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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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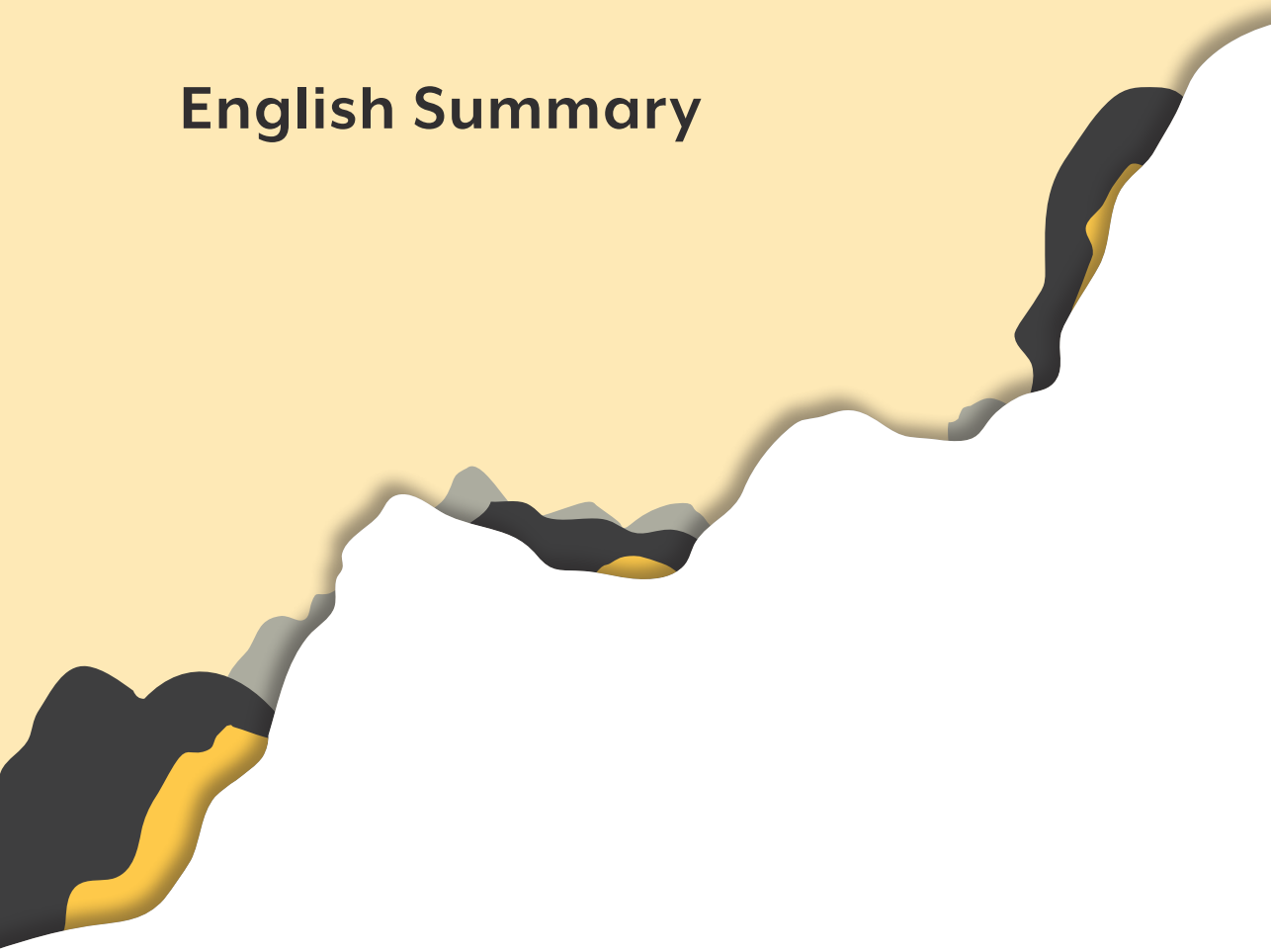
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English Summary



Appendices

Peer relationships during the formal schooling period are essential for the social and emotional development of children and adolescents. During this time, children and adolescents spent large parts of the day with their peers in school. As such, these peers provide important input and feedback about their social behavior which allows them to learn and adapt their behavior to the social environment. Yet, some children or adolescents are treated poorly by their peers, for instance because they are socially excluded or rejected by peers, or develop a poor attachment with peers. Chronic difficulties with peers can be an important source for social stress, and have been linked to the development of a wide range of psychological problems including anxiety, depression, aggression and antisocial behavior. These negative outcomes may arise due to a complex interplay between the child's or adolescent's peer experiences, their social behavior and brain development. The studies in this thesis aimed to examine this interplay.

The two overarching questions in this thesis addressed both the normative development of social behavior in the peer context and how negative experiences with peers may shape individual differences in social behavior and brain functioning. Before focusing on these two main questions, in the first section, a theoretical framework on how school social experiences may influence the developing brain was set out (chapter 2). This section also includes an extensive overview of state-of-art research on this topic. The second section examined the normative development of sharing behavior during childhood (chapter 3) and the development of neural processing of risk decisions during adolescence (chapter 4) in relation to the peer environment. The final section of this thesis assessed the role of negative peer experiences in the shaping of sharing decisions (chapter 5), neural responses to social exclusion (chapter 6) and changes in sharing behavior and associated neural responses following social exclusion (chapter 7).

To answer these questions, data were used from two different datasets. The first dataset was set out to examine the social, behavioral and emotional development in the context of the developing relationships with classroom peers and teachers of Dutch children across the primary school period. The second dataset focused on the development of risk-taking behavior in a sample of adolescents from the Appalachian regions of southwestern Virginia, USA, a geographical distinct region characterized by high numbers of low household incomes. Across datasets, measurements included repeated assessments of behavior (i.e., sharing, risk-taking) and peer relationships (i.e., peer likeability, peer preferences, peer attachment) as well as assessments of brain functioning using functional magnetic resonance imaging (fMRI). Jointly, these datasets covered the child and adolescent period from ages 8 – 17 years.

Children's school social relationships and brain development: What do we know?

The theoretical framework described in **chapter 2** makes clear that initial experiences of peer stress (e.g., peer rejection, social exclusion, negative peer feedback) will trigger a set of hormonal and neural changes which allow children and adolescents to respond in an adaptive manner to peer stressors (e.g., increased memory formation, increased attention to social information). Prolonged forms of stress trigger the opposite changes which may lead to chronic peer difficulties and eventually the development of serious mental health problems such as anxiety and depression. Furthermore, the review of the existing literature shows 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 the abundance of literature on peer influences on children's social and emotional development. However, it also demonstrates that in order to gain a full understanding of the development of social behavior, we need to study peer relationships, social behavior and brain development in concert, as they are likely to mutually influence each other throughout development.

How do sharing behavior and risk processing develop and what role do peers play?

In chapters 3 and 4 we examined the normative development of social behavior and brain functioning in relation to the peer environment. In **chapter 3** we studied the development of sharing behavior with different recipients (a friend, anonymous other and disliked peer). We found that across recipients, sharing behavior was relatively stable across grades 2 to 6, and that children shared most with their friends, followed by anonymous others and the least with children they disliked. Moreover, children who were disliked by their classmates shared less with all recipients whereas liked children shared only more with their friends. In **chapter 4** we showed that the neural processing of risk information increased from ages 13 to 17 years. This suggests an improvement in the ability to incorporate risk information during risky decisions across adolescence. Findings in chapter 4 further showed that male adolescents who felt highly attached to their peers showed more neural risk-processing, this was not found for females. Together, these results show that positive peer relationships are associated with behaviors and neural processing that may promote a healthy social development, whereas negative peer experiences may hamper such an advantageous developmental trajectory.

What happens when peer relationships become negative?

In chapters 5 – 7 we examined how negative peer experiences may shape children's behavior and brain development. In **chapter 5** we found that children who are both lowly liked and highly disliked by their classroom peers (i.e., peer rejection) started to share less over time but only with someone they do not like themselves. Rejected children did not share more with friends or anonymous others. These findings may suggest that rejected children focus on troublesome social interactions with their peers and do not focus on peers that may improve a rejected child's poor social position in the classroom. In **chapter 6**, we further found that children who are low preferred by their classmates show heightened neural activation during early stages of social exclusion and diminished activation during later stages of social exclusion in a region important for attentional control and emotion regulation. High peer preferred children showed stable levels of activation in this region. This finding may suggest that low peer preferred children are vigilant to early signs of social exclusion, and need to regulate the emotions associated with this. Last, in **chapter 7** we further found that this social exclusion experience changed neural responses when making sharing decisions involving friends for high peer preferred children but not for low peer preferred children. Specifically, an increase was found in regions implicated in processing emotions and reward as well as anticipating the outcome of a decision. This finding may suggest that high peer preferred children show neural processing that could motivate them to change their behavior toward friends in response to a negative peer experience. In contrast, this potential adaptive neural processing was absent for low peer preferred children.

Together, the behavioral and neural findings of chapters 5 – 7 may suggest that children who have many negative peer experiences show a disengagement from their peers by showing less sharing behavior over time with a focus on negative peer relationships. Moreover, these children showed a neural pattern of swift processing of social exclusion and an absence in neural processing that may motivate them to make adaptive changes in their social behavior following a social exclusion experience. Importantly, the found behavioral responses and neural processes of poorly liked children may make it unlikely that they reconnect with their peers. In fact, it makes it likely that they will develop even more troublesome relationships with their peers

Dark clouds on the horizon

The studies in this thesis demonstrate that peers have an important role in children's social behavior and brain development. The findings further suggest a troublesome picture for children with poor peer relationships. That is, children and adolescents with

many negative peer experiences seem to steer towards a developmental trajectory characterized by negative social behavior and retaliation rather than behavior which can restore or form new, positive peer relationships. In contrast, children with many positive peer experiences seem to show a developmental trajectory focused on fostering prosocial connections, and in case of social threat, on re-establishing social ties. What is striking is that the behavior and neural processes of children with positive versus negative peer experiences seem to progressively differ from each other. It may therefore become increasingly difficult for children with negative peer experiences to engage in healthy peer relationships. This increases their vulnerability to experience chronic peer difficulties which ultimately could elevate the risk of developing negative outcomes, such as the emergent of psychopathology.