Risky business? Behavioral and neural mechanisms underlying risky decision-making in adolescents

Blankenstein, N.E.

Addendum

References

Achterberg, M., Peper, J. S., van Duijvenvoorde, A. C. K., Mandl, R. C., & Crone, E. A. (2016). Frontostriatal white matter integrity predicts development of delay of gratification: A longitudinal study. *Journal of Neuroscience, 36*(6), 1954–1961.

Arnett, J. (1992). Reckless behavior in adolescence: A developmental perspective. *Developmental Review, 12*(4), 339–373.

Barkley–Levenson, E., & Galván, A. (2014). Neural representation of expected value in the adolescent brain. *Proceedings of the National Academy of Sciences, 111*(4), 1646–1651.

Bartra, O., McGuire, J. T., & Kable, J. W. (2013). The valuation system: A coordinate–based meta–analysis of BOLD fMRI experiments examining neural correlates of subjective value. *Neuroimage, 76,* 412–427.

Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10*(3), 295–307.

Becht, A. I., Bos, M. G., Nelemans, S. A., Peters, S., Vollebergh, W. A., Branje, S. J., . . . Crone, E. A. (2018). Goal-directed correlates and neurobiological underpinnings of adolescent identity: A multimethod multisample longitudinal approach. *Child Development*, *89*(3), 823–836.

Birnbaum, M., & Navarrete, J. (1998). Testing descriptive utility theories: Violations of stochastic dominance and cumulative independence. *Journal of Risk and Uncertainty, 17*(1), 49–79.

Bjork, J. M., & Pardini, D. A. (2015). Who are those "risk–taking adolescents"? Individual differences in developmental neuroimaging research. *Developmental Cognitive Neuroscience, 11*, 56–64.

Blais, A.–R., & Weber, E. U. (2006). A domain–specific risk–taking (DOSPERT) scale for adult populations. *Judgment and Decision Making, 1*(1), 33–47.

Blakemore, S. J., & Mills, K. L. (2014). Is adolescence a sensitive period for sociocultural processing? *Annual Review of Psychology, 65,* 187–207.

Blankenstein, N. E., Crone, E. A., van den Bos, W., & van Duijvenvoorde, A. C. K. (2016). Dealing with uncertainty: Testing risk–and ambiguity–attitude across adolescence. *Developmental Neuropsychology, 41*(1–2), 77–92.

Blankenstein, N. E., Peper, J. S., Crone, E. A., & van Duijvenvoorde, A. C. K. (2017). Neural mechanisms underlying risk and ambiguity attitudes. *Journal of Cognitive Neuroscience, 29*(11), 1–15.

Blankenstein, N. E., Schreuders, E., Peper, J. S., Crone, E. A., & van Duijvenvoorde, A. C. K. (2018). Individual differences in risk–taking tendencies modulate the neural processing of risky and ambiguous decision–making in adolescence. *NeuroImage, 172,* 663–673.

Bos, M. G., Peters, S., van de Kamp, F. C., Crone, E. A., & Tamnes, C. K. (2018). Emerging depression in adolescence coincides with accelerated frontal cortical thinning. *Journal of Child Psychology and Psychiatry 59*(9), 994–1002.

Bossaerts, P., Ghirardato, P., Guarnaschelli, S., & Zame, W. (2010). Ambiguity in asset Markets: Theory and experiment. *The Review of Financial Studies, 23*(4), 1325–1359.

Braams, B. R., & Crone, E. A. (2017). Peers and parents: A comparison between neural activation when winning for friends and mothers in adolescence. *Social Cognitive and Affective Neuroscience, 12*(3), 417–426.

Braams, B. R., Peper, J. S., van der Heide, D., Peters, S., & Crone, E. A. (2016). Nucleus accumbens response to rewards and testosterone levels are related to alcohol use in adolescents and young adults. *Developmental Cognitive Neuroscience, 17,* 83–93.

Braams, B. R., Peters, S., Peper, J. S., Güroğlu, B., & Crone, E. A. (2014). Gambling for self, friends, and antagonists: Differential contributions of affective and social brain regions on adolescent reward processing. *NeuroImage, 100,* 281–289.

Braams, B. R., van Duijvenvoorde, A. C. K., Peper, J. S., & Crone, E. A. (2015). Longitudinal changes in adolescent risk–taking: A comprehensive study of neural responses to rewards, pubertal development, and risk–taking behavior. *Journal of Neuroscience, 35*(18), 7226–7238.

Brett, M., Anton, J., Valabregue, R., & Poline, J. (2002). Region of interest analysis using an SMP toolbox, paper presented at: 8th International Conference on Functional mapping of the Human Brian.

Burnett, S., Bault, N., Coricelli, G., & Blakemore, S. J. (2010). Adolescents' heightened risk–seeking in a probabilistic gambling task. *Cognitive Development, 25*(2), 183–196.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta–analysis. *Psychological Bulletin, 125*(3), 367.

Camerer, C., & Mobbs, D. (2016). Differences in behavior and brain activity during hypothetical and real choices. *Trends in Cognitive Sciences, 21*(1), 46–56.

Camerer, C., & Weber, M. (1992). Recent developments in modeling preferences: Uncertainty and ambiguity. *Journal of Risk and Uncertainty, 5*(4), 325–370.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67*(2), 319.

Casey, B. J. (2015). Beyond simple models of self–control to circuit–based accounts of adolescent behavior. *Annu Rev Psychol, 66*(1), 295–319.

Casey, B., Jones, R. M., & Hare, T. A. (2008). The adolescent brain. *Annals of the New York Academy of Sciences, 1124*(1), 111–126.

Chassin, L., Hussong, A., & Beltran, I. (2004). *Adolescent substance use*. In R. Lerner & L. Steinberg (Eds.), Handbook of adolescent psychology (2nd ed., pp. 665–696). New York, NY: Wiley.

Chein, J., Albert, D., O'Brien, L., Uckert, K., & Steinberg, L. (2011). Peers increase adolescent risk taking by enhancing activity in the brain's reward circuitry. *Developmental Science, 14*(2), F1–F10.

Christopoulos, G. I., Tobler, P. N., Bossaerts, P., Dolan, R. J., & Schultz, W. (2009). Neural correlates

of value, risk, and risk aversion contributing to decision making under risk. *Journal of Neuroscience, 29*(40), 12574–12583.

Chung, D., Christopoulos, G. I., King–Casas, B., Ball, S. B., & Chiu, P. H. (2015). Social signals of safety and risk confer utility and have asymmetric effects on observers' choices. *Nature Neuroscience, 18*(6), 18(6), 912–916.

Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social–affective engagement and goal flexibility. *Nature Reviews Neuroscience, 13*(9), 636–650.

Crone, E. A., & Elzinga, B. M. (2015). Changing brains: How longitudinal functional magnetic resonance imaging studies can inform us about cognitive and social–affective growth trajectories. *Wiley Interdiscip Rev Cogn Sci, 6*(1), 53–63.

Crone, E. A., & van der Molen, M. W. (2004). Developmental changes in real life decision making: Performance on a gambling task previously shown to depend on the ventromedial prefrontal cortex. *Developmental Neuropsychology, 25*(3), 251–279.

Crone, E. A., van Duijvenvoorde, A. C. K., & Peper, J. S. (2016). Annual Research Review: Neural contributions to risk-taking in adolescence–Developmental changes and individual differences. *Journal of Child Psychology and Psychiatry, 57*(3), 353–368.

Dahl, R. E. (2004). Adolescent brain development: A period of vulnerabilities and opportunities. Keynote address. *Ann N Y Acad Sci, 1021*, 1–22.

Dale, A. M. (1999). Optimal experimental design for event–related fMRI. *Human Brain Mapping, 8*(2–3), 109–114.

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology, 44*(1), 113.

Defoe, I. N., Dubas, J. S., Figner, B., & van Aken, M. A. (2015). A meta–analysis on age differences in risky decision making: Adolescents versus children and adults. *Psychological Bulletin, 141*(1), 48–84.

Delgado, M. R. (2007). Reward-related responses in the human striatum. *Ann N Y Acad Sci, 1104*(1), 70–88.

Delgado, M. R., Nystrom, L. E., Fissell, C., Noll, D., & Fiez, J. A. (2000). Tracking the hemodynamic responses to reward and punishment in the striatum. *Journal of Neurophysiology, 84*(6), 3072–3077.

Dixon, M. L. (2015). Cognitive control, emotional value, and the lateral prefrontal cortex. *Frontiers in Psychology, 6,* 758.

Do, K. T., Guassi Moreira, J. F., & Telzer, E. H. (2017). But is helping you worth the risk? Defining Prosocial Risk Taking in adolescence. *Developmental Cognitive Neuroscience, 25,* 260–271.

Dumontheil, I., Apperly, I. A., & Blakemore, S. J. (2010). Online usage of theory of mind continues to develop in late adolescence. *Developmental Science, 13*(2), 331–338.

Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Ross, J., Hawkins, J., . . . Wechsler, H. (2008). Youth risk behavior surveillance–United States, 2007. Morbidity and mortality weekly report. Surveillance summaries (Washington, DC: 2002), 57(4), 1–131.

Eisenberg, N. (2000). Emotion, regulation, and moral development. *Annu Rev Psychol, 51*, 665–697.

Eisenberg, N., Fabes, R. A., Murphy, B., Karbon, M., Maszk, P., Smith, M., . . . Suh, K. (1994). The relations of emotionality and regulation to dispositional and situational empathy–related responding. *Journal of Personality and Social Psychology, 66*(4), 776–797.

Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. *The Quarterly Journal of Economics, 74*, 643–669.

Engelmann, J. B., & Tamir, D. (2009). Individual differences in risk preference predict neural responses during financial decision–making. *Brain Research, 1290*, 28–51.

Engelmann, J. B., Moore, S., Monica Capra, C., & Berns, G. S. (2012). Differential neurobiological effects of expert advice on risky choice in adolescents and adults. *Social Cognitive and Affective Neuroscience, 7*(5), 557–567.

Eppinger, B., Hämmerer, D., & Li, S. C. (2011). Neuromodulation of reward-based learning and decision making in human aging. *Annals of the New York Academy of Sciences, 1235*(1), 1–17.

Ernst, M., Nelson, E. E., McClure, E. B., Monk, C. S., Munson, S., Eshel, N., . . . Pine, D. S. (2004). Choice selection and reward anticipation: An fMRI study. *Neuropsychologia, 42*(12), 1585–1597.

Eshel, N., Nelson, E. E., Blair, R. J., Pine, D. S., & Ernst, M. (2007). Neural substrates of choice selection in adults and adolescents: Development of the ventrolateral prefrontal and anterior cingulate cortices. *Neuropsychologia, 45*(6), 1270–1279.

Fecteau, S., Pascual–Leone, A., Zald, D. H., Liguori, P., Theoret, H., Boggio, P. S., & Fregni, F. (2007). Activation of prefrontal cortex by transcranial direct current stimulation reduces appetite for risk during ambiguous decision making. *Journal of Neuroscience, 27*(23), 6212–6218.

Figner, B., & Weber, E. U. (2011). Who takes risks when and why? Determinants of risk taking. *Current Directions in Psychological Science, 20*(4), 211–216.

Figner, B., Mackinlay, R. J., Wilkening, F., & Weber, E. U. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task. *Journal of Experimental Psychology: Learning, Memory,and Cognition, 35*(3), 709–730.

Forbes, E. E., & Dahl, R. E. (2010). Pubertal development and behavior: Hormonal activation of social and motivational tendencies. *Brain and Cognition, 72*(1), 66–72.

Foulkes, L., & Blakemore, S.–J. (2018). Studying individual differences in human adolescent brain development. *Nature Neuroscience, 21*(3), 315–323.

Frey, R., Pedroni, A., Mata, R., Rieskamp, J., Hertwig. R. (2017). Risk preference shares the psychometric structure of major psychological traits. *Science Advances, 3*(10), e1701381.

Gabrieli, J. D., Ghosh, S. S., & Whitfield–Gabrieli, S. (2015). Prediction as a humanitarian and pragmatic contribution from human cognitive neuroscience. *Neuron, 85*(1), 11–26.

Galvan, A., Hare, T., Voss, H., Glover, G., & Casey, B. (2007). Risk-taking and the adolescent brain: Who is at risk? *Developmental Science, 10*(2), 8–14.

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology, 41*(4), 625–635.

Gianotti, L. R. R., Knoch, D., Faber, P. L., Lehmann, D., Pascual–Marqui, R. D., Diezi, C., . . . Fehr, E. (2009). Tonic activity level in the right

prefrontal cortex predicts individuals' risk raking. *Psychological Science, 20*(1), 33–38.

Giedd, J. N. (2004). Structural magnetic resonance imaging of the adolescent brain. *Ann N Y Acad Sci, 1021*(1), 77–85.

Giedd, J. N., Blumenthal, J., Jeffries, N. O., Castellanos, F. X., Liu, H., Zijdenbos, A., . . . Rapoport, J. L. (1999). Brain development during childhood and adolescence: a longitudinal MRI study. *Nature Neuroscience, 2*(10), 861.

Gilaie–Dotan, S., Tymula, A., Cooper, N., Kable, J. W., Glimcher, P. W., & Levy, I. (2014). Neuroanatomy predicts individual risk attitudes. *Journal of Neuroscience, 34*(37), 12394–12401.

Gilboa, I., & Schmeidler, D. (1989). Maxmin expected utility with non–unique prior. *Journal of Mathematical Economics, 18*(2), 141–153.

Glimcher, P. W., & Rustichini, A. (2004). Neuroeconomics: The consilience of brain and decision. *Science, 306*(5695), 447–452.

Gullone, E., Moore, S., Moss, S., & Boyd, C. (2000). The Adolescent Risk–Taking Questionnaire: Development and psychometric evaluation. *Journal of Adolescent Research, 15*(2), 231–250.

Gunther Moor, B., Crone, E. A., & van der Molen, M. W. (2010). The heartbrake of social rejection: Heart rate deceleration in response to unexpected peer rejection. *Psychological Science, 21*(9), 1326–1333.

Guroglu, B., van den Bos, W., & Crone, E. A. (2014). Sharing and giving across adolescence: An experimental study examining the development of prosocial behavior. *Frontiers in Psychology, 5*, 291.

Hall, G. S. (1904). *Adolescence: Its psychology and its relation to physiology, anthropology, sociology, sex, crime, religion, and education*. NJ: Prentice–Hall.: Englewoord Cliffs.

Harden, K. P., & Tucker–Drob, E. M. (2011). Individual differences in the development of sensation seeking and impulsivity during adolescence: Further evidence for a dual systems model. *Developmental Psychology, 47*(3), 739.

Hartley, C. A., & Somerville, L. H. (2015). The neuroscience of adolescent decision–making. *Current Opinion in Behavioral Sciences, 5*, 108–115.

Hawk, S. T., Keijsers, L., Branje, S. J., Graaff, J. V., Wied, M., & Meeus, W. (2013). Examining the Interpersonal Reactivity Index (IRI) among early and late adolescents and their mothers. *Journal of Personality Assessment, 95*(1), 96–106.

Herting, M. M., Gautam, P., Chen, Z., Mezher, A., & Vetter, N. C. (2017). Test–retest reliability of longitudinal task–based fMRI: Implications for developmental studies. *Developmental Cognitive Neuroscience, 33,* 17–26.

Herting, M. M., Johnson, C., Mills, K. L., Vijayakumar, N., Dennison, M., Liu, C., . . . Tamnes, C. K. (2018). Development of subcortical volumes across adolescence in males and females: A multisample study of longitudinal changes. *NeuroImage, 172*, 194–205.

Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., & Camerer, C. F. (2005). Neural systems responding to degrees of uncertainty in human decision–making. *Science, 310*(5754), 1680–1683.

Huettel, S. A., Song, A. W., & McCarthy, G. (2005). Decisions under uncertainty: Probabilistic context influences activation of prefrontal and parietal cortices. *Journal of Neuroscience, 25*(13), 3304–3311.

Huettel, S. A., Stowe, C. J., Gordon, E. M., Warner, B. T., & Platt, M. L. (2006). Neural signatures of economic preferences for risk and ambiguity. *Neuron, 49*(5), 765–775.

Humphrey, G., & Dumontheil, I. (2016). Development of risk–taking, perspective–taking, and inhibitory control during adolescence. *Developmental Neuropsychology, 41*(1–2), 59–76.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society, 47,* 263–291.

Klein, A., & Tourville, J. (2012). 101 labeled brain images and a consistent human cortical labeling protocol. *Frontiers in Neuroscience, 6*, 171.

Klucharev, V., Hytönen, K., Rijpkema, M., Smidts, A., & Fernández, G. (2009). Reinforcement learning signal predicts social conformity. *Neuron, 61*(1), 140–151.

Knight, F. H. (1921). *Risk, uncertainty, and profit*. New York, NY: Houghton Mifflin.

Knoch, D., Gianotti, L. R. R., Pascual–Leone, A., Treyer, V., Regard, M., Hohmann, M., & Brugger, P. (2006). Disruption of right prefrontal cortex by low–frequency repetitive Transcranial Magnetic Stimulation induces risk–taking behavior. *Journal of Neuroscience, 26*(24), 6469–6472.

Knoll, L. J., Magis–Weinberg, L., Speekenbrink, M., & Blakemore, S. J. (2015). Social influence on risk perception during adolescence. *Psychological Science, 26*(5), 583–592.

Knutson, B., & Huettel, S. A. (2015). The risk matrix. *Current Opinion in Behavioral Sciences, 5*, 141–146.

Knutson, B., Taylor, J., Kaufman, M., Peterson, R., & Glover, G. (2005). Distributed neural representation of expected value. *Journal of Neuroscience, 25*(19), 4806–4812.

Kuhnen, C. M., & Knutson, B. (2005). The neural basis of financial risk taking. *Neuron*, *47*(5), 763–770.

Lejuez, C., Aklin, W. M., Zvolensky, M. J., & Pedulla, C. M. (2003). Evaluation of the Balloon Analogue Risk Task (BART) as a predictor of adolescent real–world risk–taking behaviours. *Journal of Adolescence, 26*(4), 475–479.

Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: Insights from anatomical magnetic resonance imaging. *Neuroscience & Biobehavioral Reviews, 30*(6), 718–729.

Levy, D. J., & Glimcher, P. W. (2012). The root of all value: A neural common currency for choice. *Current Opinion in Neurobiology, 22*(6), 1027–1038.

Levy, I. (2016). Neuroanatomical substrates for risk behavior. *The Neuroscientist, 23*(3), 275–286.

Levy, I., Snell, J., Nelson, A. J., Rustichini, A., & Glimcher, P. W. (2010). Neural representation of subjective value under risk and ambiguity. *Journal of Neurophysiology, 103*(2), 1036–1047.

Li, R. (2017). Flexing dual–systems models: How variable cognitive control in children informs our understanding of risk–taking across development. *Developmental Cognitive Neuroscience, 27*, 91–98.

Li, R., Brannon, E. M., & Huettel, S. A. (2014). Children do not exhibit ambiguity aversion despite intact familiarity bias. *Frontiers in Psychology, 5*, 1519.

Mamerow, L., Frey, R., & Mata, R. (2016). Risk taking across the life span: A comparison of self–report and behavioral measures of risk taking. *Psychology and Aging, 31*(7), 711–723.

McCormick, E. M., & Telzer, E. H. (2017a). Failure to retreat: Blunted sensitivity to negative feedback supports risky behavior in adolescents. *Neuroimage, 147*, 381–389.

Mills, K. L., Goddings, A.–L., Clasen, L. S., Giedd, J. N., & Blakemore, S.–J. (2014). The developmental mismatch in structural brain maturation during adolescence. *Developmental Neuroscience, 36*(3–4), 147–160.

Mills, K. L., Goddings, A.–L., Herting, M. M., Meuwese, R., Blakemore, S.–J., Crone, E. A., . . . Sowell, E. R. (2016). Structural brain development between childhood and adulthood: Convergence across four longitudinal samples. *Neuroimage, 141*, 273–281.

Mills, K. L., Lalonde, F., Clasen, L. S., Giedd, J. N., & Blakemore, S. J. (2014). Developmental changes in the structure of the social brain in late childhood and adolescence. *Social Cognitive and Affective Neuroscience, 9*(1), 123–131.

Mohr, P. N., Biele, G., & Heekeren, H. R. (2010). Neural processing of risk. *Journal of Neuroscience, 30*(19), 6613–6619.

Nichols, T., Brett, M., Andersson, J., Wager, T., & Poline, J.–B. (2005). Valid conjunction inference with the minimum statistic. *Neuroimage, 25*(3), 653–660.

O'Doherty, J. P. (2004). Reward representations and reward–related learning in the human brain: Insights from neuroimaging. *Current Opinion in Neurobiology, 14*(6), 769–776.

O'Doherty, J., Kringelbach, M. L., Rolls, E. T., Hornak, J., & Andrews, C. (2001). Abstract reward and punishment representations in the human orbitofrontal cortex. *Nature Neuroscience, 4*(1), 95–102.

Overgaauw, S., Guroglu, B., Rieffe, C., & Crone, E. A. (2014). Behavior and neural correlates of empathy in adolescents. *Developmental Neuroscience, 36*(3–4), 210–219.

Overgaauw, S., Rieffe, C., Broekhof, E., Crone, E. A., & Guroglu, B. (2017). Assessing empathy across childhood and adolescence: Validation of the Empathy Questionnaire for Children and Adolescents (EmQue–CA). *Frontiers in Psychology, 8*, 870.

Peper, J. S., & Dahl, R. E. (2013). The teenage brain: Surging hormones– brain–behavior interactions during puberty. *Current Directions in Psychological Science, 22*(2), 134–139.

Peper, J. S., Braams, B. R., Blankenstein, N. E., Bos, M. G., & Crone, E. A. (2018). Development of multifaceted risk taking and the relations to sex steroid hormones: A longitudinal study. *Child Development, 89*(5), 1887–1907.

Peters, S., & Crone, E. (2017). Increased striatal activity in adolescence benefits learning. *Nature Communications, 8*(1), 1983.

Peters, S., Van Duijvenvoorde, A. C., Koolschijn, P. C. M., & Crone, E. A. (2016). Longitudinal development of frontoparietal activity during feedback learning: Contributions of age, performance, working memory and cortical thickness. *Developmental Cognitive Neuroscience, 19*, 211–222.

Pfeifer, J. H., & Peake, S. J. (2012). Self–development: Integrating cognitive, socioemotional, and neuroimaging perspectives. *Developmental Cognitive Neuroscience, 2*(1), 55–69.

Platt, M. L., & Huettel, S. A. (2008). Risky business: The neuroeconomics of decision making under uncertainty. *Nature Neuroscience, 11*(4), 398–403.

Poldrack, R. A. (2008). The role of fMRI in Cognitive Neuroscience: Where do we stand? Current Opinion in Neurobiology, 18(2), 223–227.

Pushkarskaya, H., Smithson, M., Joseph, J. E., Corbly, C., & Levy, I. (2015). Neural correlates of decision–making under ambiguity and conflict. *Frontiers in Behavioral Neuroscience, 9,* 325.

Qu, Y., Galvan, A., Fuligni, A. J., Lieberman, M. D., & Telzer, E. H. (2015). Longitudinal changes in prefrontal cortex activation underlie declines in adolescent risk taking. *Journal of Neuroscience, 35*(32), 11308–11314.

RCore Team. (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from http://www.R–project.org/.

Rangel, A., & Clithero, J. A. (2014). *The computation of stimulus values in simple choice.* In Neuroeconomics (Second Edition) (pp. 125–148): Elsevier.

Rao, H., Korczykowski, M., Pluta, J., Hoang, A., & Detre, J. A. (2008). Neural correlates of voluntary and involuntary risk taking in the human brain: An fMRI Study of the Balloon Analog Risk Task (BART). *Neuroimage, 42*(2), 902–910.

Raven, J., Raven, J. C., & Court, J. H. (1998). Manual for Raven's Progressive Matrices and Vocabulary Scales. *Section 3,The Standard Progressive Matrices*. Oxford, England: Oxford Psychologists Press/San Antonio, TX: The Psychological Corporation.

Romer, D., Reyna, V. F., & Satterthwaite, T. D. (2017). Beyond stereotypes of adolescent risk taking: Placing the adolescent brain in developmental context. *Developmental Cognitive Neuroscience 27,* 19–34.

Schienle, A., Köchel, A., Ebner, F., Reishofer, G., & Schäfer, A. (2010). Neural correlates ofintolerance of uncertainty. *Neuroscience Letters, 479*(3), 272–276.

*S*chreuders, E., Braams, B. R., Blankenstein, N. E., Peper, J. S., Güroğlu, B., & Crone, E. A. (2018). Contributions of reward sensitivity to ventral striatum activity across adolescence and early adulthood. *Child Development, 89*(3), 797–810.

Schriber, R. A., & Guyer, A. E. (2015). Adolescent neurobiological susceptibility to social context. *Developmental Cognitive Neuroscience, 19*, 1–18.

Sescousse, G., Caldú, X., Segura, B., & Dreher, J.–C. (2013). Processing of primary and secondary rewards: A quantitative meta–analysis and review of human functional neuroimaging studies. *Neuroscience & Biobehavioral Reviews, 37*(4), 681–696.

Shenhav, A., Botvinick, M. M., & Cohen, J. D. (2013). The expected value of control: an integrative theory of anterior cingulate cortex function. *Neuron, 79*(2), 217–240.

Sherman, L., Steinberg, L., & Chein, J. (2018). Connecting brain responsivity and real–world risk taking: Strengths and limitations of current methodological approaches. *Developmental Cognitive Neuroscience, 33,* 27–41.

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1–32.

Silverman, M. H., Jedd, K., & Luciana, M. (2015). Neural networks involved in adolescent reward processing: An activation likelihood estimation meta–analysis of functional neuroimaging studies. *NeuroImage, 122*, 427–439.

Simons–Morton, B., Lerner, N., & Singer, J. (2005). The observed effects of teenage passengers on the risky driving behavior of teenage drivers. *Accident Analysis & Prevention, 37*(6), 973–982.

Smith, A. R., Chein, J., & Steinberg, L. (2014). Peers increase adolescent risk taking even when

the probabilities of negative outcomes are known. *Developmental Psychology, 50*(5), 1564.

Smith, A. R., Steinberg, L., & Chein, J. (2014). The role of the anterior insula in adolescent decision making. *Developmental Neuroscience, 36*(3–4), 196–209.

Somerville, L. H., & Casey, B. J. (2010). Developmental neurobiology of cognitive control and motivational systems. *Current Opinion in Neurobiology, 20*(2), 236–241.

Somerville, L. H., Hare, T. A., Casey, B. J. (2011). Frontostriatal maturiation predicts cognitive control failure to appetitive cues in adolescents. *Journal of Cognitive Neuroscience, 23*(9). 2123–2134.

Somerville, L. H., Jones, R. M., & Casey, B. J. (2010). A time of change: Behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues. *Brain and Cognition, 72*(1), 124–133.

Steinberg, L. (2004). Risk taking in adolescence: What changes, and why? *Annals of the New York Academy of Sciences, 1021*(1), 51–58.

Steinberg, L. (2007). Risk taking in adolescence new perspectives from brain and behavioral science. *Current Directions in Psychological Science, 16*(2), 55–59.

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk–taking. *Developmental Review, 28*(1), 78–106.

Studer B., Apergis–Schoute A. M., Robbins, T. W., & Clark, L. (2012). What are the odds? The neural correlates of active choice during gambling. *Frontiers in Neuroscience, 6*(46), 1–16.

Tamnes, C. K., Herting, M. M., Goddings, A. L., Meuwese, R., Blakemore, S. J., Dahl, R. E., . . . Mills, K. L. (2017). Development of the cerebral cortex across adolescence: A multisample study of inter–related longitudinal changes in cortical volume, Surface area, and thickness. *Journal of Neuroscience, 37*(12), 3402–3412.

Tamnes, C. K., Overbye, K., Ferschmann, L., Fjell, A. M., Walhovd, K. B., Blakemore, S.–J., & Dumontheil, I. (2018). Social perspective taking is associated with self–reported prosocial behavior and regional cortical thickness across adolescence. [Advance online publication]

Telzer, E. H. (2016). Dopaminergic reward sensitivity can promote adolescent health: A new perspective on the mechanism of ventral striatum activation. *Developmental Cognitive Neuroscience, 17*, 57–67.

Telzer, E. H., Fuligni, A. J., Lieberman, M. D., & Galván, A. (2013). Meaningful family relationships: Neurocognitive buffers of adolescent risk taking. *Journal of Cognitive Neuroscience, 25*(3), 374–387.

Telzer, E. H., Fuligni, A. J., Lieberman, M. D., & Galvan, A. (2013). Ventral striatum activation to prosocial rewards predicts longitudinal declines in adolescent risk taking. *Developmental Cognitive Neuroscience, 3,* 45–52.

Telzer, E. H., Fuligni, A. J., Lieberman, M. D., & Galvan, A. (2014). Neural sensitivity to eudaimonic and hedonic rewards differentially predict adolescent depressive symptoms over time. *Proceedings of the National Academy of Sciences*, *USA*, *111*(18), 6600–6605.

Telzer, E. H., Masten, C. L., Berkman, E. T., Lieberman, M. D., & Fuligni, A. J. (2010). Gaining while giving: an fMRI study of the rewards of family assistance among white and Latino youth. *Social Neuroscience, 5*(5–6), 508–518.

Thijssen, S., Wildeboer, A., Muetzel, R. L., Bakermans–Kranenburg, M. J., El Marroun, H.,

Hofman, A., . . . White, T. (2015). Cortical thickness and prosocial behavior in school–age children: A population–based MRI study. *Social Neuroscience, 10*(6), 571–582.

Tobler, P. N., O'Doherty, J. P., Dolan, R. J., & Schultz, W. (2007). Reward value coding distinct from risk attitude–related uncertainty coding in human reward systems. *Journal of Neurophysiology, 97*(2), 1621–1632.

Tricomi, E. M., Delgado, M. R., & Fiez, J. A. (2004). Modulation of caudate activity by action contingency. *Neuron, 41*(2), 281–292.

Turner, L., Mermelstein, R., & Flay, B. (2004). Individual and contextual influences on adolescent smoking. *Ann N Y Acad Sci, 1021*(1), 175–197.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5*(4), 297–323.

Tymula, A., Rosenberg Belmaker, L. A., Roy, A. K., Ruderman, L., Manson, K., Glimcher, P. W., & Levy, I. (2012). Adolescents' risk–taking behavior is driven by tolerance to ambiguity. *Proceedings of the National Academy of Sciences*, *109*(42), 17135–17140.

Tymula, A., Rosenberg Belmaker, L. A., Ruderman, L., Glimcher, P. W., & Levy, I. (2013). Like cognitive function, decision making across the life span shows profound age–related changes. *Proceedings of the National Academy of Sciences, 110*(42), 17143–17148.

Urosevic, S., Collins, P., Muetzel, R., Lim, K., & Luciana, M. (2012). Longitudinal changes in behavioral approach system sensitivity and brain structures involved in reward processing during adolescence. *Developmental Psychology, 48*(5), 1488–1500.

Van den Bos, W., & Hertwig, R. (2017). Adolescents display distinctive tolerance to ambiguity and to uncertainty during risky decision making. *Scientific Reports, 7*, 40962.

Van den Bos, W., Bruckner, R., Nassar, M. R., Mata, R., & Eppinger, B. (2017). Computational neuroscience across the lifespan: Promises and pitfalls. *Developmental Cognitive Neuroscience, 33,* 42–53.

Van den Bos, W., Rodriguez, C. A., Schweitzer, J. B., & McClure, S. M. (2014). Connectivity strength of dissociable striatal tracts predict individual differences in temporal discounting. *Journal of Neuroscience, 34*(31), 10298–10310.

Van Duijvenvoorde, A. C. K., & Crone, E. A. (2013). The teenage brain: A neuroeconomic approach to adolescent decision making. *Current Directions in Psychological Science, 22*(2), 108–113.

Van Duijvenvoorde, A. C. K., Figner, B., Weeda, W. D., Van der Molen, M. W., Jansen, B. R., & Huizenga, H. M. (2016). Neural mechanisms underlying compensatory and noncompensatory strategies in risky choice. *Journal of Cognitive Neuroscience, 28*(9), 1358–1373

Van Duijvenvoorde, A. C. K., Huizenga, H. M., Somerville, L. H., Delgado, M. R., Powers, A., Weeda, W. D., . . . Figner, B. (2015). Neural correlates of expected risks and returns in risky choice across development. *Journal of Neuroscience, 35*(4), 1549–1560.

Van Duijvenvoorde, A. C. K., Jansen, B. R. J., Bredman, J. C., & Huizenga, H. M. (2012). Age–related changes in decision making: Comparing informed and noninformed situations. *Developmental Psychology, 48*(1), 192–203.

Van Duijvenvoorde, A. C. K., Jansen, B. R. J., Griffioen, E. S., Van der Molen, M. W., & Huizenga, H. M. (2013). Decomposing developmental

differences in probabilistic feedback learning: A combined performance and heart–rate analysis. *Biological Psychology, 93*(1), 175–183.

Van Duijvenvoorde, A. C. K., Op de Macks, Z. A., Overgaauw, S., Gunther Moor, B., Dahl, R. E., & Crone, E. A. (2014). A cross–sectional and longitudinal analysis of reward–related brain activation: Effects of age, pubertal stage, and reward sensitivity. *Brain and Cognition, 89*, 3–14.

Van Duijvenvoorde, A. C. K., Peters, S., Braams, B. R., & Crone, E. A. (2016). What motivates adolescents? Neural responses to rewards and their influence on adolescents' risk taking, learning, and cognitive control. *Neuroscience & Biobehavioral Reviews, 70*, 135–147.

Van Duijvenvoorde, A. C. K., Jansen, B. R., Visser, I., & Huizenga, H. M. (2010). Affective and cognitive decision–making in adolescents. *Developmental Neuropsychology, 35*(5), 539–554.

Van Duijvenvoorde, A. C. K., Peters, S., Braams, B. R., & Crone, E. A. (2016). What motivates adolescents? Neural responses to rewards and their influence on adolescents' risk taking, learning, and cognitive control. *Neuroscience and Biobehavioral Reviews, 70*, 135–147.

Van Hoorn, J., Van Dijk, E., Güroğlu, B., & Crone, E. A. (2016). Neural correlates of prosocial peer influence on public goods game donations during adolescence. *Social Cognitive and Affective Neuroscience, 11*(6), 923–933.

Van Leijenhorst, L., Gunther Moor, B., Op de Macks, Z. A., Rombouts, S. A., Westenberg, P. M., & Crone, E. A. (2010). Adolescent risky decision–making: neurocognitive development of reward and control regions. *NeuroImage, 51*(1), 345–355.

Van Leijenhorst, L., Westenberg, P. M., & Crone, E. A. (2008). A developmental study of risky decisions on the cake gambling task: Age and gender analyses of probability estimation and reward evaluation. *Developmental Neuropsychology, 33*(2), 179–196.

Van Noordt, S. J. R., & Segalowitz, S. J. (2012). Performance monitoring and the medial prefrontal cortex: A review of individual differences and context effects as a window on self–regulation. *Frontiers in Human Neuroscience, 6*, 197.

Varnum, M. E., Shi, Z., Chen, A., Qiu, J., & Han, S. (2014). When "Your" reward is the same as "My" reward: Self–construal priming shifts neural responses to own vs. friends' rewards. *NeuroImage, 87*, 164–169.

Venkatraman, V., Payne, J. W., Bettman, J. R., Luce, M. F., & Huettel, S. A. (2009). Separate neural mechanisms underlie choices and strategic preferences in risky decision making. *Neuron, 62*(4), 593–602.

Volz, K. G., Schubotz, R. I., & von Cramon, D. Y. (2003). Predicting events of varying probability: Uncertainty investigated by fMRI. *Neuroimage, 19*(2), 271–280.

Volz, K. G., Schubotz, R. I., & von Cramon, D. Y. (2004). Why am I unsure? Internal and external attributions of uncertainty dissociated by fMRI. *Neuroimage, 21*(3), 848–857.

Von Gaudecker, H.–M., Van Soest, A., & Wengström, E. (2011). Heterogeneity in risky choice behavior in a broad population. *The American Economic Review, 101*(2), 664–694.

Wierenga, L. M., Bos, M. G. N., Schreuders, E., Vd Kamp, F., Peper, J. S., Tamnes, C. K., & Crone, E. A. (2018). Unraveling age, puberty and testosterone effects on subcortical brain development across adolescence. *Psychoneuroendocrinology, 91,* 105–114.

Wildeboer, A., Thijssen, S., Muetzel, R. L., Bakermans–Kranenburg, M. J., Tiemeier, H., White, T., & van, I. M. H. (2017). Neuroanatomical correlates of donating behavior in middle childhood. *Social Neuroscience*, *13*(5), 541–552.

Willoughby, T., Good, M., Adachi, P. J., Hamza, C., & Tavernier, R. (2013). Examining the link between adolescent brain development and risk taking from a social–developmental perspective. *Brain and Cognition, 83*(3), 315–323.

Wolf, L. K., Wright, N. D., Kilford, E. J., Dolan, R. J., & Blakemore, S.–J. (2013). Developmental changes in effects of risk and valence on adolescent decision–making. *Cognitive Development, 28*(3), 290–299.

Woo, C.–W., Krishnan, A., & Wager, T. D. (2014). Cluster–extent based thresholding in fMRI analyses: pitfalls and recommendations. *Neuroimage, 91*, 412–419.

Xue, G., Lu, Z., Levin, I. P., Weller, J. A., Li, X., & Bechara, A. (2009). Functional dissociations of risk and reward processing in the medial prefrontal cortex. *Cerebral Cortex, 19*(5), 1019–1027.

Yarkoni, T. (2009). Big correlations in little studies: Inflated fMRI correlations reflect low statistical power—Commentary on Vul et al.(2009). *Perspectives on Psychological Science, 4*(3), 294–298.

Yarkoni, T., Poldrack, R. A., Nichols, T. E., Van Essen, D. C., & Wager, T. D. (2011). Large–scale automated synthesis of human functional neuroimaging data. *Nature Methods, 8*(8), 665–670.

Yarkoni, T., Poldrack, R. A., Van Essen, D. C., & Wager, T. D. (2010). Cognitive neuroscience 2.0: Building a cumulative science of human brain function. *Trends in Cognitive Sciences, 14*(11), 489–496.

Addendum

List of Publications

Blankenstein, N. E., Telzer, E. H., Do, K. T., Van Duijvenvoorde, A. C. K., & Crone E. A. (revision under review, 2018). Behavioral and neural pathways supporting the development of prosocial and risk-taking behavior across adolescence.

Blankenstein, N. E. & Van Duijvenvoorde, A. C. K. (in revision, 2018). Neural tracking of subjective value under risk and ambiguity in adolescence.

Blankenstein N. E., Peper, J. S., & Crone, E. A. (under review, 2018). Cognitive control and decision-making across child and adolescent development. To appear in O. Houdé & G. Borst (Eds.),The Cambridge Handbook of Cognitive Development. Cambridge: Cambridge University Press.

Blankenstein, N. E., Schreuders, E., Peper, J. S.,Crone, E. A., & Van Duijvenvoorde, A. C. K. (2018). Individual differences in risk-taking tendencies modulate the neural processing of risky and ambiguous decision-making in adolescence. *NeuroImage, 172,* 663-673.

Bos, M. G., Wierenga, L. M., **Blankenstein, N. E.,** Schreuders, E., Tamnes, C. K., & Crone, E. A. (2018). Longitudinal structural brain development and externalizing behavior in adolescence. *Journal of Child Psychology and Psychiatry, 59*(10), 1061-1072.

Peper, J. S., Braams, B. R., **Blankenstein, N. E.**, Bos, M. G. N., & Crone, E. A. (2018). Development of multiple-faceted risk-taking and the relations to testosterone: A longitudinal study. *Child Development, 89*(5), 1887-1907.

Schreuders, E., Braams, B. R., **Blankenstein, N. E.,** Peper, J. S., Güroğlu, B., & Crone, E. A. (2018). Contributions of reward sensitivity to ventral striatum activity across adolescence and early adulthood. *Child Development, 89*(3), 797-810.

Blankenstein, N. E., Peper. J. S., Crone, E. A., & van Duijvenvoorde, A. C. K. (2017). Neural mechanisms underlying risk and ambiguity attitudes. *Journal of Cognitive Neuroscience, 29*(11), 1-15.

Van Duijvenvoorde, A. C. K., **Blankenstein, N. E.,** Crone, E. A., & Figner, B. (2017). Towards a better understanding of adolescent risk taking: Contextual moderators and model-based analysis. In M. E. Toplak & J. Weller (Eds.), *Individual differences in judgment and decision making: A developmental perspective* (8-27). New York: Psychology Press.

Blankenstein, N. E., Crone, E. A., Van den Bos, W., & van Duijvenvoorde, A. C. K. (2016). Dealing with uncertainty: Testing risk- and ambiguity-attitude across adolescence. *Developmental Neuropsychology, 1*(1-2), 77-92.

Addendum

Curriculum Vitae

Nelia (Neeltje) Eliza Blankenstein was born on February 2nd 1991 in Leiden, the Netherlands. After graduating secondary school (Stedelijk Gymnasium Leiden) in 2009, Neeltje obtained her Bachelor's degree in Psychology in 2012 from Utrecht University and her Research Master's degree in Cognitive Neuroscience (cum laude) in 2014 from Leiden University. During her studies she completed her research internship at the Brain and Development Research Center at Leiden University, where she gained experience with functional MRI. In 2014Neeltje started her PhD project at the Brain and Development Research Center under supervision of dr. Anna van Duijvenvoorde and prof. dr. Eveline Crone. Neeltje investigated the behavioral and neural mechanisms underlying risky decision-making in adolescents from a developmental neuroeconomic perspective. In 2018 Neeltje started working as a post-doctoral researcher at Leiden University (Clinical Neurodevelopmental Sciences at the Institute of Education and Child Studies) and the VU Medical Center (Child and Adolescent Psychiatry), to investigate the contribution of behavioral and neurobiological factors to the development of antisocial behavior in adolescence.