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What are superior face identity recognizers (SFIR) made of?

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ABSTRACT

In her *Viewpoint* paper, Meike Ramon proposes a stringent operational definition to identify people who excel at face identity recognition, i.e., super face identity recognizers (SFIR). Based on difficulties at defining cases of prosopagnosia and prosopdysgnosia, I suggest adding exclusion criteria and emphasizing domain-specificity of SFIR's performance. In future work to characterize this special population, implicit electrophysiological measures obtained during fast periodic visual stimulation may be particularly valuable, providing valid, objective, sensitive, and reliable indexes of face identity recognition.

Face identity recognition (FIR) occurs when a specific response is produced to an individual based on his/her face. Human FIR is challenging for three reasons. First, while morphological diversity among individual faces is certainly higher in humans than in other animal species (Sheehan and Nachman, 2014), all human faces, in particular within a genetically homogenous group, share similar features and their overall configuration. Therefore, fine-grained visual discrimination is required to provide a specific response to each individual face. Second, a person's face changes substantially with viewing conditions (Burton et al., 2016), making generalization of a specific response across various instances of the same identity arduous. Third, in modern human societies, numerous facial identities are encountered (in real life or the media) and this number changes over time. These factors explain why artificial algorithms still struggle to come near human FIR performance, especially under different viewing conditions (Adjabi et al., 2020).

Despite this challenge, in humans, identity recognition is primarily based on the face, which, among body parts, carries the largest morphological and genetic diversity (Sheehan and Nachman, 2014). Young adults identify thousands of faces (Jenkins et al., 2018) rapidly (Hsiao et al., 2008) and automatically (i.e., not under volitional control). Thanks to these characteristics, and unlike other animal species including macaque monkeys (Rossion and Taubert, 2019), neurotypical human adults can be defined as FIR experts.

Yet, there is a wide range of variability in human adults' FIR ability. People with lifelong difficulties at FIR in the absence of neurological history – technically prosopdysgnosia (Rossion, 2018a) have become widely studied under the label "developmental prosopagnosia" (DP) in human face recognition research for two decades (Barton and Corrow, 2016). How about people are the other end of the spectrum, i.e., who seemingly excel at FIR? In French, they are usually defined as "physionomistes", which does not translate (well) in English. Instead, these people have been only recently defined as "super recognizers" (SR), a terminology adopted by Meike Ramon in her *Viewpoint* paper (Ramon, 2021).

In this *Viewpoint* paper, the author is correct to point that, despite a growing interest in this SR population for both fundamental research and societal issues, there is no formal definition of the condition. Her proposal in this regard is welcome and highly valuable, helping moving the field forward. However, rather than a formal definition, what she proposes on top of well-taken recommendations and guidelines is an *operational* definition (i.e., top 5% performance at two out of three behavioral FIR tests) in line with similar proposals for prosopdysgnosia (Barton and Corrow, 2016). Since performance at such tests depends on different factors, a multi-test operational definition makes sense. However, standard behavioral FIR tests have been developed for long (Benton and Van Allen, 1968), many are currently available (see the list and citations in the *Viewpoint* paper of Meike Ramon) and, despite more than 50 years of research on this issue, the field does not agree about which FIR test is the "best" (although I agree with Meike Ramon about the limitations of mass online tests). Moreover, beyond accuracy measures or derivatives (e.g., sensitivity in signal detection theory), an evaluation of FIR processing *speed* is often lacking: should someone taking an abnormally high amount of time to reach a top 5% score at a FIR test truly be considered as a SR?

There is no doubt that the field of human face recognition requires such operational definitions and methodological criteria to progress. However, a condition or a category based only on a quantitative threshold is problematic. Consider *prosopagnosia*, originally considered as an extremely rare neurological condition in which the patient suddenly lost identity recognition *only* for faces (Bodamer, 1947). Nowadays, unfortunately, virtually anyone who is not good at FIR, sometimes even only subjectively, tends to be defined as having prosopagnosia. This leads to circularity (i.e., 2.5% of the population would supposedly have developmental prosopagnosia; note that this proportion would be higher for SR with the above criterion of a top 5% score at two FIR tests, unless the measures are totally uncorrelated) and loss of meaning of the condition (Barton and Corrow, 2016; Rossion, 2018a).

Regarding the original condition of prosopagnosia, additional criteria beyond the objective FIR impairment can be proposed: an identifiable neurological cause, a recognition disorder specific to faces, no neurological history prior to the accident, a sudden onset, a massive impairment in terms of familiar FIR, with both anterograde and retrograde recognition impairments (Rossion, 2018b). Moreover, *exclusion* criteria, e.g., no visual object recognition impairment (to exclude cases

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of visual object agnosia) and no abnormal recognition of people's identity by other means (names, voices, …) (to exclude generic person recognition disorders; Gainotti, 2010) are required. Such stringent criteria, making cases of prosopagnosia rare (again), are fundamental to understand the nature of their impairment and what makes human adults unique in terms of FIR ability. In the same vein, for SR, *specificity* of superior performance for faces should also be key (perhaps calling for revising the terminology in "superior *face identity* recognizers", SFIR) and lead to measures of exclusion (e.g., no performance in the top 5% for recognizing nonface stimuli).

Finally, returning to operational issues, there are fundamental limitations of explicit behavioral tests of FIR, especially challenging ones as recommended by Meike Ramon to identify SFIR. For a start, performance at these tests reflect many generic sensory, cognitive and motor processes beyond FIR *per se*. Moreover, they cannot be straightforwardly applied to evaluate performance of all populations, e.g., infants (i.e., how would you detect a very young SFIR?), some clinical populations, or other animal species. This is where *implicit* measures of FIR obtained during fast periodic visual stimulation may be particularly valuable, providing valid, objective, sensitive, and reliable quantifiable measures of this function in the frequency-domain of an electroencephalogram (EEG) in a few minutes of testing (e.g., Towler et al., 2020; Yan and Rossion, 2020). Whether cases of SFIR would show distinct patterns of responses in such FPVS-EEG paradigms (e.g., larger specific response amplitudes or face inversion effects) is an outstanding question for future research, which will help not only at identifying SFIR but at understanding what they are truly made of.

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