? Wat ga ik doen na de middelbare school? Wat zijn mijn vaardigheden en interesses en welke studieopties sluiten daar bij aan?)

Het maken van dit soort belangrijke toekomstkeuzes kan echter complex zijn. Dit is terug te zien in het hoge aantal adolescenten dat problemen ervaart met het kiezen van een vervolgopleiding (Ministerie van Onderwijs, 2018). Zij stellen het maken van deze keuze uit (bijvoorbeeld door een tussenjaar te nemen), maken helemaal geen keuze, of maken een verkeerde keuze en stoppen vervolgens met hun studie. Aangezien de adolescentie bij uitstek een fase is waarin het vermogen tot zelfreflectie zich nog steeds ontwikkelt, kan de manier waarop adolescenten over zichzelf nadenken en ze zichzelf beoordelen mogelijk een belangrijke rol spelen in het verklaren van individuele verschillen in het proces van het maken van een succesvolle toekomstkeuze, zoals het kiezen van een passende studie. Dat het vermogen tot zelfreflectie zich nog ontwikkelt is ook terug te zien in de hersenen. Zo laat recent hersenonderzoek zien dat veranderingen in het zelfbeeld mogelijk samengaan met veranderingen in de anatomie en activatie van hersengebieden die betrokken zijn bij het nadenken over jezelf (Pfeifer & Peake, 2012).

Het doel van dit proefschrift is om zelfbeeldontwikkeling tijdens de adolescentie vanuit zowel een gedragsmatig als neurowetenschappelijk perspectief te onderzoeken. Ik focus me hierbij met name op de rol van zelfbeeld in het proces van het maken van een toekomstige studiekeuze tijdens de overgangsperiode tussen de middelbare school en het hoger onderwijs.

Wat is zelfbeeld?

Zelfbeeld wordt gedefinieerd als "iemands zelfpercepties die worden gevormd door ervaringen met- en interpretaties van zijn/haar sociale omgeving" (Shavelson, Hubner, & Stanton, 1976). Zoals deze definitie aangeeft, ontwikkelt het zelfbeeld zich altijd in interactie met de sociale omgeving. Je kunt je zelfs afvragen of het ontwikkelen van een idee van jezelf wel mogelijk is zonder sociaal contact. Daarom wordt zelfbeeld ook wel een 'sociaal construct' genoemd (Harter, 2012).

Zelfbeeld is subjectief, wat betekent dat aspecten van ons zelfbeeld zijn gebaseerd op onze eigen impressies van onszelf (bv. 'ik ben aantrekkelijk') in plaats van objectieve feiten (bv. 'ik heb bruin haar'). Deze subjectiviteit maakt het lastig om iemands zelfbeeld direct waar te nemen of te meten. Zelfbeeld wordt daarom onderzocht door te vragen naar iemands zelfpercepties. Deze percepties beschrijven bijvoorbeeld hoe iemand naar zichzelf kijkt, of hoe zij denken dat anderen hen zien. Ze kunnen de vorm aannemen van karaktereigenschappen (bv. nieuwsgierig zijn) of competenties (bv. goed zijn in wiskunde). Het is opvallend dat deze zelfpercepties vaak een vorm van evaluatie bevatten; we beoordelen ze als relatief positief of negatief. Daarom worden zelfpercepties ook wel 'zelfevaluaties' genoemd, en richt onderzoek zich vaak op het onderzoeken van de positiviteit van het zelfbeeld. Dit wordt gemeten door te berekenen in hoeverre mensen positieve eigenschappen bevestigen en negatieve eigenschappen afwijzen. Zelfevaluaties kunnen worden onderverdeeld in verschillende domeinen (Marsh & Shavelson, 1985). Belangrijke domeinen die tijdens de adolescentie veel naar voren komen zijn het academische domein (eigenschappen die van belang zijn binnen een schoolcontext), het sociale domein (eigenschappen die betrekking hebben op sociale vaardigheden), en het uiterlijke domein (ook wel lichaamsbeeld genoemd). Naast dat de positiviteit van het zelfbeeld op domeinniveau onderzocht kan worden, kan ook gekeken worden naar een algehele evaluatie van het zelf, ook wel zelfvertrouwen genoemd. Zelfvertrouwen gaat over iemands algehele houding tegenover zichzelf; het reflecteert een gevoel van eigenwaarde (Rosenberg, 1965).

Zowel domeinspecifieke zelfevaluaties als globaal zelfvertrouwen zijn gelinkt aan diverse belangrijke psychosociale uitkomstmaten. Waar zelfvertrouwen voornamelijk gerelateerd wordt aan mentale gezondheid (bv. positieve relaties met levenstevredenheid en negatieve relaties met mentale problemen zoals angst en depressie, Orth et al., 2012; von Soest et al., 2015), worden domeinspecifieke zelfevaluaties gelinkt aan uitkomsten in meer specifieke contexten. Veel onderzoek richt zich hierbij op de relatie tussen academisch zelfbeeld en uitkomsten binnen het onderwijs. Zo wordt een positiever academisch zelfbeeld gelinkt aan meer motivatie en een hogere prestatie op school (Valentine, Dubois, & Cooper, 2004; Huang, 2011). Echter is de rol van zowel academisch zelfbeeld als zelfvertrouwen nog niet goed onderzocht in relatie tot het maken van een succesvolle studiekeuze.

Naast het bestuderen van de *positiviteit* van diverse aspecten van het zelfbeeld op zowel domeinspecifiek als globaal niveau, kan er ook gekeken worden naar de *structuur* waarin deze aspecten zijn georganiseerd, ook wel helderheid van het zelfbeeld genoemd (self-concept clarity, SCC; Campbell, 1990). SCC geeft de mate aan waarin het zelfbeeld van een individu helder wordt gedefinieerd, intern consistent, en stabiel over tijd is (bv. 'in het algemeen heb ik een duidelijk beeld van wie ik ben'). Hoewel SCC sterk overlapt met zelfvertrouwen (mensen met meer zelfvertrouwen zijn vaak ook stabieler en consistenter in hun zelfbeschrijvingen), geeft onderzoek aan dat beide constructen mogelijk uniek geassocieerd zijn aan diverse uitkomstmaten (Story, 2004; Findley & Ojanen, 2013). Het is echter nog onduidelijk wat de invloed is van beide maten in het wel of niet slagen in het maken van een passende studiekeuze.

Zelfbeeldontwikkeling tijdens de adolescentie

Hoewel jonge kinderen zichzelf rond twee jaar al kunnen herkennen in de spiegel en zichzelf los kunnen zien van anderen (Harrigan, Hacquard, & Lidz, 2018), ondergaat het zelfbeeld de grootste veranderingen pas tijdens de adolescentie. Ten eerste wordt het zelfbeeld tijdens deze periode een stuk *complexer*. Dat heeft te maken met zowel cognitieve als sociale invloeden.

Toenemende cognitieve capaciteiten zorgen ervoor dat adolescenten zich op een steeds abstracter niveau kunnen omschrijven. Waar kinderen over zichzelf kunnen zeggen dat ze bijvoorbeeld goed kunnen rennen of lezen, hebben adolescenten het eerder over sportief of slim zijn. Naarmate adolescenten nog meer cognitieve vaardigheden ontwikkelen, kunnen ze ook het hebben van eigenschappen die elkaar tegenspreken – zoals zowel introvert als extrovert kunnen zijn – integreren in een eigenschap van een hogere orde: gedrag goed kunnen afstemmen op de situatie (adaptief zijn).

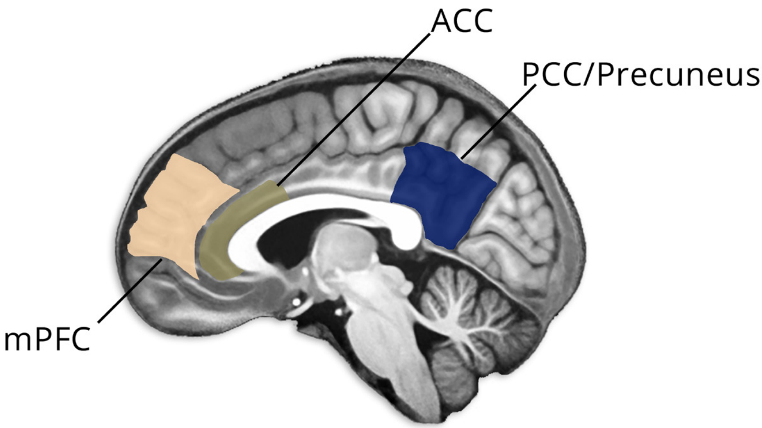
Daarnaast zijn er sociale ontwikkelingen die ervoor zorgen dat het zelfbeeld van adolescenten steeds complexer en veelzijdiger wordt. Zo bevinden jongeren zich in steeds meer verschillende sociale situaties waarin ze telkens een andere rol hebben. Jonge kinderen hoeven vaak thuis alleen de rol van kind aan te nemen. Maar als ze ouder worden, zijn ze vaak op school waar ze zich moeten gedragen als leerling , ze brengen tijd door bij vrienden, krijgen misschien wel een bijbaan of een eerste relatie. Al deze verschillende contexten vereisen verschillende versies van henzelf en dit kan ervoor zorgen dat adolescenten zichzelf anders omschrijven of beoordelen in deze verschillende omgevingen. Het zelfbeeld wordt dus naarmate jongeren ouder worden steeds veelzijdiger en meer gedifferentieerd (Marsh & Ayotte, 2003).

De sociale omgeving speelt ook een steeds belangrijkere rol in de manier waarop adolescenten hun zelfbeeld vormen. Ten eerste wordt de *mening van anderen*, en vooral die van leeftijdsgenoten, steeds belangrijker bij het vormen van het zelfbeeld (Sebastian et al., 2008). Daarnaast gebruiken adolescenten hun directe of indirecte sociale omgeving steeds meer als referentiekader om zichzelf mee te vergelijken, ook wel *sociale vergelijking* genoemd. Deze sociale vergelijkingen zijn een belangrijk mechanisme om meer informatie over het zelf te krijgen en zo een mogelijk realistischer zelfbeeld te ontwikkelen (Festinger, 1954). Het is echter nog onduidelijk in hoeverre deze sociale vergelijkingen precies bijdragen aan de ontwikkeling van (de positiviteit) van het zelfbeeld tijdens de adolescentie.

Zelfbeeld en het brein

Lang werd er gedacht dat zoiets complex als het zelfbeeld niet herleid zou kunnen worden tot in de hersenen. De laatste decennia is het met behulp van neuroimaging technieken zoals fMRI (functional Magnetic Resonance Imaging) echter steeds beter mogelijk om inzicht te krijgen in de onderliggende neurale processen die betrokken zijn wanneer iemand over zichzelf nadenkt. In onderzoeken die deze technieken gebruiken krijgen deelnemers, terwijl ze in een MRI scanner liggen, diverse eigenschappen te zien en wordt aan hen gevraagd om aan te geven in hoeverre deze eigenschappen (bv. 'ik ben grappig') op henzelf van toepassing zijn. De hersenactivatie tijdens het beoordelen van deze zelfrelevante eigenschappen wordt vervolgens vergeleken met activatie wanneer deelnemers nadenken over eigenschappen in het algemeen (niet toegespitst op zichzelf, bv. in welke categorie een eigenschap het beste past). Zo kan er goed gekeken worden welke hersengebieden specifiek actief zijn wanneer iemand nadenkt over zichzelf.

Eerder onderzoek laat consistent zien dat er een netwerk van breingebieden is dat altijd actief is wanneer mensen over zichzelf nadenken. Dit zijn de corticale midlijnstructuren (CMS) die in het midden van de binnenkant van de hersenen liggen. Ze lopen vanaf de mediale prefrontale cortex (mPFC) en de anterior cingulate cortex (ACC) aan de voorkant van het brein tot aan de posterior cingulate cortex (PCC) en precuneus aan de achterkant van de hersenen (zie **Figuur 1;** Denny, et al., 2012; Murray, Schaer, & Debbané 2012; Northoff et al., 2006).



Figuur 1. *Corticale midlijnstructuren (CMS) betrokken bij het nadenken over- en evalueren van jezelf. mPFC = medial prefrontal cortex; ACC = anterior cingulate cortex; PCC = posterior cingulate cortex*

A

Vanuit onderzoek is er voornamelijk veel interesse in de mPFC, die een hoofdrol lijkt te hebben in het ondersteunen van complexe sociaal-cognitieve processen, zoals het nadenken over jezelf binnen een sociale context (Lieberman et al., 2019). Binnen de mPFC wordt er onderscheid gemaakt in sub regio's die mogelijk sterker reageren op informatie met een hogere mate van zelfrelevantie. Zo wordt bijvoorbeeld het onderste deel van de mPFC, de ventrale mPFC (vmPFC), actiever wanneer iemand over zichzelf nadenkt of over mensen die dichtbij ze staan, of wanneer de eigenschappen die beoordeeld worden op henzelf van toepassing zijn (Moran et al., 2006). Omdat veel mensen positief over zichzelf denken, is de vmPFC daarnaast vaak actiever bij de evaluatie van positieve eigenschappen dan negatieve eigenschappen (Pauly et al., 2013).

Hoewel de mPFC betrokken lijkt te zijn bij het verwerken van allerlei vormen van zelfrelevante informatie, is het minder duidelijk of andere regio's binnen de CMS mogelijk meer differentiëren tussen het evalueren van eigenschappen uit verschillende domeinen (academisch, sociaal, uiterlijk). Onderzoek bij volwassenen duidt er op dat dit het geval is. Zo wordt de evaluatie van academische eigenschappen specifiek geassocieerd met activatie in de PCC en precuneus (van der Cruijsen et al., 2017). Het is echter nog onbekend of deze differentiatie zich ook al bij adolescenten voordoet.

Daarnaast is er bij onderzoek naar de neurale mechanismen van zelfreflectie tot nu toe minder rekening gehouden met individuele verschillen in zelfbeeldmaten die de mate van activatie in de betrokken hersengebieden mogelijk kunnen beïnvloeden. Bijvoorbeeld, mensen die positiever over zichzelf denken of een helderder zelfbeeld hebben, kunnen mogelijk ook andere patronen van hersenactivatie laten zien wanneer ze over zichzelf nadenken. Zeker aangezien tijdens de adolescentie het zelfbeeld complexer en meer gedifferentieerd raakt, kunnen verschillen tussen individuen groter worden en kan dit samengaan met meer gevarieerde patronen in hersenactivatie. In de context van het maken van een passende toekomstkeuze, zouden deze verschillen in neurale mechanismen kunnen helpen bij het verklaren waarom sommige adolescenten hier meer problemen mee ervaren dan anderen.

Tot slot is de adolescentie bij uitstek een periode waarin zowel het zelfbeeld als de onderliggende neurale mechanismen nog sterk in ontwikkeling zijn en daarbij gevoelig zijn voor omgevingsinvloeden. Dit biedt mogelijkheden voor training en interventie (Jolles & Crone, 2012). Daarom onderzoek ik in dit proefschrift of zowel de positiviteit als de helderheid van het zelfbeeld kan verbeteren door training, welke neurale mechanismen hier aan ten grondslag liggen, en of het actief stimuleren van zelfontwikkeling uiteindelijk ervoor kan zorgen dat adolescenten beter passende toekomstkeuzes kunnen maken.

Dit proefschrift

Dit proefschrift omvat de resultaten van vier empirische studies, uitgevoerd met een combinatie van gedrags- en hersenonderzoek, waarmee ik zelfbeeldontwikkeling tijdens de adolescentie heb onderzocht met daarin een focus op de rol van zelfbeeld in het proces van het maken van een toekomstige studiekeuze. Deze studies maken allen deel uit van het "Leiden Zelfbeeld Project" en bevatten meerdere steekproeven van kinderen, adolescenten en jongvolwassenen tussen de leeftijd van 9 en 25 jaar. In al deze studies maak ik gebruik van eenzelfde soort zelfbeeldtaak waar deelnemers wordt gevraagd (in of buiten een MRI scanner) om zichzelf te beoordelen op diverse eigenschappen die vallen binnen het academische, (pro)sociale, en uiterlijke domein. De bevindingen van deze vier studies zijn hieronder samengevat.

SAMENVATTING VAN DE RESULTATEN

Zelfbeeldontwikkeling en sociale vergelijking

In het eerste empirische hoofdstuk (**hoofdstuk 2**) heb ik onderzocht hoe domeinspecifieke zelfevaluatie tijdens de adolescentie zicht ontwikkelt met- en zonder de expliciete context van een sociale vergelijking. Hoewel we weten dat sociale vergelijking tijdens de adolescentie een steeds belangrijker mechanisme wordt bij zelfevaluatie, is het nog onduidelijk wat de precieze impact van sociale vergelijkingen is op de positiviteit van het zelfbeeld, en of de invloed van deze sociale vergelijkingen mogelijk verschillend is bij verschillende zelfbeelddomeinen of leeftijdsgroepen binnen de adolescentie. Om deze vragen te testen, heb ik twee taken ontwikkeld die deelnemers (*N* = 202) allebei vragen om zichzelf op diverse eigenschappen te evalueren (bv. 'ben ik spontaan?'), maar verschillen in het gebruik van een expliciete sociale vergelijking met een onbekende leeftijdsgenoot (bv. 'ben ik spontaner dan deze leeftijdsgenoot?'). Eigenschappen konden zowel positief als negatief zijn en waren ingedeeld in drie domeinen: academisch (bv. 'intelligent' of 'ongemotiveerd'), sociaal (bv. 'vriendelijk' of 'jaloers'), en uiterlijk (bv. 'aantrekkelijk' of 'mager'). Vervolgens onderzocht ik hoe de positiviteit van deze domeinspecifieke zelfevaluaties zich in de eerste en tweede taak manifesteerde in vier verschillende leeftijdsgroepen: late kindertijd (9 - 11 jaar), vroege adolescentie (12 - 14 jaar), midden adolescentie (15 - 17 jaar), en jong volwassenen (18 - 25 jaar).

De resultaten van de eerste taak (zonder expliciete sociale vergelijking) lieten zien dat de twee jongste leeftijdsgroepen (9 – 14 jaar) zichzelf, vergeleken met de twee oudere leeftijdsgroepen, consistent in alle domeinen het meest positief en minst negatief evalueerden. Dat kan een illustratie zijn van de zogenaamde 'positiviteitsbias' (Harter, 2012), die aangeeft dat jonge kinderen en adolescenten hun eigenschappen en talenten vaak overschatten en nog een onrealistisch positief zelfbeeld hebben. Dit effect bleef in stand tijdens de tweede taak waarin deelnemers zichzelf op dezelfde eigenschappen expliciet vergeleken met een leeftijdsgenoot. Echter resulteerde deze taak in extra leeftijdsverschillen die ook meer domeinspecifiek waren. Zo leken voornamelijk de mid-adolescenten (15 – 17 jarigen) het meest negatief beïnvloed door de context van sociale vergelijking; zij kenden zichzelf meer negatieve -, en minder positieve eigenschappen toe vergeleken met andere leeftijdsgroepen. Dit effect was het sterkst voor het academische domein. Mogelijk heeft dit te maken met de schoolcontext waar prestatie tastbaar wordt gemaakt door middel van cijfers die makkelijk met elkaar vergeleken kunnen worden. Daarnaast worden de latere jaren van de bovenbouw, waarin deze groep zich bevindt, gekenmerkt door een grotere focus op prestatie, wat negatieve uitkomsten van sociale vergelijkingen in de hand kan werken.

Samen ondersteunen deze bevindingen het idee dat er een 'sociale heroriëntatie' plaats vindt tijdens de mid-adolescentie, waarbij een grotere focus op de sociale context ervoor kan zorgen dat de positiviteit van zelfevaluaties sterker beïnvloed worden. In het volgende hoofdstuk zoom ik verder in op deze leeftijdsgroep die zich in de laatste jaren van de middelbare school bevindt, en onderzoek ik de rol van het academische zelfbeeld bij de oriëntatie op een vervolgopleiding.

Academisch zelfbeeld en studieoriëntatie

In **hoofdstuk 3** start ik mijn onderzoek naar de rol van zowel gedragsmatig als neurale indicatoren van zelfbeeld in het proces van het maken van een toekomstige studiekeuze. In dit hoofdstuk richt ik me op de oriëntatiefase van dit proces, aangezien dit een belangrijke eerste stap is die zowel bewustzijn als actie vraagt van adolescenten om te gaan starten met plannen en exploreren van opties. Ik focus me op de rol van academisch zelfbeeld en onderzoek hoe de positiviteit van academisch zelfbeeld op zowel gedrags- als neuraal niveau samenhangt met de problemen die adolescenten kunnen ervaren met studieoriëntatie. Daarnaast test ik of academisch zelfbeeld uniek is in deze relatie door ook andere academische maten, zoals academische prestatie, te includeren.

Deelnemers waren 48 adolescenten (14 – 20 jaar) die allen in de laatste jaren van de bovenbouw zaten en daarom zich moesten gaan oriënteren op een vervolgopleiding. Ze beoordeelden zichzelf op diverse positieve en negatieve academische eigenschappen terwijl ze in een MRI scanner lagen. Daarnaast vulden ze vragenlijsten in over problemen die ze ervaarden met het oriëntatieproces en maakten ze een lees- en IQ test als maat voor academische prestatie. De gedragsresultaten lieten zien dat een positiever academisch zelfbeeld geassocieerd was met minder problemen met studieoriëntatie. Deze link werd niet gevonden met maten van academische prestatie. In het brein vond ik dat de precuneus gevoelig was voor individuele verschillen in academisch zelfbeeld. Dat wil zeggen, de precuneus was actiever wanneer deelnemers over hun academische eigenschappen nadachten als ze ook positiever waren over deze eigenschappen. Deze regio van de CMS is belangrijk voor perspectief nemen, zoals jezelf in meerdere sociale contexten kunnen zien. Daarnaast speelde de activatie in de precuneus ook een belangrijke rol in de relatie tussen academisch zelfbeeld en studieoriëntatie. Samen laten deze resultaten zien dat de precuneus een belangrijk hersengebied is dat verwerkt hoe adolescenten academische eigenschappen evalueren, en vervolgens kan beïnvloeden hoe adolescenten nadenken over hun toekomstige academische zelf door studieoriëntatie.

Zelfbeeld en problemen met studiekeuze

Nadat ik in hoofdstuk 3 heb gekeken naar de relatie tussen zelfbeeld en studiekeuze in een normale populatie, focus ik me in **hoofdstuk 4** specifiek op adolescenten die serieuze problemen ervaren met het maken van een succesvolle studiekeuze. In Nederland is er een toenemend aantal adolescenten dat het maken van een studiekeuze uitstelt, bijvoorbeeld door een of meerdere tussenjaren te nemen (van 6% in 2015 tot 12% in 2017). Veel anderen lijken een verkeerde keuze te maken waardoor ze uitvallen of switchen van studie (33% stopt met de studie in het eerste jaar). In dit hoofdstuk heb ik gedragsmatige en neurale maten van zelfbeeld gecombineerd om zo beter te begrijpen wat adolescenten kenmerkt die zoveel problemen ervaren met het maken van een studiekeuze. Deelnemers waren 38 adolescenten (16 – 24 jaar) die zouden gaan starten met een Breekjaar programma. Dit programma geeft invulling aan een tussenjaar en richt zich op persoonlijke ontwikkeling voor adolescenten die gestopt zijn met hun studie of onbeslist blijven na de middelbare school. Deze adolescenten heb ik op diverse zelfbeeldmaten vergeleken met leeftijdsgenoten die al wel een succesvolle studiekeuze hadden gemaakt.

Gedragsresultaten lieten zien dat de Breekjaar groep (adolescenten die problemen ervaren met studiekeuze) een lagere mate van zelfvertrouwen en helderheid van het zelfbeeld rapporteerden vergeleken met adolescenten die deze problemen niet ervaarden. De groepen verschilden echter niet in domeinspecifieke zelfevaluaties (zoals beoordeling van academische of sociale eigenschappen). Mogelijk zijn zelfinzicht en zelfvertrouwen belangrijke factoren die nodig zijn om een succesvolle studiekeuze te kunnen maken. Op neuraal niveau werden tijdens zelfevaluatie bij beide groepen regio's van de CMS actief, zoals de mPFC en ACC. De sterkte van de activatie van de mPFC hing echter af van de mate van zelfvertrouwen; adolescenten met meer zelfvertrouwen hadden meer activatie in de mPFC tijdens zelfevaluatie dan wanneer adolescenten minder zelfvertrouwen rapporteerden. Deze resultaten laten zien dat zelfvertrouwen een belangrijke voorwaarde kan zijn om individuen te helpen om op zichzelf te kunnen reflecteren. Samen dragen deze resultaten bij aan een beter begrip van wat adolescenten met studiekeuze problemen op het gebied van zelfbeeld kenmerkt. Een belangrijke volgende stap is om te onderzoeken of het trainen van zelfbeeld in deze adolescenten mogelijk kan helpen in het maken van succesvolle, passende toekomstkeuzes.

Zelfbeeldtraining en succesvolle studiekeuzes

Het doel van **hoofdstuk 5** was om te onderzoeken wat (op gedrags- en neuraal niveau) de effecten zijn van een zelfbeeldtraining die plaatsvindt in de context van een tussenjaar, op zowel de positiviteit als de helderheid van het zelfbeeld van adolescenten die problemen ervaren met studiekeuze. Daarnaast was een belangrijk doel om te onderzoeken of deelname aan deze zelfbeeldtraining er ook voor kan zorgen dat adolescenten beter passende toekomstkeuzes kunnen maken. Dezelfde 38 adolescenten uit het vorige hoofdstuk heb ik gevolgd gedurende hun hele Breekjaar. Het Breekjaar programma staat in het teken van zelfontwikkeling. Zo leren deelnemers in een groep en met behulp van coaches en elkaar meer over zichzelf, hoe ze zich verhouden tot anderen, en leren ze om keuzes te maken. Ik heb de deelnemers voor, tijdens, en aan het einde van hun Breekjaar getest op diverse zelfbeeldmaten (elk meetmoment 5 maanden uit elkaar). Daarnaast was er 6 maanden na Breekjaar een vervolgmeting om te checken hoe het met de deelnemers ging, en wat voor toekomstkeuze ze uiteindelijk hadden gemaakt.

Er waren vier belangrijke resultaten. Ten eerste was de eenjarige breekjaartraining geassocieerd met verbeteringen in alle zelfbeeldmaten (zelfvertrouwen, helderheid van het zelfbeeld, en positiviteit in domeinspecifieke zelfevaluaties). Echter verschilde het traject van deze verbeteringen. Zo liet zelfvertrouwen een hele gelijke toename zien gedurende het hele jaar, maar verbeterde de helderheid van het zelfbeeld pas in de tweede helft van het jaar. Bij de domeinspecifieke zelfevaluaties was het opvallend dat het sociale domein de sterkste toenames liet zien. Dit doet vermoeden dat de problemen die deze groep jongeren ervaart verder gaat dan alleen het niet goed kunnen kiezen, mogelijk vinden ze het lastig om ‘erbij te horen’ en aansluiting te vinden in een nieuwe sociale context, zoals bij een nieuwe studie. De tweede en derde bevinding zijn gerelateerd aan activatie in de mPFC tijdens zelfevaluatie. Als eerste lieten deelnemers met minder activatie in de mPFC bij de start van de training grotere toenames zien in zelfvertrouwen gedurende hun Breekjaar. De activatie in de mPFC lijkt dus niet alleen gerelateerd aan zelfvertrouwen (**hoofdstuk 4**), maar ook voorspellend te zijn voor veranderingen hierin. Ten tweede was de activatie in de mPFC ook gerelateerd aan veranderingen in positiviteit; na de training was de activatie bij de evaluatie van positieve eigenschappen toegenomen, maar niet bij negatieve eigenschappen. Dit kan aangeven dat positieve eigenschappen na de training als meer zelfrelevant werden beschouwd. Tot slot waren veranderingen van de helderheid van het zelfbeeld en positiviteit van sociale zelfevaluaties gerelateerd aan positieve uitkomstmaten 6 maanden later. Adolescenten die hier sterker in vooruit gingen, lieten vervolgens een betere sociale aansluiting bij hun vervolgopleiding zien en presteerden beter. Samen laten deze resultaten zien dat training met een focus op het zelf positieve veranderingen in zelfbeeld en gerelateerde academische uitkomsten teweeg kan brengen bij adolescenten.

DISCUSSIE EN IMPLICATIES

De studies beschreven in dit proefschrift laten allen zien dat zelfbeeld een veelzijdig en complex construct is dat niet alleen ontwikkelt *in interactie* met de sociale omgeving, maar ook een *impact* kan hebben op iemands toekomstige omgeving. Resultaten uit **hoofdstuk 2** laten bijvoorbeeld zien dat de sociale omgeving, in de vorm van sociale vergelijkingen, de positiviteit van het zelfbeeld op verschillende manieren kan beïnvloeden, afhankelijk van het zelfbeelddomein en fase van de adolescentie. **Hoofdstuk 3** liet zien hoe het academische zelfbeeld van adolescenten hun motivatie kan beïnvloeden om aan de slag te gaan met hun toekomstige academische omgeving door middel van studieoriëntatie. **Hoofdstuk 4** illustreerde verschillen in maten van zelfvertrouwen en helderheid van het zelfbeeld in adolescenten die verschilden in de problemen die ze ervaarden met het uitkiezen van deze toekomstige academische omgeving. Tot slot liet **hoofdstuk 5** zien dat ook in de late adolescentie, gevoeligheid voor omgevingsinvloeden kan helpen om zelfontwikkeling te stimuleren door middel van training, en dat dit uiteindelijk positieve gevolgen kan hebben voor het maken van een passende studiekeuze. Samen geven deze studies een overzichtelijk beeld van zelfbeeldontwikkeling tijden de adolescentie die plaatsvindt in een bredere sociale, en academische context. In de volgende sectie licht ik een aantal bevindingen uit die over alle studies heen het meest opvallend zijn.

Zelfbeeld binnen een schoolcontext

De eerste algemene bevinding is gerelateerd aan het academische domein van zelfbeeld tijdens de fase van de mid-adolescentie (14 – 17 jaar). Tijdens deze fase zitten de meeste adolescenten in (de laatste jaren) van de middelbare school, werken ze toe naar eindexamens en bereiden ze zich voor op de periode hierna. In **hoofdstuk 2** kwam naar voren dat voor deze groep adolescenten, de positiviteit van academische zelfevaluaties het meest negatief werd beïnvloed door sociale vergelijkingen vergeleken met andere leeftijdsgroepen. Deze uitkomst is een uitbreiding van een eerder onderzoek (van der Cruijsen, Peters, van der Aar, & Crone, 2018) waar werd gevonden dat het academische domein een dip in positiviteit liet zien gedurende de mid-adolescentie, terwijl dit bij sociale en fysieke zelfevaluaties niet het geval was. Dat juist het academische domein deze dip laat zien en gevoelig is voor negatieve uitkomsten van sociale vergelijking (door bijvoorbeeld de nadruk op cijfers) kan problematisch zijn, gezien **hoofdstuk 3** laat zien dat een positief academisch zelfbeeld juist in deze fase van belang kan zijn voor het nastreven van toekomstige academische doelen door middel van studieoriëntatie. Zo liet ik zien dat adolescenten die hun huidige academische eigenschappen, interesses en prestatie positiever evalueerden, ook meer bewustzijn en motivatie hadden om te beginnen met het oriëntatieproces voor een vervolgopleiding. Hoewel eerder onderzoek heeft laten zien dat er een sterk verband is tussen het academisch zelfbeeld van adolescenten en hun motivatie voor kortetermijndoelen die binnen de schooltijd vallen (Bong & Skaalvik, 200; Guay et al., 2010), voegt dit onderzoek toe dat positieve academische zelfevaluaties ook een belangrijke motivator kunnen zijn voor lange termijn doelen, zoals een toekomstige studiekeuze.

De tweede algemene bevinding gaat over hoe verschillende aspecten van zelfbeeld mogelijk een verschillende rol kunnen hebben binnen het proces van het maken van een toekomstige studiekeuze. Zo vond ik in **hoofdstuk 4** dat zowel zelfvertrouwen als de helderheid van het zelfbeeld verlaagd waren in adolescenten die problemen ervaarden met het maken van een passende studiekeuze. Daarnaast lieten deze beide maten juist een grote verbetering zien gedurende een zelfbeeldtraining tijdens een tussenjaar (**hoofdstuk 5**). Tot slot waren specifiek de verbeteringen in helderheid van het zelfbeeld en sociale zelfevaluaties voorspellend voor positieve uitkomstmaten in het hoger onderwijs, zoals een betere sociale aansluiting en academische prestatie bij de gekozen vervolgopleiding (**hoofdstuk 5**). Interessant genoeg speelde academische zelfevaluaties in deze hoofdstukken geen noemenswaardige rol. Zo verschilden adolescenten niet in positiviteit van academische zelfevaluaties, en waren veranderingen in de positiviteit van deze evaluaties niet voorspellend voor positieve uitkomstmaten in het hoger onderwijs. Samen laten deze resultaten zien dat hoewel de positiviteit van academische zelfevaluaties belangrijk kan zijn voor (intrinsieke) motivatie tijdens de start van het studiekeuzeproces, deze evaluaties later in het proces geen wezenlijke rol meer spelen. Integendeel, het hebben van een duidelijk en helder beeld van wie jij bent lijkt de beste en belangrijkste factor voor het maken van een passende studiekeuze en het vinden van aansluiting in het hoger onderwijs.

Zelfbeeld in het brein en studiekeuze

Om de rol van zelfevaluatie in het proces van het maken van een studiekeuze beter te begrijpen, heb ik zelfbeeld ook op een neuraal niveau onderzocht. Uit deze studies kwamen twee opvallende bevindingen. Ten eerste, hoewel resultaten lieten zien dat zelfevaluatie geassocieerd was met activatie in de CMS zoals de mPFC en precuneus, waren de meest opvallende bevindingen gerelateerd aan breinregio's die gevoelig waren voor *individuele verschillen* in zelfbeeld. Zo was de precuneus actiever voor adolescenten die positiever waren over hun academische eigenschappen en was deze activatie gerelateerd aan verminderde problemen met studiekeuze (**hoofdstuk 3**). Daarnaast was de mPFC minder actief voor adolescenten met een laag zelfvertrouwen, een kenmerk van adolescenten die problemen ervaarden met studiekeuze (**hoofdstuk 4**). Opmerkelijk hierbij is dat deze relaties tussen breinactivatie en eigenschappen alleen gevonden is voor positiviteitsaspecten van zelfbeeld en niet voor structuuraspecten (zoals individuele verschillen in helderheid van het zelfbeeld). Samen laten deze resultaten zien dat het includeren van deze verschillen kan helpen bij het beter begrijpen van de onderliggende mechanismen van zelfevaluatie in een academische context.

Ten tweede bleek uit **hoofdstuk 5** dat activatie in deze CMS gebieden ook gevoelig is voor verandering wanneer zelfontwikkeling wordt gestimuleerd, zoals tijdens het Breekjaar programma. Deelname aan dit programma was geassocieerd met toenames in activatie in de mPFC voor de evaluatie van positieve eigenschappen, maar niet voor negatieve eigenschappen, wat kan aangeven dat positieve eigenschappen na de training als meer zelfrelevant werden beschouwd. Samen bieden deze resultaten een eerste stap in het onderzoeken van veranderingen in neurale activatie in de context van een zelfbeeldtraining.

Praktische implicaties

De bevindingen in dit proefschrift bieden belangrijke implicaties voor de praktijk. Zo laten de resultaten zien dat deelname aan een zelfbeeldtraining die plaatsvindt tijdens een tussenjaar, zoals het Breekjaar programma, gunstig is voor zowel de verbetering van diverse zelfbeeldaspecten als het kiezen van een passende vervolgopleiding. Deelname aan een onafhankelijk programma zoals Breekjaar kan echter erg kostbaar zijn. Om de voordelen van een programma als Breekjaar breder toegankelijk te maken, zou ik scholen aanbevelen om al tijdens de middelbare school meer te investeren in zelfbeeldontwikkeling van adolescenten. Dit idee wordt ook geopperd door andere onderwijsonderzoekers die aangeven dat er op school momenteel te weinig aandacht wordt besteed aan zogenaamde 'soft skills'; persoonlijke, sociale, of emotionele vaardigheden (bv. kunnen reflecteren op anderen en jezelf; Chatterjee Singh & Duraiappah, 2020). In het Brain & Development Research Center hebben we een eerste stap gezet in het verbreden van kennis en vaardigheden van leerlingen door lespakketten te ontwikkelen om jongeren zo meer te stimuleren over zichzelf na te denken.

Tot slot is het belangrijk om aan te geven dat in dit proefschrift "het maken van een verkeerde studiekeuze" wordt benaderd als iets wat voorkomen zou moeten worden, omdat bevindingen een samenhang laten zien met ongunstige uitkomstmaten zoals een laag zelfvertrouwen of weinig zelfinzicht. Echter, is het kiezen van een studie die niet gelijk de best passend optie blijkt te zijn per se iets slechts? De adolescentie is juist bij uitstek een fase van onzekerheid en exploratie. In deze context zou het uitproberen van verschillende studieopties die soms verkeerd kunnen uitpakken onderdeel moeten zijn van normale ontwikkeling en juist als mogelijkheid kunnen fungeren om meer over jezelf te weten te komen. Helaas is het Nederlandse onderwijssysteem hier momenteel niet op ingericht. Zo zorgt het huidige onderwijsbeleid ervoor dat adolescenten al vanaf een jonge leeftijd belangrijke toekomstkeuzes moeten vastleggen die bepaalde richtingen uitsluiten, en is er weinig ruimte om te wisselen van profiel of studie zonder dat dit extra kosten en stress met zich meebrengt. Het is belangrijk dat dit systeem verandert. Door adolescenten meer tijd en tools te geven om hun zelfbeeld te ontwikkelen zullen zij geholpen worden om uiteindelijk een toekomstkeuze te kunnen maken die bij hen past.

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CURRICULUM VITAE

Laura Pleuni Elisabeth van der Aar was born on July 8th 1988 in Leiderdorp, the Netherlands. After graduating secondary school (Visser 't Hooft Lyceum, Leiden) in 2006, she obtained her Bachelor's degree in Psychology in 2010 from Leiden University. During her bachelor's programme, she spent an extra semester abroad at Queen's University in Kingston, Canada. In 2010, Laura started the Research Master Developmental Psychology at Leiden University. During her master's, she took a gap year to organize the yearly introduction week for first-year students of Leiden University (EL CID week). She completed her Research Master in 2014 with a thesis written on the topic of creativity training and the adolescent brain in the Brain and Development Research Center (BDRC).

From 2013 to 2015, Laura worked as a teacher and research assistant in the BDRC at Leiden University. In 2016, she started her PhD project at the BDRC under supervision of prof dr. Eveline Crone and dr. Sabine Peters. Her research focused on self-concept development in adolescence within the context of future-oriented educational decision-making. After completing her PhD research in 2020, Laura started working as a project leader within the Student Wellbeing Program at Erasmus University Rotterdam. Additionally, she is writing a popular science book on self-concept development together with Eveline Crone, Renske van der Cruijsen, and Jochem Spaans.

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