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Individual Differences in Face Recognition: A Decade of Discovery

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Abstract

Given the vital role face recognition plays in human social interaction, variations in this ability hold inherent interest and potential consequence. Yet the science of such differences has long lagged behind that of differences in other cognitive domains. In particular, although scattered case reports of catastrophic face-recognition deficits due to brain damage date back more than a century, for many decades, virtually no attention was paid to naturally occurring individual differences in face recognition. This past decade, in contrast, has seen a remarkable acceleration of research into these naturally occurring differences, spurred by the creation and validation of high-quality measures, open sharing of these measures, new options for remote testing, and a concerted move toward larger and more multivariate investigations. In this article, I recount six fundamental insights gained during the past decade about individual differences in face recognition—concerning their broad range, cognitive specificity, strong heritability, resilience to change, life-span trajectory, and practical relevance. Insights like these support a richer understanding of individual social experience and could enable more informed individual and institutional decision making.

Keywords

face recognition, individual differences, face processing, specificity, heritability

The human face—studied since ancient times by fine artists, philosophers, and writers—is a major focus of contemporary mind, brain, and computer sciences. Long overlooked, however, were individual differences in face processing, especially in face recognition (Wilmer, Germine, & Nakayama, 2014; Fig. 1). The aim of this focused review is to recount a string of key discoveries about individual differences in face recognition made during the last decade.

Face recognition is defined here as the ability to memorize the identity of several new faces, then accurately pick them out when they are interspersed among other faces. This procedure may be considered a proxy for a common everyday experience: encountering previously met individuals in a group context, such as at work or school or while walking down the street. This is not the only possible operational definition of face recognition. It is, however, the one employed by the most widely used test of face-recognition ability, the Cambridge Face Memory Test (Duchaine & Nakayama, 2006), and by several other high-quality tests of face recognition (e.g., Croydon, Pimperton, Ewing, Duchaine, & Pellicano, 2014; Dalrymple, Corrow, Yonas, & Duchaine, 2012; Herzmann, Danthiir, Schacht, Sommer, & Wilhelm, 2008; McKone et al., 2011; McKone et al., 2012; Wilhelm et al., 2010).

In past reviews, my colleagues and I have used individual differences in face recognition to elucidate broader scientific principles: (1) how individual differences can test cognitive theories (Wilmer, 2008; Yovel, Wilmer, & Duchaine, 2014), (2) how to isolate new dimensions of cognitive variation (Wilmer et al., 2012; Wilmer et al., 2014), (3) how to translate experimental research into an understanding of individual differences (DeGutis, Wilmer, Mercado, & Cohan, 2013),[1] and (4) how facilitation of individual self-discovery can fuel scientific progress (Germine et al., 2012; Wilmer et al., 2012). In contrast, the present work reviews insights gained about individual differences in face recognition per se.

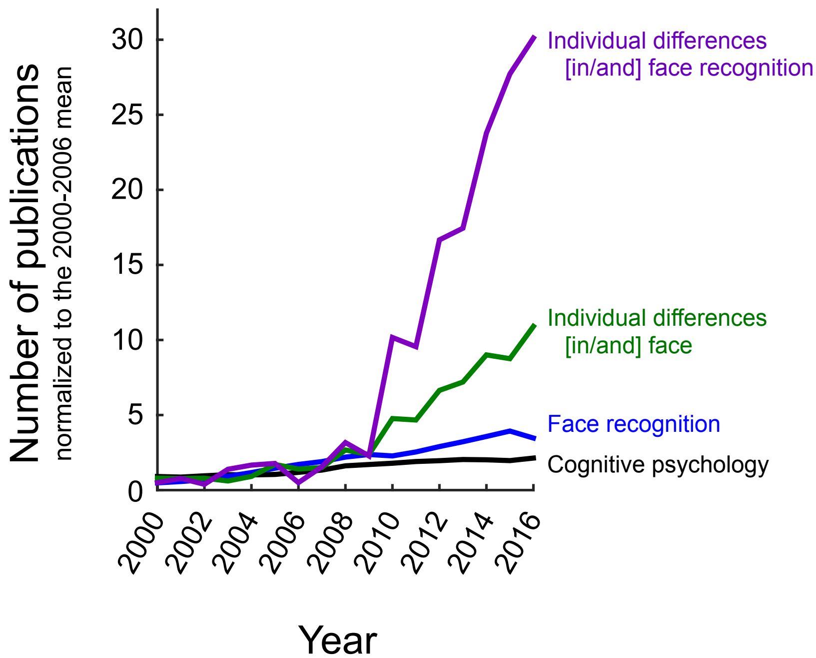

Figure 1. The recent acceleration of research on individual differences in face recognition. Each line represents averaged results for similar searches (producing similar results) in Google Scholar (full text search) and the Web of Science Core Collection (topic search). Units on the y-axis represent the number of publications divided by the mean value for 2000 through 2006 to enable direct comparisons between searches. Plotted searches were for the phrases shown to the right of the graph; searches in Google Scholar used the word “in,” and searches in Web of Science used the Boolean operator AND. The number of hits for these phrases in a 2016 Google Scholar search were 40 for “individual differences in face recognition,” 96 for “individual differences in face” (face processing, face identification, face perception, etc.), 19,700 for “face recognition,” and 25,200 for “cognitive psychology”; the number of hits for these phrases in a 2016 Web of Science search were 26 for “individual differences” AND “face recognition,” 164 for “individual differences” AND “face,” 1,784 for “face recognition,” and 200 for “cognitive psychology.”

Magnitude and and Stability

The most fundamental question about individual differences in any cognitive domain is whether they exist, and, if they do, how large and how stable they are. Theoretically, there are at least two reasons that the capacity to recognize faces might not differ between individuals. First, from a classic evolutionary perspective, if face-recognition ability were determined by a relatively small number of genes and good face recognition were strongly selected for, then genetic variation in face recognition might decrease over time (Plomin, DeFries, Knopik, & Neiderheiser, 2013). Second, it is difficult to think of cognitive skills that are more intensively demanded and trained by the environments of nearly all people throughout life than face recognition. If this environmental stimulation were to effectively produce ceiling-level performance in all individuals, then there might exist relatively little environmental variation in face recognition.

As studies have repeatedly shown, however, it is not at all difficult to find individuals who, in the absence of brain damage and despite normal visual experience, have spent their lives failing to recognize friends, relatives, and famous celebrities (Duchaine & Nakayama, 2006). Similarly, on the other end of the spectrum are those who routinely recognize the shallowest of acquaintances from years prior (Russell, Duchaine, & Nakayama, 2009). In between are temporally stable individual differences across the entire spectrum between these two extremes (Wilmer et al., 2010).

Cognitive Specificity

Once cognitive individual differences are shown to exist, a next logical question is whether they are reasonably specific to that cognitive domain or reflect more general cognitive functioning. Theories that speculate about the existence of many independent abilities are intuitively appealing, well cited, and influential (Wilmer et al., 2014). Most of what is known about cognitive individual differences, however, still revolves around the broadest of all cognitive abilities, often called IQ or g for general intelligence.

Recent studies have demonstrated that individual differences in face recognition are unusually specific, in the sense that they are mostly separate from IQ. Brief, standardized IQ tests have explained only 3% or less of the reliable variation[2] in face recognition (Gignac, Shankaralingam, Walker, & Kilpatrick, 2016; Richler, Wilmer, & Gauthier, in press; Shakeshaft & Plomin, 2015; Van Gulick, McGugin, & Gauthier, 2016; Wilmer et al., 2014). Moreover, a highly multivariate study that measured face recognition via three tests and IQ via 17 tests found that IQ explained only 4% of the reliable variation in face recognition (Wilhelm et al., 2010), and another multivariate investigation found that face recognition's specificity relative to IQ remained roughly constant across a wide range of ages (Hildebrandt, Wilhelm, Schmiedek, Herzmann, & Sommer, 2011). Even other recognition abilities have shown surprisingly limited associations with face recognition. For example, verbal and visual recognition respectively explained 4% and 11% to 21% of the reliable variation in face recognition (Dennett et al., 2012; Richler, Wilmer, & Gauthier, in press; Wilhelm et al., 2010; Wilmer et al., 2012; Wilmer et al., 2010).

In sum, tests of more general abilities—even memory-related abilities—do a surprisingly poor job of predicting an individual's face recognition ability. As an illustration of some of the many practical implications of these results, imagine that one were looking to hire an individual with exceptional face-recognition ability—say, for a job as a police detective, political lobbyist, or high-level executive. One should be nearly as likely to find such a person among those who have struggled academically as among those who have excelled.

High Heritability

Once cognitive individual differences are shown to exist and to be reasonably specific, a next question is what causes them. The relative degree to which genes versus (familial and nonfamilial) environmental factors cause cognitive variation can be estimated via studies of twins and families. A classic finding in such studies is that more genetically influenced abilities overlap more with IQ and less genetically influenced abilities overlap less with IQ (Plomin & Kovas, 2005).

Face recognition provides a clear exception to this classic finding by being both specific (low IQ-overlap), as discussed above, and strongly heritable (high genetic influence). Two independent studies of twins raised together have documented a strong genetic influence on face recognition. A study of older twins (age range = 18–65; mean age = 37.2) showed that between 76% and 97%[3] of the reliable variation in face-recognition ability was attributable to genetic influences (Wilmer et al., 2010). Surprisingly, though the heritability of cognitive abilities tends to increase with age (Plomin et al., 2013), face recognition was nearly as heritable in a much younger sample of twins (ages 19–20; Shakeshaft & Plomin, 2015). In the latter study, 68% to 87% of the reliable variation in face-recognition ability was attributable to genetic influences. In sum, face recognition provides rare evidence for a largely IQ-independent genetic influence on cognition.

If specific face-recognition-associated genetic variants could be identified, they might provide a window into biological mechanisms used to recognize faces. Some small studies have provided initial, mixed evidence for such genetic correlates (Hildebrandt, Kiy, Reuter, Sommer, & Wilhelm, 2016; Kiy, Wilhelm, Hildebrandt, Reuter, & Sommer, 2013; Skuse et al., 2014; Verhallen et al., 2016). In the future, large-scale genome-wide association studies could help to screen more broadly and powerfully for such genes.

Resilience to Change

Three lines of evidence suggest that face recognition is relatively resilient to both positive and negative change. The first line of evidence comes from the twin studies reviewed above (Shakeshaft & Plomin, 2015; Wilmer et al., 2010). These studies have attributed less than a third—and perhaps as little as one twenty-fifth—of natural variation in adult face-recognition ability to environmental influences, suggesting a relative lack of susceptibility to those environmental factors that varied in the studied populations. The second line of evidence comes from training studies. Such studies have found little to no evidence that face-recognition ability can be trained, even with intensive, weeks-long interventions, in individuals with either clinically poor or normal face recognition (DeGutis, Chiu, Grosso, & Cohan, 2014; Dolzycka, Herzmann, Sommer, & Wilhelm, 2014). Finally, a third line of evidence comes from “natural experiments” in which participants with exceptionally positive or negative experiences have been studied to see if their abilities differ from the norm. At the negative extreme, individuals who had weathered extreme childhood adversity (e.g., physical, psychological, or sexual abuse) showed no signs of reduced face recognition, despite reduced face expression recognition (Germine, Dunn, McLaughlin, & Smoller, 2015). At the positive extreme, portrait artists with thousands of hours of intensive training in perceiving and visually reproducing faces recognized faces with about the same level of accuracy as matched controls, despite clearly enhanced performance on perceptual tests and on a test of encoding and recognition of novel abstract art stimuli (Devue & Barsics, 2016; Tree, Horry, Riley, & Wilmer, 2017). Together, these three lines of evidence provide a remarkably consistent story of high resilience to both positive and negative change.

Clearly, resilience to negative change is desirable. Indeed, it may be worth considering whether face recognition has something to teach us about neurocognitive resilience in general. Yet what of face recognition’s resilience to positive change? Is that cause for despair? I would argue, instead, to take it as a call to action by, and on behalf of, those who struggle to recognize faces: a call to seek commonsense accommodations in schools, workplaces, and public institutions; to develop assistive technologies; to work on raising public awareness; and to treat training interventions with healthy skepticism until their benefits are clearly demonstrated to outweigh their costs.

Life-Span Trajectory

Research on cognition has traditionally focused on development and aging as two separate processes. Development is studied as the increases in performance observed over the first 10, or perhaps 20, years of life. Aging is studied as the decreases in performance observed from the 50s or 60s on. Absent from these two largely independent lines of research is a conception of what happens in the middle three to four decades of life.

Several recent studies have mapped out a life-span trajectory for face recognition whose detail and comprehensiveness is unusual among studies of cognitive development (Bowles et al., 2009; Germine, Duchaine, & Nakayama, 2011; Hildebrandt et al., 2011; Susilo, Germine, & Duchaine, 2013; Wilmer et al., 2012). These studies varied in what tests they used, how participants were recruited, whether participants were tested in person or remotely, and whether or not IQ and other cognitive abilities were controlled for—yet they all showed peak performance between 30 and 40 years of age. The largest of these studies, with over 60,000 participants, showed a rapid 1-SD increase from 10 to 20 years of age, a slower 0.25-SD increase from age 20 to age 32, a slow 0.30-SD decrease from age 32 to age 55, and then a faster 0.50-SD decrease from age 55 to age 70 (Germine et al., 2011).

Taken together, these studies suggest that face recognition does not fit straightforwardly into the traditional dichotomy between early-peaking fluid intelligence (with a peak around age 20 or earlier) and late-peaking crystallized intelligence (with a peak at or after age 50; Hartshorne & Germine, 2015). Rather, it represents a third class of cognitive functions that show an extended maturational process culminating in a midlife peak.

Practical Relevance

It is easy to imagine practical, everyday experiences that rely heavily on the ability to recognize faces. Yet can one find concrete evidence of links between objectively measured individual differences in face recognition and real-world phenomena? Several real-world correlates of face recognition have been identified to date. These include autism (Weigelt, Koldewyn, & Kanwisher, 2012), eyewitness identification (Andersen, Carlson, Carlson, & Gronlund, 2014), social anxiety (Davis et al., 2011), and empathy (Bate, Parris, Haslam, & Kay, 2010). In addition, a special London police unit whose members are selected for their exceptional face-recognition ability has reported increased success in identifying criminals picked up by London's network of public video cameras (Duchaine, 2015; Robertson et al., 2016). More fundamentally, objective tests predict self-reported everyday successes and failures in face recognition about four to eight times more powerfully (Bobak, Pampoulov, & Bate, 2016; Verhallen et al., 2017; Wilmer et al., 2010) than is the case for other domains of recognition memory (Zell & Krizan, 2014). Although there clearly remain many more questions about the nature of links between face recognition and everyday life (e.g., concerning their detailed causal mechanisms), the links found so far suggest a promising domain of inquiry.

Future Directions

As highlighted above, research over the past decade has yielded key insights about individual differences in face recognition, including their broad range, cognitive specificity, strong heritability, resilience to change, life-span trajectory, and practical relevance.

Despite these advances, there remains a great deal of important work to be done. Just a few of the mysteries that remain to be solved are:

- What other aspects of life—in arenas such as work, school, social life, and the public sphere—are impacted by individual differences in face recognition?
- To what degree can the negative consequences of poor face recognition ultimately be ameliorated via clever workaround strategies, evolving technology, and reasonable school or workplace accommodations?
- To what degree can the lessons learned from face recognition be applied to discover other cognitively and/or genetically specific abilities?
- In what ways do individual differences in other aspects of face processing—for example, the perception of expression, trustworthiness, and attractiveness—relate to or dissociate from individual differences in face recognition?
- From which particular cognitive subprocesses, brain substrates, and/or genetic mechanisms do individual differences in face recognition arise?

Recommended Reading

Germine, L. T., Duchaine, B., & Nakayama, K. (2011). (See References). A 60,000-participant study of the life-span trajectory of face recognition.

Wilhelm, O., Herzmann, G., Kunina, O., Danthiir, V., Schacht, A., & Sommer, W. (2010). (See References). A highly multivariate, statistically sophisticated exploration of face recognition's cognitive specificity.

Wilmer, J. B., Germine, L., Chabris, C. F., Chatterjee, G., Gerbasi, M., & Nakayama, K. (2012). (See References). A methodological tutorial that uses a detailed investigation of individual differences in face recognition to illustrate how to isolate cognitively specific abilities and includes a 1,471-participant normative data set for the Cambridge Face Memory Test, the most widely used measure of individual differences in face recognition.

Wilmer, J. B., Germine, L., Chabris, C. F., Chatterjee, G., Williams, M., Loken, E., . . . Duchaine, B. (2010). (See References). The original report of face recognition's heritability and an early, large-sample treatment of its cognitive specificity.

Wilmer, J. B., Germine, L. T., & Nakayama, K. (2014). (See References). A brief, whirlwind history of attempts to measure individual differences in face-recognition ability, including two revealing false starts, nearly 70 years apart, starting in the year 1928.

Yovel, G., Wilmer, J. B., & Duchaine, B. (2014). (See References). A review of efforts to use individual differences in face recognition and face perception to test a variety of cognitive theories.

Notes

1. Consistent with our prior statistical recommendations (DeGutis et al., 2013), the present review excludes studies that have taken the statistically incorrect analytic step of computing an individual person's performance as the numerical difference between his or her performance in an experimental (e.g., face recognition) condition versus a control (e.g., non-face recognition) condition. Such difference scores are a misapplication of experimental reasoning to individual-differences data and should be replaced by standard regression-based methods (DeGutis et al., 2013).

2. The term "reliable variation" refers to the proportion of reliable variance. In a correlational study, this value can be computed by dividing the squared correlation by the product of the reliabilities of the two measures being correlated (Wilmer et al., 2012); in a twin study, this value can be computed by dividing an estimate of shared genetic or shared environmental influence by the reliability of the measure (Plomin, DeFries, Knopik, & Neiderheiser, 2013; Wilmer et al., 2010).

3. The range of values depends on the particular method used for separating reliable signals from measurement noise: internal reliability, alternate-forms reliability, or test-retest reliability.

References

Andersen, S. M., Carlson, C. A., Carlson, M. A., & Gronlund, S. D. (2014). Individual differences predict eyewitness identification performance. *Personality and Individual Differences, 60*, 36–40.

Bate, S., Parris, B., Haslam, C., & Kay, J. (2010). Socio-emotional functioning and face recognition ability in the normal population. *Personality and Individual Differences, 48*, 239–242.

Bobak, A. K., Pampoulov, P., & Bate, S. (2016). Detecting superior face recognition skills in a large sample of young British adults. *Frontiers in Psychology, 7*, Article 1378. doi:10.3389/fpsyg.2016.01378

Bowles, D. C., McKone, E., Dawel, A., Duchaine, B., Palermo, R., Schmalzl, L., . . . Yovel, G. (2009). Diagnosing prosopagnosia: Effects of ageing, sex, and participant–stimulus ethnic match on the Cambridge Face Memory Test and Cambridge Face Perception Test. *Cognitive Neuropsychology, 26*, 423–455.

Croydon, A., Pimperton, H., Ewing, L., Duchaine, B. C., & Pellicano, E. (2014). The Cambridge Face Memory Test for Children (CFMT-C): A new tool for measuring face recognition skills in childhood. *Neuropsychologia*, 62, 60-67.

Dalrymple, K. A., Corrow, S., Yonas, A., & Duchaine, B. (2012). Developmental prosopagnosia in childhood. *Cognitive Neuropsychology, 29*, 393–418.

Davis, J. M., McKone, E., Dennett, H., O'Connor, K. B., O'Kearney, R., & Palermo, R. (2011). Individual differences in the ability to recognise facial identity are associated with social anxiety. *PLoS ONE, 6*(12), e28800. doi:10.1371/journal.pone.0028800

DeGutis, J., Wilmer, J., Mercado, R. J., & Cohan, S. (2013). Using regression to measure holistic face processing reveals a strong link with face recognition ability. *Cognition, 126*, 87–100.

DeGutis, J. M., Chiu, C., Grosso, M. E., & Cohan, S. (2014). Face processing improvements in prosopagnosia: Successes and failures over the last 50 years. *Frontiers in Human Neuroscience, 8*, Article 561. doi:10.3389/fnhum.2014.00561

Dennett, H. W., McKone, E., Tavashmi, R., Hall, A., Pidcock, M., Edwards, M., & Duchaine, B. (2012). The Cambridge Car Memory Test: A task matched in format to the Cambridge Face Memory Test, with norms, reliability, sex differences, dissociations from face memory, and expertise effects. *Behavior Research Methods, 44*, 587–605.

Devue, C., & Barsics, C. (2016). Outlining face processing skills of portrait artists: Perceptual experience with faces predicts performance. *Vision Research, 127*, 92–103.

Dolzycka, D., Herzmann, G., Sommer, W., & Wilhelm, O. (2014). Can training enhance face cognition abilities in middle-aged adults? *PLoS ONE, 9*(3), e90249. doi:10.1371/journal.pone.0090249

Duchaine, B. (2015, June). Individual differences in face recognition ability: Impacts on law enforcement, criminal justice and national security. *Psychological Science Agenda*. Retrieved from http://www.apa.org/science/about/psa/2015/06/face-recognition.aspx

Duchaine, B., & Nakayama, K. (2006). The Cambridge Face Memory Test: Results for neurologically intact individuals and an investigation of its validity using inverted face stimuli and prosopagnosic participants. *Neuropsychologia, 44*, 576–585.

Germine, L. T., Duchaine, B., & Nakayama, K. (2011). Where cognitive development and aging meet: Face learning ability peaks after age 30. *Cognition, 118*, 201–210.

Germine, L., Dunn, E. C., McLaughlin, K. A., & Smoller, J. W. (2015). Childhood adversity is associated with adult theory of mind and social affiliation, but not face processing. *PLoS ONE, 10*(6), e0129612. doi: 10.1371/journal.pone.0129612

Germine, L., Nakayama, K., Duchaine, B. C., Chabris, C. F., Chatterjee, G., & Wilmer, J. B. (2012). Is the Web as good as the lab? Comparable performance from Web and lab in cognitive/perceptual experiments. *Psychonomic Bulletin & Review, 19*, 847–857.

Gignac, G. E., Shankaralingam, M., Walker, K., & Kilpatrick, P. (2016). Short-term memory for faces relates to general intelligence moderately. *Intelligence, 57*, 96–104.

Hartshorne, J. K., & Germine, L. T. (2015). When does cognitive functioning peak? The asynchronous rise and fall of different cognitive abilities across the life span. *Psychological Science, 26*, 433–443.

Herzmann, G., Danthiir, V., Schacht, A., Sommer, W., & Wilhelm, O. (2008). Toward a comprehensive test battery for face cognition: Assessment of the tasks. *Behavior Research Methods, 40*, 840–857.

Hildebrandt, A., Kiy, A., Reuter, M., Sommer, W., & Wilhelm, O. (2016). Face and emotion expression processing and the serotonin transporter polymorphism 5−HTTLPR/rs22531. *Genes, Brain and Behavior, 15*, 453–464.

Hildebrandt, A., Wilhelm, O., Schmiedek, F., Herzmann, G., & Sommer, W. (2011). On the specificity of face cognition compared with general cognitive functioning across adult age. *Psychology and Aging, 26*, 701–715.

Kiy, A., Wilhelm, O., Hildebrandt, A., Reuter, M., & Sommer, W. (2013). On the genetic basis of face cognition and its relation to fluid cognitive abilities. *Genes, Brain and Behavior, 12*, 438–445.

McKone, E., Hall, A., Pidcock, M., Palermo, R., Wilkinson, R. B., Rivolta, D., . . . O'Connor, K. B. (2011). Face ethnicity and measurement reliability affect face recognition performance in developmental prosopagnosia: Evidence from the Cambridge Face Memory Test–Australian. *Cognitive Neuropsychology, 28*, 109–146.

McKone, E., Stokes, S., Liu, J., Cohan, S., Fiorentini, C., Pidcock, M., . . . Pelleg, M. (2012). A robust method of measuring other-race and other-ethnicity effects: The Cambridge Face Memory Test format. *PLoS ONE, 7*(10), e47956. doi:10.1371/journal.pone.0047956

Plomin, R., DeFries, J. C., Knopik, V. S., & Neiderheiser, J. (2013). *Behavioral genetics* (6th ed.). New York, NY: Worth Publishers.

Plomin, R., & Kovas, Y. (2005). Generalist genes and learning disabilities. *Psychological Bulletin, 131*, 592–617.

Richler, J. J., Wilmer, J. B., & Gauthier, I. (in press). General object recognition is specific: Evidence from novel and familiar objects. *Cognition*.

Robertson, D. J., Noyes, E., Dowsett, A. J., Jenkins, R., & Burton, A. M. (2016). Face recognition by Metropolitan Police super-recognisers. *PLoS ONE, 11*(2), e0150036. doi:10.1371/journal.pone.0150036

Russell, R., Duchaine, B., & Nakayama, K. (2009). Super-recognizers: People with extraordinary face recognition ability. *Psychonomic Bulletin & Review, 16*, 252–257.

Shakeshaft, N. G., & Plomin, R. (2015). Genetic specificity of face recognition. *Proceedings of the National Academy of Sciences, USA, 112*, 12887–12892.

Skuse, D. H., Lori, A., Cubells, J. F., Lee, I., Conneely, K. N., Puura, K., . . . Young, L. J. (2014). Common polymorphism in the oxytocin receptor gene (OXTR) is associated with human social recognition skills. *Proceedings of the National Academy of Sciences, USA, 111*, 1987–1992.

Susilo, T., Germine, L., & Duchaine, B. (2013). Face recognition ability matures late: Evidence from individual differences in young adults. *Journal of Experimental Psychology: Human Perception and Performance, 39*, 1212–1217.

Tree, J. J., Horry, R., Riley, H., & Wilmer, J. B. (2017). Are portrait artists superior face recognizers? Limited impact of adult experience on face recognition ability. *Journal of Experimental Psychology: Human Perception and Performance, 43*, 667–676.

Van Gulick, A. E., McGugin, R. W., & Gauthier, I. (2016). Measuring nonvisual knowledge about object categories: The Semantic Vanderbilt Expertise Test. *Behavior Research Methods, 48*, 1178–1196.

Verhallen, R. J., Bosten, J. M., Goodbourn, P. T., Lawrance-Owen, A. J., Bargary, G., & Mollon, J. D. (2016). The oxytocin receptor gene (OXTR) and face recognition. *Psychological Science, 28*, 47–55.

Verhallen, R. J., Bosten, J. M., Goodbourn, P. T., Lawrance-Owen, A. J., Bargary, G., & Mollon, J. D. (2017). General and specific factors in the processing of faces. *Vision Research*. Advance online publication.

Weigelt, S., Koldewyn, K., & Kanwisher, N. (2012). Face identity recognition in autism spectrum disorders: A review of behavioral studies. *Neuroscience & Biobehavioral Reviews, 36*, 1060–1084.

Wilhelm, O., Herzmann, G., Kunina, O., Danthiir, V., Schacht, A., & Sommer, W. (2010). Individual differences in perceiving and recognizing faces—One element of social cognition. *Journal of Personality and Social Psychology, 99*, 530–548.

Wilmer, J. B. (2008). How to use individual differences to isolate functional organization, biology, and utility of visual functions; with illustrative proposals for stereopsis. *Spatial vision*, 21(6), 561-579.

Wilmer, J. B., Germine, L., Chabris, C. F., Chatterjee, G., Gerbasi, M., & Nakayama, K. (2012). Capturing specific abilities as a window into human individuality: The example of face recognition. *Cognitive Neuropsychology, 29*, 360–392.

Wilmer, J. B., Germine, L., Chabris, C. F., Chatterjee, G., Williams, M., Loken, E., & Duchaine, B. (2010). Human face recognition ability is specific and highly heritable. *Proceedings of the National Academy of Sciences, USA, 107*, 5238–5241.

Wilmer, J. B., Germine, L. T., & Nakayama, K. (2014). Face recognition: A model specific ability. *Frontiers in Human Neuroscience, 8* Article 769. doi:10.3389/fnhum.2014.00769

Yovel, G., Wilmer, J. B., & Duchaine, B. (2014). What can individual differences reveal about face processing? *Frontiers in Human Neuroscience, 8*, Article 562. doi: 10.3389/fnhum.2014.00562

Zell, E., & Krizan, Z. (2014). Do people have insight into their abilities? A metasynthesis. *Perspectives on Psychological Science, 9*, 111–125.