Applying an individual-differences lens to understanding human cognition

Editorial by Stephanie C. Goodhew to Special Issue on Individual Differences in *Consciousness and Cognition*

The study of human cognition has traditionally sought to identify contextual factors that affect how humans perceive, attend to, think or reason about, or remember information from the world around them. Typically, such factors are varied experimentally in laboratory studies. For example, it is well documented that humans fail to notice important visual information in their environment, a phenomenon known as inattentional blindness (IB). Experimental studies have sought to identify the contextual factors that render individuals most susceptible to IB, by comparing IB rates in one experimental condition versus another. This is typical of the traditional approach to the scientific study of cognition in both cognitive psychology and cognitive neuroscience, which has relied upon theories and frameworks for analysing data that focus on levels of performance *averaged across individuals*. As a consequence, variation that is unique to particular individuals or groups is treated as nuisance variance. While this approach has important utility and much knowledge has been gained from it, it can obscure other important aspects of the phenomenon. For instance, even given the identical physical information, some individuals experience IB whereas others do not. Why? Can this variance be meaningfully explained by individual or group factors? These are the sorts of questions that are beginning to be addressed more commonly in the science of cognition, and this is why this Special Issue is a timely contribution.

The purpose of this Special Issue is to put the spotlight on individual-differences approaches to understanding cognitive processes. In cognitive psychology, understanding individual differences most commonly entails synthesising traditional experimental approaches with individual-difference variables. This means that some variable(s) are experimentally manipulated, and the consequences for task performance are quantified, and others are measured (typically via self-report), and then the association between or among these different types of variables is assessed. Alternatively, individual differences in performance across different experimental conditions has also been used to provide important insight into cognitive processes. Different studies in this issue have adopted both of these approaches. While many Special Issues are united by a focus on a single cognitive process, this Special Issue is distinct in that the unifying theme is the lens of considering whether and how individuals differ in meaningful ways with respect to how cognitive processes manifest or operate, and how they respond to different contexts that experimenters introduce. This approach will be triangulated by researchers from a number of distinct areas, including visual attention, perception, and memory, employing both behavioural and neuroscientific methods. We are very fortunate to have contributions from leading researchers in these areas, including those who have made seminal contributions to the field's understanding of theoretical and methodological issues to such approaches. In the following section, I will give an overview of the papers that constitute this Special Issue on Individual Differences. This Special Issue includes two review papers, which aim to synthesise literature and make recommendations for future individual-differences research. As these provide a conceptual overview that is relevant to the subsequent empirical papers, I will discuss these first.

When researchers seek to answer individual-difference type questions about cognitive psychological processes, the research design typically entails adapting an experimental paradigm that has been used such that performance from all of the individuals in a given experimental condition are aggregated. For instance, the attentional blink paradigm was first used as a demonstration of an attentional limitation that groups of participants experienced, seemingly with the implicit assumption that most or all individuals would experience this to similar extents (Raymond, Shapiro, & Arnell, 1992). However, more recent research has revealed that individuals reliably differ in the magnitude of their attentional blink, such that some individuals are considered "non-blinkers" who do not experience the effect at all (Enns, Kealong, Tichon, & Visser, 2017; Martens & Wyble, 2010). Moreover, the extent to which individuals experience the blink, that is, the magnitude of their attentional blink, is related to other attentional tendencies (Dale & Arnell, 2015), and even personality variables (Maclean & Arnell, 2010). In their review that opens this Special Issue, Goodhew and Edwards (2019) discuss a number of key conceptual and methodological issues that need to be considered as researchers' thinking and experimental techniques make this transition from experimental condition-level analyses to individual-difference level analyses.

In particular, Goodhew and Edwards (2019) explain how adapting experimental procedures into the sphere of individual-differences challenges many long-held assumptions, ways of thinking, and routine practices of traditional group-level research. For example, it is discussed how counterbalancing experimental tasks can actually be counterproductive to the goals of individual-differences research. Goodhew and Edwards (2019) also seek to raise awareness about important practices, which, while routine in questionnaire-based individual-differences research, are rarely considered in experimental-inspired individual-differences research, and that experimentalists need to adopt. For instance, the maximum observable correlation between any two variables is constrained by *reliability* of the two measures contributing to the correlation. This is why in questionnaire research the reliability of measures is routinely reported, and explicitly considered in measure selection and study interpretation. Reliability is an equally important consideration when assessing the correlation between a questionnaire and experimental measure, or between two experimental measures, but it is not (yet) common practice to report the reliability of experimental measures. Goodhew and Edwards (2019) raise this important issue, and advise researchers to adopt this practice. Furthermore, in their review, Goodhew and Edwards discuss issues and propose practical solutions for research on important issues such as distinguishing stable individual-differences in generic task performance from process-specific performance, using between-participation variation to select measures or versions of measures that are best-suited to the goals of individual-differences research, and alternative performance metrics (e.g., variance rather than mean) and what they can meaningfully tell us about human cognition and neuroscience. To summarise, Goodhew and Edwards (2019) should be consulted as a *user's guide* for researchers.

In the next review in the Special Issue, Tulver (2019) tackles the important issue of the *factor structure* of individual-differences in visual processing. That is, if we consider psychological processes for which there is a well-developed literature on individual differences, such as cognitive abilities or personality, these literatures have the benefit of well-validated factor structures, such as the evidence for 'g' factor underling cognitive abilities. Tulver (2019) discusses the contributions and pitfalls of the search for an analogous 'v' factor that correlates with most measures of visual ability. Evidence for such a factor has proved elusive. That is, there has not been strong support for models of visual processing which propose a single underlying factor. Instead, there has been stronger evidence for more domain-specific factors of visual perception. For instance, there appears to be robust correlations among some different measures of face processing and recognition (Verhallen et al., 2017). However, as discussed by Tulver (2019), not all such approaches have met with success. Tulver considers why: is it because these latent factors are truly not there? Is it instead because the constructs that are theorised to be factors are poorly defined? Alternatively, is it because of issues with the reliability of experimental measures, as considered in Goodhew and Edwards (2019)? Finally, Tulver weighs the strengths and limitations of different analytic approaches, which need to be considered in future research. Most importantly, Tulver's (2019) contribution in the Special Issue highlights that beyond looking for correlations between individual measures, this area of research can and should be guided by and in turn influence the development of theoretical models about the underlying architecture of visual processing.

In the following sections, I describe some of the key contributions from the empirical papers in this Special Issue. Given that the synthesising theme is the focus on individual differences, rather than a particular research topic, this will require me introducing a number of distinct psychological processes. Several of the empirical papers in the Special Issue examine individual differences in higher-level cognitive processes, including for complex tasks and decisions. One of these contributions is from Hedge and colleagues (Hedge, Vivian-Griffiths, Powell, Bompas, & Sumner, 2019). Readers may be familiar with the recent ground-breaking and influential paper in which Hedge and colleagues demonstrated the fundamental tension between mean group-level analysis versus correlational design research (Hedge, Powell, & Sumner, 2018). That is, Hedge et al. (2018) showed that tasks with high levels of reliability at the group level (e.g., Stroop) can have compromised reliability when it comes to individual-differences (i.e., the task' ability to consistently rank-order individuals). This is because the very feature that ensures that tasks produce robust and easily-replicable group-level experimental effects – low between-participant variability, or the tendency for individuals to show very similar magnitude effects – is that which makes them problematic as tools for individual differences research. This highlights that the ideal tools for individual-differences research are those with large between-participant variation – which, counterintuitively, are likely those tasks whose effects are less robust at the group level (Hedge et al., 2018). (In their review, Goodhew and Edwards (2019) discuss the practical implications of Hedge's findings.)

In this issue, Hedge et al. (2019) assess the extent to which there are stable individual differences in *response strategy*. That is, trade-offs between speed and accuracy on cognitive tasks are often considered a source of error variance in experimental studies. Here, however, Hedge et al. (2019) consider whether there are stable and meaningful individual differences in this cognitive process. To this test, these authors manipulated response caution via speed or accuracy-emphasised instructions across several different tasks (Stroop, flanker, and dot motion), and apply a diffusion model for conflict tasks and correlate the change in boundary (speed-accuracy) across session and task. These authors found moderate test-retest reliability across the tasks, and medium to large correlations among them (Hedge et al., 2019). More broadly, this contribution emphasises how important it is to apply an individual-differences-specific lens when considering sources of variance. In particular, sources of between-participant variance such as this that are obscured by considering only group aggregate performance, and treated as noise in experimental studies, can be stable within an individual. Considering between-participant variance in response strategy may shed new light on how individuals differ and what variables predict how individuals will perform on tasks, and may even provide new insight into the cognitive process that these tasks operationalise.

Another contribution that focusses on high-level cognitive process is that by Visser et al. (2019). In particular, Visser et al. (2019) study the cognitive origins of *overconfidence*. That is, in everyday life, we often draw conclusions about our abilities to perform certain tasks, and how we rank relative to others in these abilities. A well-established phenomenon is for people to overestimate their abilities relative both to others, and to objective performance. As these authors highlight, while there can be positive consequences of confidence, such as creativity and resilience, overconfidence can lead to serious negative consequences, such as academic underachievement, risk driving behaviour, and even criminal behaviour. It is therefore crucial to improve our understanding of this phenomenon. Here, Visser et al. (2019) explore the individual-differences factors that do and do not predict overconfidence during a challenging air traffic control simulation, and their work also reveals how confidence fares in complex tasks with regular feedback.

Newman and colleagues' contribution (Newman, Jalbert, Schwarz, & Ly, 2020) considers the role of individual differences in *judgements of truth*. That is, how do humans decide whether a statement is truthful, or not? Are all individuals equally susceptible to the effect of different factors? One important cognitive process which underlies such judgements is that of ease of processing, or cognitive fluency. That is, in general, people are more likely to judge a statement as true the more fluently they are able to process it. Previous research has considered various experimentally-manipulated factors which influence such processes at the overall group level. However, there has been scant consideration of how individuals differ. Here, Newman and colleagues (Newman et al., 2020) break new ground on this issue, examining the role of Need for Cognition, which measures an individual's preference for elaborative thought. This paper provides an exciting new direction for understanding how humans reach such important judgements. This paper by Newman is also an excellent read for those interested in psychological influence issues in general.

Working memory capacity is a cognitive process for which there is a relatively developed literature on measuring and theorising about variation across individuals. Working memory capacity relates to the ability to sustain and regulate attention to optimise adaptive outcomes, and to ignore and inhibit distraction (Kane et al., 2004; Redick & Engle, 2006). The go/no-go task is a popular experimental paradigm in psychology to measure inhibition. In their contribution to this issue, Wiemers and Redick (2019) explore how changing parameters of the *go/no-go task* impact the relationship between performance and *working memory capacity*. In a similar vein, *Dissociative Absorption* (DA) is the psychological tendency to become fully immersed in a stimulus or task, at the expense of attention to the broader context. In this issue, Bregman-Hai and colleagues (Bregman-Hai, Kessler, & Soffer-

Dudek, 2020) examine how individual differences in DA relates to meta-conscious processes such as memory for one's own actions.

The human brain is highly sensitive to regularities in the environment. This sensitivity is adaptive, such that associations between stimuli and outcomes can be understood and exploited. However, a by-product of this adaptive mechanism is that it means people can succumb to superstitious beliefs, and believe that there are patterns and associations even in completely random sequences and scenarios. Previous research has examined contextual factors (e.g., high-stakes contexts) which make humans more likely to form associations. The contribution to the Special Issue by Daprati, Sirigu, Desmurget, and Nico (2019) is novel in that it considers how individual differences in the tendency to form associations between stimuli is conducive to *superstitious beliefs*. That is, these authors find correlations between the tendency to implicitly learn sequences to optimise responses on experimental tasks, and self-report indices of superstitious beliefs in daily lives. This demonstrates how adopting the lens of considering individual-differences can meaningfully explain variance in important cognitive processes which would otherwise be treated as noise.

There is typically far too much information available in visual scenes for the human brain to process at once, and so visual attention fulfils a crucial filtering function, prioritising relevant and salient information for processing. One key way in which humans can regulate their attentional resources is via the *breadth of attention*. That is, attention can be allocated to the global structure of a scene (i.e., the forest), or to the local elements that constitute stimuli (i.e., the trees). Previous work has shown stable individual differences in the extent to which individuals preferentially adopt a global or local attentional breadth (Dale & Arnell, 2013; Dale & Arnell, 2014). In their current contribution, Pitchford and Arnell (2019) discover that individual differences in attentional breadth can be predicted from resting-state electroencephalography (EEG). This provides insight into the underlying neural mechanisms of this reliable individual-difference.

In the opening of this editorial, I gave the example of IB, that is, the failure to perceive an unexpected stimulus. Much previous research has investigated the *contextual* factors that moderate IB rates, such as participants' top-down attentional set (i.e., the features that define the target relative to non-targets) (Most et al., 2001), the perceptual load of the display when the unexpected stimulus is shown (Cartwright-Finch & Lavie, 2007), and even seemingly incidental factors such as whether or not participants listen to music (Beanland, Allen, & Pammer, 2011). Here, however, Zhang, He, Yan, Zhao, and Xie (2019) demonstrate a role of the individual-difference variable of *age* in IB rates in preschool children. Finally, in this issue, Ryckman, Bandzo, Qian, and Lambert (2019) show differences between individuals with low versus high *contrast discrimination* thresholds, in the extent to which these individuals orient their *attention* in response to cues.

In conclusion, the papers in this Special Issue represent a diverse snapshot of the utility of synthesising an individual-differences lens with traditional experimental approaches to understanding a wide range of cognitive processes. This includes higher-level cognitive tasks such as learning, memory, judgement, and decision-making, and even influencing relatively low-level processes such as the intake and processing of sensory information via visual attentional mechanisms. I hope that this issue provides an authoritative overview of this approach, whets your appetite for and inspires future research in this domain.

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