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## The dark clouds of being a social outcast

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2020

### **document version**

Publisher's PDF, also known as Version of record

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### **citation for published version (APA)**

Asscheman, J. S. (2020). *The dark clouds of being a social outcast: The behavioral and neural fingerprint of being disliked in school.*

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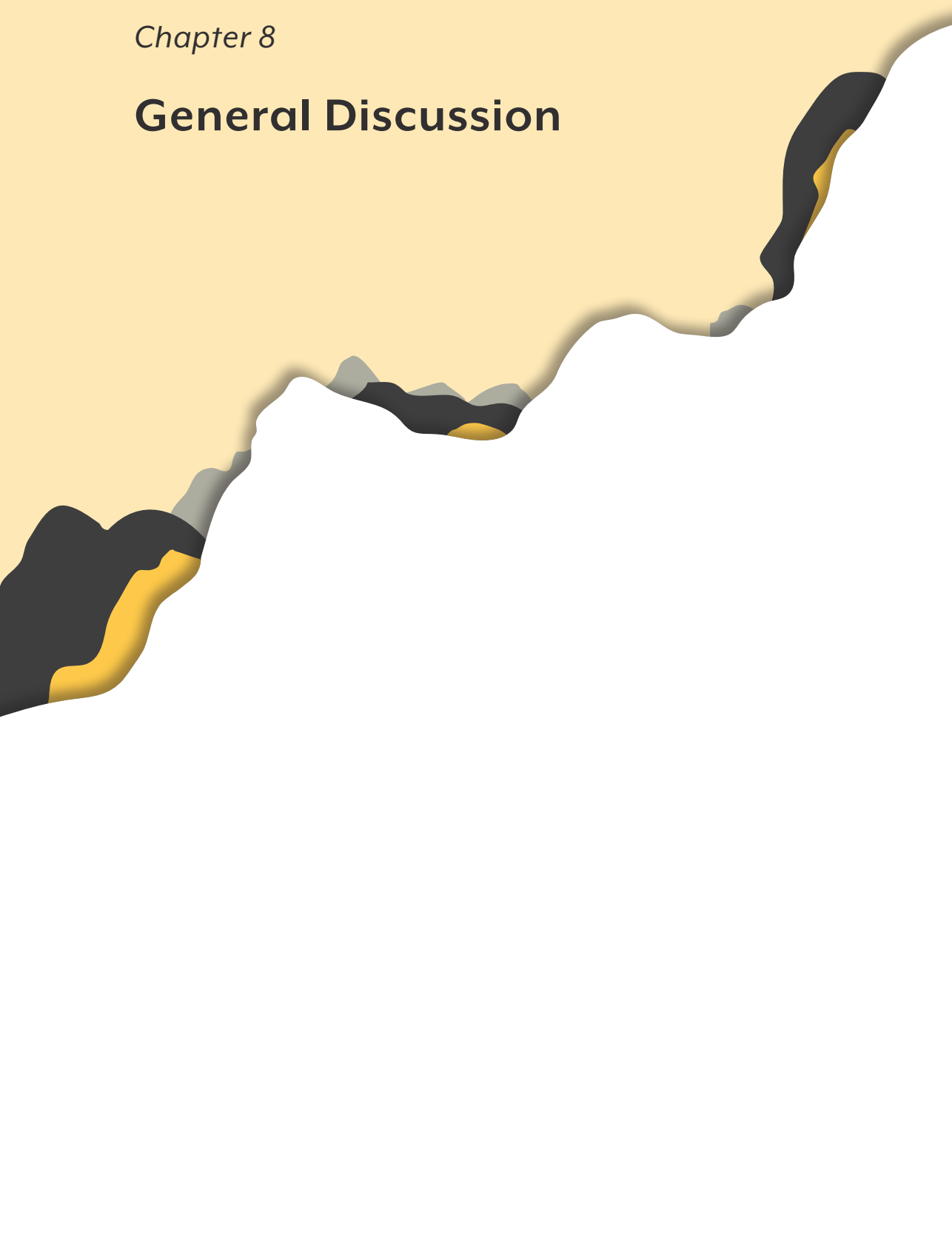
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*Chapter 8*

# **General Discussion**



Peer relationships during the formal schooling period play an important role in children's and adolescents' social and emotional development (Bukowski, Laursen, & Rubin, 2018). During this period, peers can function as an important socializing agent in the development of youth's social behavior. However, our knowledge on the normative development of social behavior and what role peers play in this development is far from complete. This is in part related to the fact that prior studies were mostly cross-sectional. This limits our ability to draw conclusions on the normative development of social behavior (Kraemer, Yesavage, Taylor, & Kupfer, 2000). Moreover, prior longitudinal studies on the normative development of social behavior did not consider the peer context such as whom the recipient of the social behavior is, or how the relationships with peers may influence this behavior. This is problematic as social behavior is often shown in the peer context. Last, prior studies did not study the development of social behavior in concert with brain development. However, during childhood and adolescence the brain undergoes tremendous changes (Fox, Levitt, & Nelson III, 2010; Mills et al., 2016; Mills, Lalonde, Clasen, Giedd, & Blakemore, 2014; Tau & Peterson, 2009). It is likely that the experiences children and adolescents have with their peers influence the developing brain (Cicchetti, 2002; Schriber & Guyer, 2016). Yet, knowledge on the role of peers in neurobiological development is still limited.

Therefore, the overall aim of this thesis was to increase our understanding of the interplay between peers, social behavior and brain development. The overarching questions in this thesis were:

1. What is the role of peers in the normative development of social behavior and brain functioning across childhood and adolescence?
2. How do negative peer experiences shape individual differences in social behavior and brain functioning?

These objectives were addressed in three sections. The first section was comprised of a theoretical framework and an overview of state-of-art research on school social experiences and brain functioning during childhood. The second section addressed the normative development of social behavior across childhood and adolescence and the role of the peer context in this development. The third section examined the impact of negative peer experiences on social behavior and brain functions. In this general discussion, the answers to these research questions will be discussed first per section and later in an overarching discussion. Subsequently, some limitations of the studies presented in this thesis will be discussed and implications for both research and practice will be elaborated on. This chapter will be concluded by some final remarks.

## Part 1: Peers and the developing brain

In the first part of this thesis, we provided a theoretical framework to describe the impact of different peer experiences on brain development. The framework described in **Chapter 2** makes clear that although the initial impact of peer stressors on brain development may be adaptive, chronic stressful peer experiences eventually will have detrimental effects on brain development. Specifically, short and single events of peer stress provoke a set of hormonal and neural changes that may enhance memory formation, attention control as well as emotion regulation to deal with peer stressors in adaptive ways (Lupien, McEwen, Gunnar, & Heim, 2009). However, enduring forms of peer stress such as chronic peer rejection may lead to neuronal atrophy in the prefrontal cortex and hippocampus resulting in impairments in goal-directed behavior and memory formation (Lucassen, Korosi, Krugers, & Oomen, 2016; McEwen, Nasca, & Gray, 2015). In addition, peer stressors may lead to a hyperactive amygdala, which increases stress-sensitivity and affective responses toward new peer stressors (Roozendaal, McEwen, & Chattarji, 2009). These neural alterations caused by exposure to chronic forms of peer stress are likely to increase the risk for psychosocial difficulties and health problems, such as depression and aggression later in life (Bolton, Molet, Ivy, & Baram, 2017; Callaghan & Tottenham, 2016).

The second goal of this section was to summarize the literature on peer experiences and brain functioning during childhood as opposed to the more extensive literature covering adolescence. This overview showed that already during primary school, children demonstrate neural activation in brain regions important for detecting social salient information and regulating emotions when receiving feedback from peers or when being excluded by peers. This adds to and underscores the abundance of research showing peer influences on children's social and behavioral development (Bukowski et al., 2018). In fact, it suggests that to understand children's social and behavioral development, we need to study these behaviors in concert with children's brain development and their social relationships with peers. This to understand how brain development, social relationships with peers and social behaviors – likely – mutually influence each other and shape children's social and behavioral development.

This triangle of influences of behavior, peer relationships, and brain functions was, therefore, the focus of the following empirical sections. Specifically, part 2 of this thesis focused on the normative development of social behavior, peer relationships and – in chapter 4 – the development of brain functions. The empirical studies in part 3 of this thesis focused on individual differences in peer experiences. Specifically, these studies aimed to understand how prior negative experiences with peers may impact brain function and subsequent social behavior.

## Part 2: Peers and the normative development of social behavior and brain function

The studies in the second part of this thesis explored the normative development of sharing behavior (chapter 3) and risk-taking behavior (chapter 4) across two important developmental spans, namely during primary school (chapter 3) and mid-adolescence (chapter 4). Although not exclusively, these two forms are social behaviors that are frequently employed in the peer context and may be used by children and adolescents to shape their relationships with peers (Berndt, 2002; Duell & Steinberg, 2019). That is, acting prosocial (e.g., sharing materials during social activities) may lead to the formation of new positive peer relationships or may maintain high-quality peer relationships. Similarly, engaging in risky behaviors, such as drinking alcohol or reckless driving, may increase social visibility or even acceptance among peers, or may alter the way peers appreciate a child or adolescent. Yet, high levels of risk taking also have important health implications (e.g., addiction or increased risk for car accidents) (Kann et al., 2018).

Although the studies in chapters 3 and 4 examined different social behaviors (i.e., sharing behavior vs. risk-taking behavior), across different developmental periods (i.e., childhood vs. adolescence) and used different assessment methods (i.e., behavior vs. neuroimaging), several findings stand out. First, results in **Chapter 3** showed that the development of sharing behavior across grades 2 – 6 of primary school was relatively stable. Yet, children consistently shared most with a friend, followed by an anonymous other, and the least with a disliked peer. Moreover, girls shared more than boys regardless of the recipient. Nevertheless, it was expected that sharing behavior would still increase during this period as two important processes, namely perspective-taking and behavioral control, still develop during this period (Best & Miller, 2010; Frith & Frith, 2003). It is possible though that the required level of perspective-taking and behavioral control necessary for sharing behavior are already developed before the age of 8 and do not further influence sharing behavior.

With the start of adolescence, other social behaviors such as risk-taking behavior may become more important in the peer context (Romer & Hennessy, 2007; Steinberg, 2008). Results of **Chapter 4** showed that processing information on risk decisions in the prefrontal cortex, one process important for determining whether to engage in risky behavior, increased linearly across ages 13 – 17 years. This finding is in line with theory suggesting that the prefrontal cortex matures gradually during adolescence and gains control over adolescent risk-taking decision-making (Casey, Jones, & Hare, 2008; Steinberg, 2007). Chapter 4 adds to this literature by showing that across adolescence, youths become increasingly able to incorporate information on

riskiness of their decisions which enables them to make more thoughtful decisions across development.

Results from **Chapters 3 and 4** not only add to our understanding on the normative development of social behavior. Each of the studies also incorporated important aspects of peer relationships in studying this development. Indeed, a common factor across these studies was that peer experiences such as being liked or disliked by peers (chapter 3) or the quality of attachment to peers (chapter 4) were included. The results of both studies showed that such peer relationships are an important factor in the development of children's and adolescents' social behaviors. Specifically, children who are disliked by classmates shared less with all recipients across grades 2 - 6, whereas children who are liked shared more but only with friends (chapter 3). In addition to this, results in chapter 4 showed that male adolescents who reported high levels of peer attachment exhibited higher activation in the right insula during risk decisions. The insula has been implicated in processing risk information and risk-averse behavior (Mohr, Biele, & Heekeren, 2010; Platt & Huettel, 2008; van Duijvenvoorde et al., 2015). These results may thus suggest that male adolescents who feel greater psychological security provided by peers are more sensitive to information about potential risks. In contrast, male adolescents lacking these high-quality relationships with peers were less sensitive to risk information.

Thus, positive peer experiences (i.e., being liked, high peer attachment) were linked to higher levels of – normative – sharing behavior and increased sensitivity to risk information which may demote risky behavior. These findings are in line with literature suggesting that positive peer experiences during childhood and adolescence may promote self-regulation skills (Farley & Kim-Spoon, 2014). Sharing more may benefit existing relationships and supports new peer interactions. Being more sensitive to risks may allow adolescents to make more thoughtful decisions which could promote peer relationships and health outcomes. In contrast, negative peer experiences (i.e., being disliked, low peer attachment) were linked to reduced sharing behavior and lower neural sensitivity to risk information. This pattern of lower sharing behavior shown by disliked children could potentially be very disadvantageous for them, as sharing more with – for instance – friends may aid these disliked children in restoring social connections. Moreover, lower neural sensitivity to risk information may result in a higher tendency to take risks. Although taking more risks could aid – possibly short term – social acceptance among some peers, it may also be disadvantageous as high levels of risky behavior may have serious health consequences. Collectively, these results show that whereas children with positive peer experience may follow a healthy social behavioral trajectory, children with negative peer experiences seem to show a developmental trajectory

that further hampers their social and healthy development. Therefore, in part three of this thesis, the potential impact of negative peer experiences in the classroom on the development of social behavior and brain function was further examined.

### **Part 3: The impact of negative peer experiences on social behavior and brain function**

In the third part of this thesis, we examined how negative peer experiences may shape social behavior and brain functions during childhood. With the start of primary school, children start to interact and form relationships with their classroom peers. For some children, these peer experiences can be particularly troublesome (Bukowski et al., 2018). These children are at-risk for experiencing chronic levels of peer difficulties, also when being placed in a new social context (Coie & Kupersmidt, 1983; Hardy, Bukowski, & Sippola, 2002; Jiang & Cillessen, 2005; Ladd, 2006; Mayeux & Cillessen, 2008). One potential explanation for this stability of negative peer experiences may be that these peer experiences affect a child's behavior and neural processing underlying social behavior. Given the serious consequences linked to chronic peer difficulties, it is important to understand how negative peer experience may become embedded in children's behavior and neurobiology.

Results presented in part three of this thesis indeed suggest that negative peer experiences become embedded in children's behavior and brain functioning, which may affect their social behavior. Specifically, in **Chapter 5** it was found that particularly the combination of low peer likeability and high peer dislikeability (peer-rejection) predicted that children shared less over time with disliked peers. These findings extend prior work by showing that prosocial behavior may not decrease toward all classroom peers (Caputi, Lecce, Pagnin, & Banerjee, 2012; Haselager, Cillessen, Van Lieshout, Riksen-Walraven, & Hartup, 2002; Ladd & Troop-Gordon, 2003; Zimmer-Gembeck, Geiger, & Crick, 2005) but rather only towards someone rejected children do not like. Importantly, rejected children did not at the same time invest more over time in friends who may protect the rejected child against the negative consequences of peer rejection. Results suggest that rejected children no longer focus on enhancing social bonds, strengthening social ties, or activating protective agents, by increasing their prosocial behavior with peers or particularly their friends. Rather, they seem to engage in vindictive, punishing behavior directed toward peers they dislike.

The results of **Chapters 6 and 7** may provide, from a neural level, novel insights into why rejected children may engage in the found vindictive and non-prosocial responses in chapter 5. In both chapters, children with a history of poor preference

among peers were compared to children who had a history of high preference among peers in the three years prior to the fMRI study. Results of **Chapter 6** showed that boys who have a history of low social preference in primary school show increased neural processing in regions important for controlling emotions and attention (lateral prefrontal cortex) during a new social exclusion experience. Interestingly, low preferred boys showed increased neural activation during early phases of social exclusion and a marked decrease in neural activation during later phases of social exclusion, whereas high preferred boys showed relatively stable levels of neural activation in this region. Results may thus suggest that low preferred boys are sensitive to early social exclusion experiences, try to deal with this and then seem to become indifferent to the social exclusion, at least on a neural level. In contrast, high peer preferred boys appear to regulate their emotions and pay attention to the situation throughout the social exclusion experience.

**Chapter 7** further dove into the effects of social exclusion for low and high peer preferred children by studying changes in sharing behavior and the underlying neural responses following a social exclusion experience. Results showed that following this social exclusion experience, high peer preferred boys showed increased activation in a region implicated in affective processing and delayed reward processing (posterior insula) and in a region important for anticipating the outcome of a decision (putamen) during sharing decisions involving friends. Importantly, low peer preferred children did not show significant increases in neural processing during sharing decisions from before to after social exclusion. These results may indicate that high peer preferred children following social exclusion may use their emotions more than before social exclusion (i.e., affective processing) to guide their decisions on how to share coins with their friends and also process how this decision may be beneficial for them on the long-term (e.g., social support). Although more research is necessary, the found increases could potentially suggest that high peer preferred children show neural processing that allows them to effectively change their attitude or behaviors in an affiliative way which could ensure social connections with other peers. In contrast, low peer preferred boys did not show such neural processing that may aid them in re-establishing bonds.

Altogether, the findings of these three chapters seem to suggest that indeed negative peer relationships during childhood may shape children's social behavior and likely underlying brain functions. These results provide important insight into why negative peer relationships have such a profound and persistent impact on the social development of children, and may eventually lead to poor developmental outcomes. That is, rejected children did not engage in higher levels of prosocial behavior with friends, although friends may buffer some of the negative consequences of peer rejection such as social connectedness. In fact, their social



decisions mostly suggested vindictive responses. This coincided with the fact that unlike high preferred peers, children with a history of low peer preference appeared to respond on the neural level mostly during early social exclusion experiences and showed deactivation during later social exclusion experiences. This is in contrast to high peer preferred children who seem to have stable neural processing throughout the social exclusion experience. In addition, low peer preferred children showed decreases in neural processing during sharing behavior from before to after a social exclusion experience, whereas high peer preferred children showed increases in neural responses when making sharing decisions with friends following social exclusion. When looking at the possible interpretation of the neural responses, low peer preferred children seem to focus on early social exclusion experiences and regulate these negative feelings followed by a swift disengagement from the social exclusion. Possibly as a consequence, low peer preferred children did not compensate for this experience by demonstrating positive social behavior to peers or neural processing that may benefit their social behavior. Rather, they almost seem to act, at least on a neural level, as if nothing ever happened and already coped with this peer stressor. This is in stark contrast with high peer preferred children. High peer preferred children seem to focus on the entire social exclusion experience. Moreover, when making sharing decisions following this experience they show increased affective processing and neural processing that could indicate that they were considering and focusing on the long-term goals. This seems to suggest that high peer preferred children on the neural level may actively and adequately cope with the social rejection experience, and focus on investing in social bonds. This adaptive pattern was not found for children with negative peer experiences, both on the neural level, and in their social decisions.

## **Diverging behavioral and neural responses to peer experiences**

The findings presented in this thesis seem to suggest some rather dark clouds on the horizon for children and adolescents who experience difficulties in their relationships with peers. That is, the studies focusing on peer experiences in primary school showed that children who were disliked by peers shared less regardless of the peer (friend or foe), and that particularly peer-rejection predicted children to engage in vindictive non-prosocial behavior with peers they disliked. Moreover, on the neural level, it was found that children with a history of poor peer relationships in primary school focused, when faced with an in-vivo social inclusion and exclusion experience, on the negative social experiences and coped with this stressor quickly.

In contrast, children who were liked by their classmates seemed, on a neural level, less sensitive to the social exclusion experiences compared to children with a history of poor peer preference. Moreover, liked children, following the social exclusion experience seemed to focus on how to re-establish social connections and their social position whereas this was not found for disliked children. Thus, both the behavioral and neural differences between liked and disliked children seem to be at opposite ends. Children who are liked by peers seem to be focusing on prosocial behaviors and re-establishing bonds. Children who are disliked focus on vindictive responses and on coping with social stressors.

When focusing on peer attachment in adolescence, a somewhat similar picture emerged. That is, adolescents who reported having good relationships with peers showed, on the neural level higher activation in brain regions implicated in processing risk information and risk-averse behavior. This may suggest that having solid relationships with peers may provide a secure base for processing risk-information and making more deliberate risk-decisions. However, this seemingly protective effect was not found for adolescents who reported having low attachment with their peers. Importantly, this was studied across ages 13 – 17 years, which is a period that is characterized by an increased focus on peer relationships, and coincides with increased risk-taking tendencies. Having solid relations with peers may thus provide a secure base that aids adolescents' brain development towards making thoughtful decisions. This may not be the case for adolescents who have poor relationships with peers.

Collectively, and as stated earlier, the studies suggest some rather dark clouds on the horizon for children and adolescents who experience poor relationships with their mainstream peers. Although the focus on early recognition and heightened neural processing of social exclusion as well as the subsequent changes in social behavior shown by poorly accepted children may be understandable as they may protect the child from further social threats, in the long run it may place these children in an increasingly vulnerable position. That is, due to their neural processing and behavioral responses, these poorly accepted children are increasingly unlikely to engage in healthy interactions with peers or to re-establish social ties that may facilitate their social development. Possibly as a consequence, these children may 'select' future negative peer interactions and this chronic exposure to negative peer experiences can have long-lasting effects on internalizing and externalizing problems (Modin, Östberg, & Almquist, 2011; Takizawa, Maughan, & Arseneault, 2014). Although not studied as such in this thesis, it may well be that children who had poor experiences during primary school are also the ones who build low attachment relationships with their peers during adolescence. The results described in chapter 4 of this thesis may therefore not only suggest a troublesome impact of such poor peer relationships with respect to risk-processing. It may well suggest

that this was – in part – the result of prolonged negative peer experiences during the period of formal schooling. The results of this thesis thus urge for early interventions to prevent an escalating path of early negative peer experiences.

## **Peer experiences and the shaping of brain functioning during childhood**

The question then is, which cannot be answered in this thesis, how the early negative peer experiences may shape the neurobiology of these children. It has been suggested that social stress may accelerate the development of emotion circuits in the brain to deal with social stressors (Callaghan & Tottenham, 2016). However, this accelerated development may come at the cost of energy, resources and time necessary for other developmental processes such as learning and refining behavioral and social skills essential for dealing with the psychosocial challenges found during childhood and adolescence (Ge & Natsuaki, 2009). Accordingly, rapid maturation may leave poorly preferred children with a deficiency in their behavioral repertoire necessary to build successful social interactions with peers (Lemerise & Arsenio, 2000). The heightened activation in brain regions implicated in emotion regulation during a new peer stressor (chapter 6) as well as disadvantageous sharing behavior (chapters 3, 5) and altered neural processing during sharing decisions following social exclusion (chapter 7) may be indicative of such acceleration. Alternatively, initial experiences of social stress may result in the engagement of systems aimed to deal with the social stress. Chronic exposure may result to the wear and tear of the stress system which may result in rapid detection and processing of social stressors (chapter 6) and subsequent withdrawal from peer interactions reflected in reduced prosocial behavior (chapters 3, 5) as well as altered neural activation following new peer stressors (chapter 7) (Behnsen, Buil, Koot, Huizink, & van Lier, 2018; McEwen, 2006; Ouellet-Morin et al., 2011; Williams, 2007).

It needs to be noted, however, that an alternative explanation is that the social behaviors and neural activation patterns found in children who during the formal schooling period develop poor relationships with peers are already present before these children enter primary school. In other words, there may be no shaping of the neurobiology or embedding of the peer experiences, as the (neural) differences found in this thesis are simply already present before schooling, and cause the negative peer experiences. However, prior studies showed that children become more sensitive to rejection over time (London, Downey, Bonica, & Paltin, 2007) and that peer experiences uniquely predict increases in internalizing and externalizing behaviors even when considering existing problem behavior (Gooren, van Lier,

Stegge, Terwogt, & Koot, 2011; Laird, Jordan, Dodge, Pettit, & Bates, 2001; Reijntjes et al., 2011; Troop-Gordon & Ladd, 2005; van Lier & Koot, 2010). Evidence for such a heightened sensitivity was also found in this thesis (chapter 6). Moreover, differences between disliked and liked children became visible only after a social exclusion experience (chapter 7). Indeed, poorly and highly accepted children showed a differential change in neural processing which emerged in response to the social exclusion experience. Furthermore, the theoretical framework described in chapter 2 suggests that stress has profound effects on brain development. Peer rejection is also considered an important stressor. As such, the explanation that negative peer experiences may shape social behavior and brain functioning seems more plausible than that children are born with these specific behaviors and brain responses. Future studies that repeatedly assess social behavior, (emerging) peer relationships and brain functions in parallel, preferably starting before the transition to formal schooling and following children across a prolonged period are needed to further understand the impact of negative peer experiences on brain development.

## Limitations

The present thesis increases our understanding of the normative development of social behavior and brain functions, the role of peer relationships in this development as well as how negative peer relationships may become embedded in children's behavior and neurobiology. Yet, when interpreting the overall findings in this thesis, several limitations should be considered, in addition to the specific limitations mentioned in each chapter.

First, the findings of this thesis, except those in chapter 4, are based on a sample of Dutch children participating in a classroom-based study in central and eastern parts of the Netherlands. Schools were not randomly selected, but rather this was a convenience sample in schools that were willing to participate in the longitudinal study, which covered the period of children moving from kindergarten to the end of primary school. The sample consisted predominantly of children from a Caucasian ethnical background and from medium to high socioeconomic households. In contrast, the adolescents in chapter 4 were from an Appalachian region of the United States which is a distinct geographic and cultural area with relatively low household incomes. As such, our results may not be generalizable to children from broader ethnical, cultural or socioeconomic backgrounds (Moreland, Raup-Krieger, Hecht, & Miller-Day, 2013; Padilla-Walker, Carlo, & Memmott-Elison, 2018; Scharpf, Paulus, & Wörle, 2017; Wewers, Katz, Fickle, & Paskett, 2006). Future studies are needed to examine the generalizability of the findings in this thesis.

Second, the majority of studies presented in this thesis examined the role of classroom peers on social development (chapters 3, 5, 6, 7). However, children's social lives do not only involve those social interactions with classroom peers but occur in a dynamic process involving peers, teachers, parents, siblings and neighborhood peers. These social interactions will also have an influence on children's and adolescents' development (Bronfenbrenner, 1992), or may mitigate or accentuate the effects of peer relationships on children's and adolescents' social development as found in this thesis.

Last, although several studies presented in this thesis were longitudinal, care is needed when interpreting the direction of effects. Some of the analyses used in this thesis can determine temporal ordering (i.e., cross-lagged analysis in chapter 5) whereas others examined associations between peer variables and behavioral or neural factors. Notably, no causal inferences can be made from these analyses (Orobio de Castro, Thomaes, & Reijntjes, 2015), also because these processes are intertwined and likely affect each other in a transactional manner over the course of development.

## Recommendations for future research

The results of this thesis suggest that peers have an important role in children's social development and brain functioning. Yet, many outstanding questions remain and should be examined in future research.

The first recommendation for future studies concerns the improvement of existing study designs. Specifically, the effects of peer relationships are likely to occur on short time scales (Orobio de Castro et al., 2015) and social networks of children and adolescents can change considerably over a few weeks (Cairns, Leung, Buchanan, & Cairns, 1995; Chan & Poulin, 2007). In addition, social interactions are highly complex and dynamic and require fast real-time processing and integration of information that depends heavily on white matter structures (Kennedy & Adolphs, 2012). Therefore, future studies should assess social behavior and neural functioning already at the start of formal schooling and over short time scales (e.g., days or weeks rather than years). Moreover, these studies should include more comprehensive measures such as motivations to act less prosocial (Will, Crone, van Lier, & Güroğlu, 2016) as well as measures on structural brain changes ("neurons that fire together, wire together", Hebb, 1949; du Plessis, Smeekens, Cillessen, Whittle, & Güroğlu, 2019). Examining changes over shorter time scales using multimodal measures will provide a more detailed understanding of how and why poor peer relationships can lead to the development of psychopathology.

The second recommendation for future research concerns studying potential protective factors. That is, although poor peer relationships are relatively stable across primary school (Brendgen, Vitaro, Bukowski, Doyle, & Markiewicz, 2001; Jiang & Cillessen, 2005), some poorly preferred children are able to 'escape' the escalating cycle of peer difficulties and problem behavior. For example, prior studies found that having supportive friendships (Hodges, Boivin, Vitaro, & Bukowski, 1999) or increasing prosocial behavior (Griese & Buhs, 2014; He, Koot, Buil, & Van Lier, 2018) were factors which prevented an unfavorable developmental trajectory for poorly preferred children. Teachers and parents could also buffer or protect children from negative peer experiences (Cohen, Gottlieb, & Underwood, 2000). For example, teacher efforts to diminish differences in social preference between children reduced victimization levels in the classroom (Serdiouk, Rodkin, Madill, Logis, & Gest, 2015). Future studies should focus on teacher practices that improve peer relationships in the classroom. An important factor could be to examine how to improve feelings of self-efficacy of teachers and parents in improving peer relationships. Furthermore, already during teacher training programs, there should be a focus on strategies to improve classroom climates. These studies could have important implications for understanding links between peer rejection and adjustment as well as insights for intervention and prevention studies.

A final recommendation for future research is to conduct studies that are able to unravel causal processes of peer relationships, brain development, and social-emotional development. The association studies in this thesis add to an extensive and solid theoretical framework necessary for establishing experimental studies on causality (Moffitt, 2005). However, in order to advance the field, studies need to assess neural responses during social behavior together with peer relationship variables across several years. Furthermore, these longitudinal studies should examine genetic influences and effects of intervention studies to gain additional insight into possible causal links (Orobio de Castro et al., 2015; Rutter, Caspi, & Moffitt, 2003; Rutter, Pickles, Murray, & Eaves, 2001). For example, an intervention study that is focused on reducing peer difficulties which demonstrate changes in neural responses over time may give additional insights into the neural embedding of poor peer relations. Nevertheless, intervention studies are often complex and typically target several relationship variables in the broader social classroom context, not just – troublesome – peer relationships. Despite this, such insights into the influence of peer relationship variables on neural and social development allow for the advancement of existing intervention and prevention studies as well as in the development of new studies.

## Implications for practice

The findings in this thesis also provide important implications for practice. Specifically, the findings in this study suggest an early embedding of peer relationships on a behavioral and neural level. This underscores the importance of reducing peer relationship problems early during development. Since 2015, all schools in the Netherlands are obliged to monitor their students' welfare and increase school efforts to prevent bullying. However, some major shortcomings exist. That is, schools are allowed to decide how to monitor this welfare and choose whether and which anti-bullying program to implement. However, the effectiveness of some of these anti-bullying programs is not proven (Orobio de Castro et al., 2018). Moreover, the implementation of some programs is suboptimal with certain elements of the programs being skipped because of time constraints or difficulties in implementation (Orobio de Castro et al., 2018). This thesis again emphasizes that reducing peer problems is crucial for child and adolescent development. The results also show that schools should not only focus on bullying behavior but also on other measures of peer relationships such as peer rejection or the quality of peer relationships (i.e., peer attachment). Moreover, schools should be more attentive to the amount of time that is devoted to social and emotional learning in their curricula (in addition to standard academic subjects) from kindergarten onwards, to promote a healthy social and emotional development (Greenberg, Domitrovich, Weissberg, & Durlak, 2017; Osher et al., 2016). Such programs could be augmented by specific intervention components facilitating healthy peer relationships, such as changing the seating arrangement (van den Berg & Cillessen, 2015; van den Berg, Segers, & Cillessen, 2012) or improving the quality of the child-teacher relationship (Howes, 2000). Thus, based on the findings in this thesis we recommend schools to systematically implement an effective monitoring system, track peer relationships at the classroom level and invest more in the social and emotional learning of children from kindergarten onwards.

For (school) psychologists, the results of this thesis may underscore the daily difficulties these children may experience in their social behavior. Based on these findings, (school) psychologists may try to – for instance – improve prosocial behavior among youth with poor peer relationships as increases in prosocial behavior have been linked to improvements in social status among peers (He et al., 2018). However, such focus on individual children's social behavior should be augmented by focusing on other contextual factors as these contextual factors, such as the classroom context, may be important for the effectiveness of such interventions (Card, Isaacs, & Hodges, 2008; Farrell, Henry, & Bettencourt, 2013).

Last, all of the suggested implications for schools and (school)psychologists require a joint effort together with policymakers, governmental and health institutions to

implement these suggested changes on a structural basis. For example, policymakers could advise these institutions to implement a new curriculum in schools such that social-emotional learning becomes a core element in the teaching programs already from kindergarten and onwards. Furthermore, policymakers could increase financial means so that schools can implement programs that reduce peer problems in school. However, the decision on which programs to implement should be based on scientific evidence on the effectiveness of these programs (Orobio de Castro et al., 2018). Such a focus on enhancing social-emotional learning of children and facilitating healthy peer relationships may foster the healthy social and behavioral development of children and adolescents.

## Conclusion

This thesis started with a question about whether we needed to worry about a child who may receive negative social evaluations or becomes rejected by its peers, at the start of kindergarten because of the behavior he or she shows (e.g., anxiety, aggression, low prosocial behavior). Findings from this thesis suggest that this child may start to act less prosocial toward peers and may also become more sensitive to new negative peer experiences, a process that can be found on the neural level as well. As a result, the child may respond in more reactive and maladaptive ways during new peer provocations which further exacerbates the peer difficulties. By the time this child reaches adolescence, these prior experiences during primary school have influenced how the child behaves toward new peers in secondary school. For example, the poorly preferred child may have developed an insecure attachment with its peers which may make him or her less sensitive to risk information. This child may start to show more risky behavior which could have serious health consequences (e.g., drug use, reckless driving) or show more problem behaviors with peers which could further hinder peer relationships. As such, poor peer relationships in early primary school may set the stage for a developmental course which could potentially lead to the development of internalizing or externalizing problems.

Thus, overall this thesis indeed suggests that we need to worry about the developmental course of the described child. Importantly though, the results in this thesis are based on group-level differences. As mentioned before, this means that not all children will follow this potentially detrimental developmental course. Nevertheless, this thesis demonstrates that peer relationships play a key role in the development of children's and adolescents' normative social behavior and brain functioning. Findings also show that when peer relationships go awry, they may shape behavior and neural responses during development. These alterations may be one potential explanation by which poor peer relationships may lead to the development of unfavorable outcomes.