# Social behavior in young twins : are fearfulness, prosocial and aggressive behavior related to frontal asymmetry?

Wijk, I.C. van

**Author**: Wijk, I.C. van
**Title**: Social behavior in young twins : are fearfulness, prosocial and aggressive behavior related to frontal asymmetry?
**Issue Date**: 2019-06-12

# CHAPTER 1

## General introduction

# General introduction

Children react to and interact with the world in their own unique way: some children approach new situations with joy whereas others are careful and tend to withdraw. Whether children show adequate approach or withdrawal reactions depends on the situation but also on the temperament and social competences of the child. For example, when someone needs help, it is desirable to show approach behavior, however, some children might be too shy or fearful to help. On the other hand, when someone gives a negative judgment it is often more appropriate to let it go and withdraw but some children react aggressively. Previous studies have shown that approach and withdrawal tendencies can be examined using a specific measure of frontal brain activity, namely frontal asymmetry (FA, Harmon-Jones, Gable, & Peterson, 2010). In this thesis we were specifically interested in FA as a possible neural correlate in relation to fearfulness, prosocial behavior and aggressive behavior. Because we investigated this in a sample of young twins we could also examine heritability of the traits.

It is important to investigate temperamental factors like fearfulness and social behavior like prosociality and aggression in early childhood because these variables have a great impact on social competences later in life (Crick, 1996; Zentner & Shiner, 2015; Buss & Plomin, 2014; Dodge et al., 2003; Buckley, Winkel, & Leary, 2004). In our study, we obtained FA data from 4-6 year old children, an age range that is not often examined in FA research. Most studies include adults or children aged 0-3 years or 6-18 years old (see Coan & Allen, 2004; Reznik & Allen, 2018 for reviews). Especially in recent studies there seems to be a gap of FA research around the age of 4-6 years old, although social behavior plays an important role around the age of four as most children attend school at this age and experience social acceptance and rejection from classmates. Therefore we developed tasks for 4-6 year old children to measure prosocial behavior in reaction to social exclusion of others and to measure aggressive behavior in reaction to social judgments. We hypothesized that relatively greater left frontal brain activity (left FA), related to approach behavior, would be associated to prosocial and aggressive behavior. On the other hand, we hypothesized that relatively greater right frontal brain activity (right FA), related to withdrawal behavior, would be associated to fearfulness.

Furthermore, we hypothesized that an overlap in genetic and/or environmental influences would underlie possible associations between FA and fearfulness. In the following sections we will elaborate on measuring FA and the associations between FA and fearfulness, prosocial behavior and aggressive behavior.

## *Frontal asymmetry*

Research shows that motivational tendencies are related to asymmetric frontal brain activity: relatively greater left frontal brain activity reflects a tendency toward approach behavior and relatively greater right frontal brain activity reflects a tendency toward withdrawal behavior (Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Harmon-Jones et al., 2010; Harmon-Jones & Gable, 2018). This difference in frontal brain activity between the right and left frontal cortex, referred to as Frontal Asymmetry (FA), can be measured with electroencephalography (EEG). EEG is a method to record electrical activity of the brain by placing electrodes along the scalp (see Figure 1A). When the brain signal is amplified, the voltage fluctuations of the electrical currents in the brain cells can be seen as oscillations at various frequencies (faster and slower waves in the ongoing EEG). The magnitude or prominence of activity at a particular frequency is referred to as power and is commonly expressed in either squared microvolts or decibels. The frequency of an oscillation is different under specific situations, for instance when someone is concentrated the frequency of the oscillations is higher than in rest. To compute FA we use the alpha frequency range because higher power in the EEG alpha waves reflects deactivation (Cook, O'Hara, Uijtdehaage, Mandelkern, & Leuchter, 1998; Laufs et al., 2003). Alpha waves are thus oscillations that arise during rest and occur in the frequency range of 8 – 12 Hz in adults. In children the brain in still developing and in 4-6 year old children a frequency range of 6 – 10 Hz resembles the adult frequency range of alpha waves (Marshall, Bar-Heim, & Fox, 2002). As described above, higher alpha power reflects deactivation. With regard to computing FA this means that higher alpha power over the left frontal cortex (compared to the right frontal cortex) reflects deactivation over the left frontal cortex and thus greater activity of the right frontal areas (compared to the left frontal cortex). We will refer to this as right FA. Conversely, higher alpha power over the right than the left frontal cortex

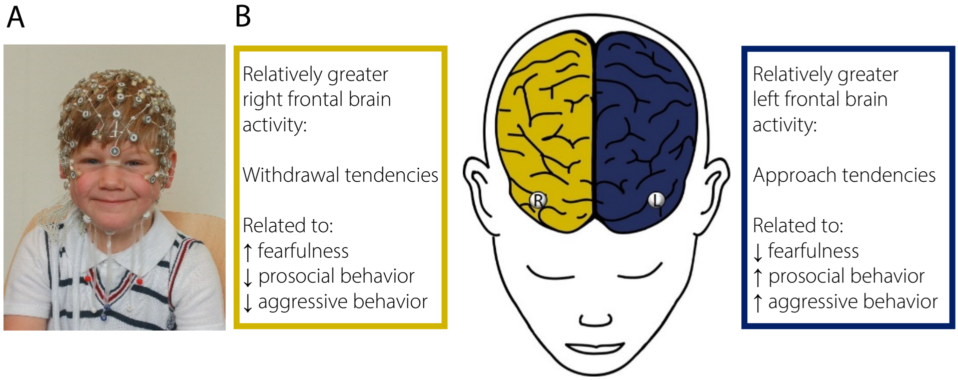


*Figure 1*. EEG and frontal asymmetry. A) Child wearing an EEG net. B) Visual overview of our hypotheses: the associations between FA and fearfulness, prosocial behavior and aggressive behavior are depicted with arrows. The right site of the brain is presented in yellow and the left site of the brain is presented in blue. FA was measured by using two electrodes which are depicted at the frontal left (L) and right (R) site.

reflects relatively greater activity of the left frontal cortex, which we will refer to as left FA. According to the motivational direction model (Davidson et al., 1990; Harmon-Jones et al., 2010; Harmon-Jones & Gable, 2018) approach behavior is related to left FA and withdrawal behavior is related to right FA. In this thesis we focus on three different characteristics that are related with either approach or withdrawal behavior: fearfulness, prosocial behavior and aggressive behavior, see Figure 1B. FA can be measured both as a state and as a trait. In this thesis we take both approaches into account, for more information see chapter 2 and 3 for state-related FA and chapter 4 for trait-related FA.

## *Fearfulness*

Fear indicates how nervous or worried someone is in relation to anticipated pain, distress or threatening situations. Most individuals tend to avoid frightening situations or stimuli, but some children are more fearful in general than others. This is part of their temperament and known as fearfulness. Because fearfulness usually results in withdrawal behavior we hypothesize that it is related to right FA according to the motivational direction model. Indeed, research has shown that relatively greater right frontal brain activity during rest is related to fearfulness in adults (Mathersul, Williams, Hopkinson, & Kemp, 2008) and children (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Schmidt, 2008). However, developmental samples show inconsistent results for the relation between fear and/or fearfulness and FA (Diaz & Bell, 2012; Howarth, Fettig, Curby, & Bell, 2016; LoBue, Coan, Thrasher, & DeLoache, 2011). A possible explanation for these inconsistent results could be that effortful control, another temperamental factor, is involved in the relation between fearfulness and right FA (see Neal & Gable, 2017). For instance, children who are fearful but can control their fear because of their effortful control may show relatively greater right frontal brain activity but score lower on the fearfulness factor. In Chapter 2 of this thesis we will examine the relation between fearfulness and FA more in depth and investigate whether the two traits show an overlap in their genetic and/or environmental influences. In addition we will take effortful control into account by computing partial correlations between fearfulness and FA with effortful control as covariate. Next to the relation between withdrawal behavior and right FA we are also interested in the relation between approach behavior and left FA, in particular prosocial behavior.

### *Prosocial behavior*

In general, prosocial behavior can be defined as “any action that serves to benefit another person” (Schroeder & Graziano, 2015). In light of the motivational direction model we expect that prosocial behavior is related to approach tendencies because prosocial actions like helping, sharing, comforting or including others often start with approaching the other person. Research indeed showed that prosocial behavior like comforting is related to left FA in infants (Paulus, Kühn-Popp, Licata, Sodian, & Meinhardt, 2013) and prosocial behavior like donating to a charity is related to left FA in adults (Huffmeijer, Alink, Tops, Bakermans-Kranenburg, & Van IJzendoorn, 2012). Prosocial behavior can be measured in various ways, for instance using parental report, which indicates the prosocial behavior of the child in a more general, trait-related way, or with observations and behavioral tasks that are more focused on one specific form of prosocial behavior like helping, sharing or comforting (Paulus, 2018). However, research has shown that these different measures are not strongly correlated with each other, suggesting that prosociality is a multidimensional construct (Paulus, 2018; Padilla-Walker & Carlo, 2015) and that prosocial performance depends on situational factors like probing or modelling (Van IJzendoorn, Bakermans-Kranenburg, Pannebakker, & Out, 2010; Wildeboer et al., 2017). In this thesis we are specifically interested in prosocial behavior in response to perceived social exclusion and the association with left FA. Previous studies in adults, adolescents and older children have shown that most individuals compensate for social exclusion by including the excluded player (Riem, Bakermans-Kranenburg, Huffmeijer, & Van IJzendoorn, 2013; Vrijhof et al., 2016; Van der Meulen, Van IJzendoorn, & Crone, 2016; Van der Meulen et al., 2017). In Chapter 3 we present an adjusted version of this prosocial task for 4-6 year old children: the Prosocial Owl Games (POG). In the POG, two cartoon owls exclude a third owl, and the child can compensate for this exclusion by giving the excluded owl the next turn. We hypothesized that prosocial behavior as measured with the POG is associated with left FA. Next to prosocial behavior we were also interested in the association between left FA and aggressive behavior in response to social judgments in early childhood.

### *Aggressive behavior*

According to the social belongingness hypothesis (Baumeister & Leary, 1995) social acceptance is important for individuals. Being rejected or receiving negative social judgments during childhood may results in mental health problems and higher stress levels later in life (Lereya, Copeland, Costello, & Wolke, 2015; Newman, Holden, & Delville, 2010). Moreover, negative social judgments are associated with anger and sadness that in turn can lead to aggressive behavior (Dodge et al., 2003; Buckley et al., 2004). Previous studies have shown that both adults and 7-10 year old children react more aggressively after a negative social judgment compared to a positive social judgment (Achterberg, van Duijvenvoorde, Bakermans-Kranenburg, & Crone, 2016; Achterberg et al., 2017). In these studies aggressive behavior was measured by blasting noises to the judging peers. After receiving a social judgment, the participant could press a button; the longer the participant pressed the button, the louder the noise was to the judging peer. In Chapter 4 we present an adjusted version of this social judgment task to measure aggressive behavior in early childhood. In the Social

Network Aggression Task for Early Childhood (SNAT-EC), children receive positive, negative and neutral social judgments about their chosen cuddly animal by same-aged unfamiliar peers. Aggressive behavior was operationalized as the duration of a button press with which children could destroy balloons of the judging peer, thus reducing the number of remaining balloons for that peer. In addition, we examined the role of FA in aggressive behavior in 4-6 year old children. Research showed that in adults anger and aggression are related to left FA (see Harmon-Jones et al., 2010 for a review) and more specifically, anger provoked by receiving insults from peers results in left FA (Harmon-Jones & Sigelman, 2001). Therefore we hypothesized that FA might operate as a mediator: negative social judgments result in relatively greater left frontal brain activity and in turn, left FA induces more aggressive behavior as measured with our newly developed task in early childhood.

## *Setting and design*

The studies of this thesis were embedded in a larger, longitudinal twin study: the Leiden Consortium on Individual Development (L-CID). The goal of L-CID is to examine the efficacy of an intervention (the Video-feedback Intervention to promote Positive Parenting and Sensitive Discipline, VIPP-SD, Juffer, Bakermans-Kranenburg, & Van IJzendoorn, 2008) on parenting quality and children's social competences and behavioral control (see for the study protocol Euser et al., 2016). At this moment L-CID consists of two cohorts each including about 250 families, an early childhood cohort with 3-4 year old twins and a middle childhood cohort with 7-8 year old twins at the start of the study. By using two cohorts in an experimental cohort-sequential design with twin families we are able to combine a randomized control trial with an accelerated longitudinal study. The two cohort have overlapping measurements, the children of one cohort will be 7-9 years old during the last two measurements and the children of the other cohort will be 7-9 years old during the first two measurements. This way we obtain data from twin families with twins in the age range of 3-14 years. Families with same-sex monozygotic or dizygotic twins were recruited in the western region of the Netherlands. Each family was invited to take part in the study for six years with yearly visits, either at home or in the laboratory at the university of Leiden. The first two visits were used as baseline assessments and took part before the VIPP-SD intervention. The last four visits serve as post-test assessments. For the current thesis we used data from a pilot study and from the second visit of the early childhood cohort, at this point in time the children were around the age of 4-6 years old. The visits took place at the laboratory of the Leiden University.

### *Behavioral genetics*

Because we included same-sex mono- and dizygotic twins we could examine genetic and environmental influences on the traits, that is, estimate heritability by examining the MZ/DZ correlations. By using an ACE model individual differences in phenotypes are explained by either genetic (A), shared environment (C) or unique environment (E, including measurement error). These factors can be quantified using a twin ACE-model because monozygotic (MZ) and dizygotic (DZ) twins differ in their genetic relatedness: MZ twins share virtually 100% of their structural genome and thus have a correlation of 1 in their genetic factors, whereas DZ twins share on average 50% of their genome and thus have a correlation of .50. Shared environmental factors are events that lead to similarities between the twins and derive from e.g. family, household and residential area. Because C is the same for both twins the correlation is 1. Variance not explained by A or C results from unique environmental factors and measurement error. As E is unique for both twins, the correlation is 0. Heritability is based on the difference in genetic relatedness of MZ and DZ twins: higher MZ correlations than DZ correlations for a trait suggest genetic influences on that trait.

### *Replicability*

Another advantage of twins is the possibility to replicate findings by creating two very similar groups: each child from a twin pair was randomly assigned to the test or replication sample. We tested our hypotheses in the test sample and replicate the findings in the replication sample. This way we optimize the chance of replication because the two samples are equal in background variables like age and gender and similar in shared environmental factors. Thus, non-replication is not easily explained by differences between the samples. Furthermore, replication of false positives and noise is unlikely, and accordingly replicated outcomes can be considered reliable. In the past years researchers have shown concerns about the lack of replication in scientific studies (see Pashler and Wagenmakers, 2012). Therefore we aimed for a replication design within our studies that examined new tasks as it enhances the validity and robustness of our findings.

## *Outline*

The general aim of the current thesis is to gain insight in the neural correlates of fearfulness, prosocial behavior and aggressive behavior in early childhood. We focused on FA because right FA has been associated to withdrawal tendencies like in fearfulness and left FA has been associated to approach tendencies like prosocial behavior and aggressive behavior in adults and/or infants. However, there seems to be a gap in the FA-literature with regard to early childhood, even though this is an important age for the expression of temperament and social behavior. Regarding temperament we were particularly interested in the genetic and environmental influences that explain fearfulness and FA, which we examined in Chapter 2 by using behavioral genetic modeling. The genetic, shared and unique environmental influences on each of the traits are examined in univariate models. However, because both fearfulness as FA are related to withdrawal tendencies we were also interested in whether overlapping genetic or environmental influences explained individual differences in the traits, which we examined in bivariate models.

The response to social exclusion or social judgements in relation to approach tendencies and thus left FA was examined in Chapter 3 and 4. Chapter 3 focuses on prosocial behavior in reaction to social exclusion by using the "Prosocial Owl Game" (POG). To check whether prosociality during the POG was related to other, more conventional prosocial measures we related the POG results to parent-reported prosocial behavior and the donating task, a costly measurement of prosocial behavior. We also hypothesized that showing more prosocial behavior is driven by approach tendencies and thus related to left FA. The main focus of Chapter 4 is to examine aggressive behavior in response to social judgments by using the

"Social Network Aggression Task – Early Childhood" (SNAT-EC). We examined whether children react more aggressively after receiving a negative social judgment compared to a positive social judgment from a peer. We hypothesized that aggressive behavior is mediated by left FA after receiving a negative social judgment, therefore we measured FA during the task and examined state-related aggression and FA. In Chapter 5 we present the main findings and conclusions of this thesis. Furthermore, in this closing Chapter we will discuss the strengths and limitations of this thesis and directions for future research.

# References

Achterberg, M., van Duijvenvoorde, A. C., Bakermans-Kranenburg, M. J., & Crone, E. A. (2016). Control your anger! The neural basis of aggression regulation in response to negative social feedback. *Social cognitive and affective neuroscience*, nsv154. https://doi.org/10.1093/scan/nsv154

Achterberg, M., van Duijvenvoorde, A. C., van der Meulen, M., Euser, S., Bakermans-Kranenburg, M.J., & Crone, E. A. (2017). The neural and behavioral correlates of social evaluation in childhood. *Developmental cognitive neuroscience*, 24, 107-117. http://dx.doi.org/10.1016/j.dcn.2017.02.007

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological bulletin*, 117(3), 497-529. https://doi.org/10.1037/0033-2909.117.3.497

Buckley, K. E., Winkel, R. E., & Leary, M. R. (2004). Reactions to acceptance and rejection: Effects of level and sequence of relational evaluation. *Journal of Experimental Social Psychology*, 40(1), 14-28. https://doi.org/10.1016/S0022-1031(03)00064-7

Buss, A. H., & Plomin, R. (2014). *Temperament: Early developing personality traits* (Vol. 3) New York: Psychology Press. https://doi.org/10.4324/9781315745701

Coan, J. A., & Allen, J. J. (2004). Frontal EEG asymmetry as a moderator and mediator of emotion. *Biological psychology*, 67(1), 7-50. https://doi.org/10.1016/j.biopsycho.2004.03.002

Cook, I. A., O'Hara, R., Uijtdehaage, S. H., Mandelkern, M., & Leuchter, A. F. (1998). Assessing the accuracy of topographic EEG mapping for determining local brain function. *Electroencephalography and clinical neurophysiology*, 107(6), 408-414. https://doi.org/10.1016/S0013-4694(98)00092-3

Crick, N. R. (1996). The role of overt aggression, relational aggression, and prosocial behavior in the prediction of children's future social adjustment. *Child development*, 67(5), 2317-2327. https://doi.org/10.2307/1131625

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology: I. *Journal of personality and social psychology*, 58(2), 330. https://doi.org/10.1037/0022-3514.58.2.330

Diaz, A., & Bell, M. A. (2012). Frontal EEG asymmetry and fear reactivity in different contexts at 10 months. *Developmental psychobiology*, 54(5), 536-545. https://doi.org/10.1002/dev.20612

Dodge, K. A., Lansford, J. E., Burks, V. S., Bates, J. E., Pettit, G. S., Fontaine, R., & Price, J. M. (2003). Peer rejection and social information-processing factors in the development of aggressive behavior problems in children. *Child development*, 74(2), 374-393. https://doi.org/10.1111/1467-8624.7402004

Euser, S., Bakermans-Kranenburg, M. J., van den Bulk, B. G., Linting, M., Damsteegt, R. C., Vrijhof, C. I., van Wijk, I.C., Crone, E.A., van IJzendoorn, M. H. (2016). Efficacy of the Video feedback Intervention to promote Positive Parenting and Sensitive Discipline in Twin Families (VIPP-Twins): Study protocol for a randomized controlled trial. *BMC psychology*, 4(1), 1. https://doi.org/10.1186/s40359-016-0139-y

Fox, N. A., Henderson, H. A., Rubin, K. H., Calkins, S. D., & Schmidt, L. A. (2001). Continuity and discontinuity of behavioral inhibition and exuberance: Psychophysiological and behavioral influences across the first four years of life. *Child development*, 72(1), 1-21. https://doi.org/10.1111/1467-8624.00262

Harmon-Jones, E., & Gable, P. A. (2018). On the role of asymmetric frontal cortical activity in approach and withdrawal motivation: An updated review of the evidence. *Psychophysiology*, 55(1), 42-64. https://doi.org/10.1111/psyp.12879

Harmon-Jones, E., Gable, P. A., & Peterson, C. K. (2010). The role of asymmetric frontal cortical activity in emotion-related phenomena: A review and update. *Biological Psychology*, 84, 451-462. https://doi.org/10.1016/j.biopsycho.2009.08.010

Harmon-Jones, E., & Sigelman, J. (2001). State anger and prefrontal brain activity: evidence that insult related relative left-prefrontal activation is associated with experienced anger and aggression. *Journal of personality and social psychology*, 80(5), 797. https://doi.org/10.1037/0022-3514.80.5.797

Howarth, G. Z., Fettig, N. B., Curby, T. W., & Bell, M. A. (2016). Frontal electroencephalogram asymmetry and temperament across infancy and early childhood: An exploration of stability and bidirectional relations. *Child development*, 87(2), 465-476. https://doi.org/10.1111/cdev.12466

Huffmeijer, R., Alink, L. R., Tops, M., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2012). Asymmetric frontal brain activity and parental rejection predict altruistic behavior: Moderation of oxytocin effects. *Cognitive, Affective, & Behavioral Neuroscience*, 12(2), 382-392. https://doi.org/10.3758/s13415-011-0082-6

Juffer F., Bakermans-Kranenburg M.J., & Van IJzendoorn M.H. (Eds). (2008). *Promoting Positive Parenting: An Attachment-Based Intervention.* New York: Lawrence Erlbaum Associates.

Laufs, H., Krakow, K., Sterzer, P., Eger, E., Beyerle, A., Salek-Haddadi, A., & Kleinschmidt, A. (2003). Electroencephalographic signatures of attentional and cognitive default modes in spontaneous brain activity fluctuations at rest. *Proceedings of the national academy of sciences*, 100(19), 11053-11058. https://doi.org/10.1073/pnas.1831638100

Lereya, S. T., Copeland, W. E., Costello, E. J., & Wolke, D. (2015). Adult mental health consequences of peer bullying and maltreatment in childhood: two cohorts in two countries. *The Lancet Psychiatry*, 2(6), 524-531. https://doi.org/10.1016/S2215-0366(15)00165-0

LoBue, V., Coan, J. A., Thrasher, C., & DeLoache, J. S. (2011). Prefrontal asymmetry and parent rated temperament in infants. *PloS one*, 6(7), e22694. https://doi.org/10.1371/journal.pone.0022694

Marshall, P. J., Bar-Haim, Y., & Fox, N. A. (2002). Development of the EEG from 5 months to 4 years of age. *Clinical Neurophysiology*, 113(8), 1199-1208. https://doi.org/10.1016/S1388-2457(02)00163-3

Mathersul, D., Williams, L. M., Hopkinson, P. J., & Kemp, A. H. (2008). Investigating models of affect: Relationships among EEG alpha asymmetry, depression, and anxiety. *Emotion*, 8, 560-572. https://doi.org/10.1037/a0012811

Neal, L. B., & Gable, P. A. (2017). Regulatory control and impulsivity relate to resting frontal activity. *Social cognitive and affective neuroscience*, 12(9), 1377-1383. https://doi.org/10.1093/scan/nsx080

Newman, M. L., Holden, G. W., & Delville, Y. (2010). Coping with the stress of being bullied: Consequences of coping strategies among college students. *Social Psychological and Personality Science*, 1948550610386388. https://doi.org/10.1177/1948550610386388

Padilla-Walker, L. M., & Carlo, G. (2015) The study of prosocial behavior. In Padilla-Walker, L.M., & Carlo, G. (Eds.). *Prosocial development: A multidimensional approach* (pp. 3-16). New York: Oxford University Press.

Pashler, H., & Wagenmakers, E. J. (2012). Editors' introduction to the special section on replicability in psychological science a crisis of confidence? *Perspectives on Psychological Science*, 7(6), 528-530. https://doi.org/10.1177/1745691612465253

Paulus, M. (2018). The multidimensional nature of early prosocial behavior: A motivational perspective. *Current Opinion in Psychology*, 20, 111–116. https://doi.org/10.1016/j.copsyc.2017.09.003

Paulus, M., Kühn-Popp, N., Licata, M., Sodian, B., & Meinhardt, J. (2013). Neural correlates of prosocial behavior in infancy: different neurophysiological mechanisms support the emergence of helping and comforting. *Neuroimage*, 66, 522-530. https://doi.org/10.1016/j.neuroimage.2012.10.041

Reznik, S. J., & Allen, J. J. (2018). Frontal asymmetry as a mediator and moderator of emotion: An updated review. *Psychophysiology*, 55(1), e12965. https://doi.org/10.1111/psyp.12965

Riem, M. M., Bakermans-Kranenburg, M. J., Huffmeijer, R., & van IJzendoorn, M. H. (2013). Does intranasal oxytocin promote prosocial behavior to an excluded fellow player? A randomized controlled trial with Cyberball. *Psychoneuroendocrinology*, 38(8), 1418-1425. https://doi.org/10.1016/j.psyneuen.2012.12.023

Schmidt, L. A. (2008). Patterns of second-by-second resting frontal brain (EEG) asymmetry and their relation to heart rate and temperament in 9-month-old human infants. *Personality and Individual Differences*, 44, 216–225. https://doi.org/10.1016/j.paid.2007.08.001

Schroeder, D. A., & Graziano, W. G. (Eds.). (2015). The Oxford handbook of prosocial behavior. New York: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195399813.001.0001

Van der Meulen, M., Steinbeis, N., Achterberg, M., Bilo, E., van den Bulk, B. G., van IJzendoorn, M.H., & Crone, E. A. (2017). The neural correlates of dealing with social exclusion in childhood. *Neuropsychologia*, 103, 29-37. https://doi.org/10.1016/j.neuropsychologia.2017.07.008

Van der Meulen, M., van IJzendoorn, M. H., & Crone, E. A. (2016). Neural correlates of prosocial behavior: compensating social exclusion in a four-player cyberball game. *PloS one*, 11(7),e0159045. https://doi.org/10.1371/journal.pone.0159045

Van IJzendoorn, M.H., Bakermans-Kranenburg, M.J., Pannebakker, F., & Out, D. (2010). In defense of situational morality: Genetic, dispositional and situational determinants of children's donating to charity. *Journal of Moral Education*. 39, 1-20. https://doi.org/10.1080/03057240903528535

Vrijhof, C. I., van den Bulk, B. G., Overgaauw, S., Lelieveld, G. J., Engels, R. C., & van IJzendoorn, M. H. (2016). The Prosocial Cyberball Game: compensating for social exclusion and its associations with empathic concern and bullying in adolescents. *Journal of adolescence*, 52, 27-36. https://doi.org/10.1016/j.adolescence.2016.07.005

Wildeboer, A., Thijssen, S., Bakermans-Kranenburg, M. J., Jaddoe, V. W., White, T., Tiemeier, H., & Van IJzendoorn, M. H. (2017). Anxiety and Social Responsiveness Moderate the Effect of Situational Demands on Children's Donating Behavior. *Merrill-Palmer Quarterly*, 63(3), 340-366. https://doi.org/10.13110/merrpalmquar1982.63.3.0340

Zentner, M., & Shiner, R. L. (Eds.). (2015). *Handbook of temperament*. New York: Guilford.