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The Emergence of Perceptual Expertise with Fingerprints Over Time

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Can early individual differences in performance predict later expertise in the applied domain of fingerprint identification? We tracked 24 new trainees over the course of a year as they accumulated experience working in a fingerprint unit. We tested their performance every three months on four measures of fingerprint expertise. Trainees significantly improved on all four measures, with the majority of learning occurring within the first three months. When we indexed trainees' performance, by averaging across their percent correct scores on all four measures of expertise, we found early indexed performance was significantly and positively related to their indexed performance three, six, nine, and 12 months later. These findings provide a rich example of how perceptual expertise can emerge within an applied domain, and evidence that early individual differences on a composite measure of performance can be diagnostic of later expertise.

General Audience Summary

How does expertise develop in radiology, face recognition or fingerprint identification? Surprisingly few studies have examined the development of expertise over a long period of time. We also know little about whether some people are more cut out for these applied domains. We addressed this gap in the context of fingerprint identification, by examining the performance of trainee examiners over their first 12 months of working in a fingerprint unit. We tested trainee examiners on four established measures of fingerprint expertise every three months in their workplace, and indexed their performance on each occasion by averaging across their percent correct scores. We found that trainees' accuracy on the fingerprint index (and on each measure separately) improved considerably with just three months experience, but learning plateaued after this time. Trainees' early scores on the fingerprint index were also a reliable predictor of their indexed performance three, six, nine, and 12 months later—meaning that the top performers tended to remain at the top. These findings have implications for theories of perceptual expertise because they provide compelling evidence that both experience and prior individual differences can be diagnostic of performance in an applied perceptual domain. Within the context of fingerprint identification, these findings demonstrate that training and experience in the domain—a benchmark often used to make decisions about the admissibility of expert evidence in legal proceedings—contributes to the development of fingerprint expertise. The development of evidence-based training methods and selection tools could be useful avenues for more efficiently cultivating expert examiners.

Keywords: Perceptual expertise, Individual differences, Forensic science, Expertise acquisition, Work-based learning

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People vary in their ability to recognise perceptual categories. Developmental prosopagnosics perform significantly below average at recognising faces (Kress & Daum, 2003) and others—termed *super recognisers*—perform significantly above average across face memory and face matching tasks (Bobak, Hancock, & Bate, 2015; Russell, Duchaine, & Nakayama, 2009). Other examples of expert-novice differences in perceptual domains abound (Tarr & Cheng, 2003). The prevailing view in cognitive psychology is that variation in performance is largely a result of variation in the amount of deliberate practice an individual engages in (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005; Ericsson, 2007, 2014; Ericsson, Krampe, & Tesch-Römer, 1993). Indeed, in perceptual domains experience with identifying and discriminating bird species (Tanaka, Curran, & Sheinberg, 2005), other-race faces (Bukach, Cottle, Ubiwa, & Miller, 2012), shapes (Garrigan & Kellman, 2008), and fictitious beasts (Gauthier & Tarr, 1997; Wong, Palmeri, & Gauthier, 2009), has been shown to facilitate learning and the development of expertise. While deliberate practice is undoubtedly important, commentators have called for research examining whether effects of expertise observed across a wide range of domains could also be underpinned by prior individual differences (e.g., Macnamara, Hambrick, & Oswald, 2014). We test this hypothesis in the perceptual domain of fingerprint identification, by examining whether prior individual differences in performance on a composite measure of fingerprint expertise can predict performance on that same measure over a 12-month period of working in a fingerprint unit.

Dissecting Existing Expertise

A common approach to assessing individual differences in perceptual expertise has been to retrospectively examine the relationship between domain-specific measures of performance and measures of more general abilities, such as IQ and visual memory. Other studies have made use of retrospective twin designs to determine whether there is a genetic component to expertise. In face recognition, there is evidence of a higher correlation between identical twins compared to fraternal twins in their ability to recognise faces (Wilmer et al., 2010), but no correlation between face recognition ability and general intelligence (IQ), or general visual memory (Davis et al., 2011). Further afield, others have reported a genetic component to reading skill using a retrospective twin design (Plomin, Shakeshaft, McMillan, & Trzaskowski, 2014), and a significant relationship between several measures of general cognitive ability (e.g., IQ and visual memory) and chess skill among children (Bilalić, McLeod, & Gobet, 2007; Horgan & Morgan, 1990), and adults (Grabner, Stern, & Neubauer, 2007; but for conflicting results, see Waters, Gobet, & Leyden, 2002). While these findings offer insights about a possible source of variation among individuals, it is impossible to tease apart the relative contribution of experience using retrospective methods. With twins, for instance, fraternal pairs may vary more than identical pairs in their sets of experiences, resulting in more varied performance.

Predicting Future Expertise

A second approach to assessing individual differences in expertise is to predict future achievement based on current performance. One particular domain that has an established literature on predicting future achievement is medicine. Admission to postgraduate medical science programmes is highly competitive, the candidates are all highly qualified, and attrition rates are typically very low (Eva, Rosenfeld, Reiter, & Norman, 2004; Salvatori, 2001). The traditional personal interview approach to selecting candidates is also prone to context specificity effects (Eva et al., 2004). To overcome some of these issues, medical education researchers developed the *multiple mini-interview*, a selection tool that involves averaging across scores from multiple samples of short, structured interviews with candidates (Eva et al., 2004). Increasing the number of interviews (and interviewers) dilutes the chances of candidates being selected on the basis of compatibility with a particular interview panel, or a once off favourable performance on the day. We borrow aspects of this multiple samples method in our current study. Predicting future behaviour, however, also has limits. There is no way to assess the future performance of selected candidates relative to the future performance of rejected candidates *had* they been selected (Schmidt & Hunter, 1998). Because the range of people to test down the track is restricted, it can be difficult to know whether a selection tool actually discriminates top future performers from the rest.

Tracking the Emergence of Expertise Over Time

A third approach to testing whether individual differences underlie perceptual expertise, is to collect longitudinal data. However, there are surprisingly few longitudinal studies mapping the development of expertise over time in applied domains. Prior work integrating dual-process and individual differences theories suggests that early individual differences among naïve performers remain stable over a period of learning (in a single session) when the task demands vary (e.g., randomly intermixing targets and distractors on a verbal category search task), but they diminish when the task demands remain consistent (e.g., colour naming, symbol sorting; see Ackerman, 1987). Tasks with *inconsistent* components are thought to imply the use of more controlled or effortful processes, whereas tasks with *consistent* components are thought to become more automated with experience. From this perspective, individual differences in general ability may be equated with differences in cognitive capacity or amount of attentional resources, and the transition from controlled to more automatic processing with expertise is synonymous with becoming less sensitive to general resource limitations (Ackerman, 1987). While this work is based on relatively artificial cognitive tasks, it offers a theoretical framework for assessing individual differences in perceptual expertise. Early individual differences in learners' ability to classify and discriminate objects or categories might remain stable for tasks that are inconsistent, novel, or that allow controlled, effortful, analytic processing, but not for tasks that come to rely on fast, intuitive, non-analytic processing with experience.

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