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Short-term memory for faces relates to general intelligence moderately☆

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ABSTRACT

The results associated with a small number of investigations suggest that individual differences in memory for faces, as measured by the Cambridge Face Memory Test (CFMT), are independent of intelligence. Consequently, memory for faces has been suggested to be a special construct, unlike other cognitive abilities. However, previous investigations have measured intelligence with only one or two subtests. Additionally, the sample sizes upon which previous investigations were based were relatively small ($N = 45$ to 80). Consequently, in this investigation, a battery of eight cognitive ability tests and the CFMT were administered to a relatively large number of participants ($N = 211$). Based on a correlated-factor model, memory for faces was found to be correlated positively with fluid intelligence (.29), short-term memory (.23) and lexical knowledge ability (.19). Additionally, based on a higher-order model, memory for faces was found to be associated with *g* at .34. The results are interpreted to suggest that memory for faces, as measured by the CFMT, may be characterised as a relatively typical narrow cognitive ability within the Cattell–Horn–Carroll (CHC) model of intelligence, rather than a special ability (i.e., independent of other abilities). Future research with a greater diversity in the measurement of face recognition ability is encouraged (e.g., long-term memory), as the CFMT is a measure of short-term face memory ability.

1. Introduction

The capacity for face identity recognition has been a significant source of research over the years (e.g. Carey, Diamond, & Woods, 1980, Galper & Hochberg, 1971, Tanaka & Farah, 1993), perhaps in part because of the sensational phenomenon of prosopagnosia: the incapacity of otherwise cognitively able individuals to recognise familiar faces (Duchaine, 2011). In recent years, a number of investigators have begun to investigate face identity recognition ability as an individual difference construct (e.g. Dennett, McKone, Edwards, & Susilo, 2012, Rhodes, Jeffery, Taylor, Hayward, & Ewing, 2014, Sekiguchi, 2011). The empirical evidence suggests that face recognition ability lies along a continuum, with some individuals in possession of relatively poor levels of face recognition ability to those who may be considered "super recognizers" (Russell, Duchaine, & Nakayama, 2009).

At least superficially, individual differences in the capacity to memorise and recall faces may be suggested to be a cognitive ability, given that it is similar in nature to other types of well-established cognitive abilities such as short-term memory (*Gsm*) and visual–spatial ability (*Gv*): two lower-order constructs known to be associated with general intelligence (*g*; Carroll, 1993). To-date, the empirical research relevant to the association between face recognition ability and intelligence is very mixed. Some research suggests that there is a substantial association between face recognition ability and other cognitive abilities (e.g., Hildebrandt, Wilhelm, Schmiedek, Herzmann, & Sommer, 2011). By contrast, others have contended that face identity recognition ability is a construct completely distinct from other cognitive abilities, including *g* (Wilmer, Germine, & Nakayama, 2014).

Arguably, previous investigations may be suggested to be limited, as they have not administered a comprehensive battery of cognitive ability tests, or they have not administered the most commonly administered measure of face recognition ability, the Cambridge Face Memory Test (CFMT; Duchaine & Nakayama, 2006). Consequently, the purpose of this investigation was to estimate the latent variable association between face recognition ability and other cognitive abilities, including *g*, through administration of a battery of cognitive ability tests and the CFMT.

1.1. Face identity recognition ability and individual differences

Although it has been stated that all adult humans are experts at face recognition (Haxby, Hoffman, & Gobbini, 2000), the empirical research suggests that there are, nonetheless, a non-negligible amount of

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individual differences in the capacity to recognise faces. For example, individual differences in the capacity to recognise faces are apparent in the distribution of scores associated with the CFMT (Duchaine & Nakayama, 2006). The CFMT is the most commonly used test of face recognition ability (Cho et al., 2015). The items within the CFMT (72 in total) consist of photos of faces displayed on a computer monitor. The photos are ellipsoid in shape such that they exclude characteristics such as the model's hair and neck/clothes. Additionally, the models are not wearing make-up or jewelry. Consequently, the participant viewing the images cannot rely upon non-intrinsic characteristics of the face for the purposes of memorisation.[1] For each trial, the participant must first memorise three faces on a computer screen over a period of 20 s, after which the faces disappear from the screen. Then, another series of three faces appear on the screen and the participant must identify which one of the three faces was presented during the memorisation phase. Because the test phase within the CFMT occurs essentially immediately after the memorisation phase, a score on the CFMT is probably best considered as an indicator of short-term face memory, rather than long-term face memory. Also, note that for each CFMT item, there is a correct response alternative, and the participant must select one of the three faces. Thus, the CFMT is arguably not susceptible to response biases (e.g., tendency to respond "haven't seen").

Short-term face recognition ability has been found to be a dimension associated with a moderate amount of variability. For example, based on a university sample ($N = 50$), the CFMT has been reported to be associated with a mean of 57.92 and a standard deviation of 7.91 (Duchaine & Nakayama, 2006), which corresponds to a coefficient of variation of .14 ($7.91 / 57.92 = .14$). Based on a larger sample recruited from the general community ($N = 107$), Bowles et al. (2009) reported a mean of 54.6 and a standard deviation of 9.4 on the CFMT, which corresponds to a coefficient of variation of .17. For the purposes of comparison, Gignac (2015) reported a coefficient of variation of .19 for digit span forward, across several normative samples. Consequently, with respect to variability, short-term face recognition ability, as measured by the CFMT, is very comparable to serial recall of digits — a cognitive capacity well-known to be associated positively with *g*. Thus, short-term face recognition ability may be considered as a possible correlate of *g*, as it shares approximately the same amount of variability in the normal population as other indicators of short-term memory.

1.2. Short-term memory and g

It has been well established that short-term memory capacity is related positively to *g* (Bachelder & Denny, 1977; Gignac & Watkins, 2015; Miller & Vernon, 1992). Within the Cattell–Horn–Carroll (CHC) three stratum model (McGrew, 2009), short-term memory (G_{sm}) is known as one of the nine broad (stratum II) factors, alongside fluid intelligence (*Gf*), crystallised intelligence (*Gc*) and processing speed (*Gs*), for example (Carroll, 2003). Based on the Wechsler Adult Intelligence Scale — IV (Wechsler, 2008) normative sample ($N = 2200$), Gignac (2014) found that a *Gsm* lower-order factor was associated with *g* at .84; a result replicated closely with Wechsler Intelligence Scale for Children — V (Wechsler, 2014) normative sample (Gignac & Watkins, 2015). In another investigation based on a combination of the Differential Ability Scales (Elliott, 1990) and the Woodcock–Johnson Tests of Cognitive Abilities-III (Woodcock, McGrew, & Mather, 2001), Sanders, McIntosh, Dunham, Rothlisberg, and Finch (2007) reported an association of .61 between *Gsm* and *g*. Additionally, a lower-order visual processing factor (*Gv*) was reported to be associated with *g* at .76. Similarly, Reynolds, Keith, Fine, Fisher, and Low (2007) reported *Gsm* and *Gv* associations with *g* of .70 and .83, respectively based on the KABC — II (Kaufman & Kaufman, 2004). Thus, as it may be suggested that the completion of short-term face recognition ability tests involves short-term memory and visual processing processes, it is plausible to suggest that short-term face recognition ability may be related to *g*.

Typically, individual tests of short-term memory capacity are observed to relate to *g* moderately (.30 to .50), rather than very appreciably in magnitude (.60 to .70). For example, digit span forward has been shown to relate to *g* at approximately .40, based on a bifactor model of the Wechsler Adult Intelligence Scale (Wechsler, 2008) normative sample (Gignac and Weiss, 2015). Thus, serial recall for digits (verbal memory) shared approximately 15% of its variance with *g*. Somewhat more appreciably, backward digit span, which is considered to involve some working memory capacity processing, was found to be related to *g* at .48.

Measures of visual memory have also been found to relate to *g* moderately. Consider, for example, the Rey–Osterrieth Complex Figure test (Osterrieth, 1944; Rey, 1941), which requires participants to copy a visually displayed complex figure on paper with a pencil. After a particular period of time, during which the participant completes other tasks, the participant is requested to re-draw the complex figure without forewarning (delayed recall). Higher scores are achieved contingent upon the accuracy with which a participant recreated the complex figure. Based on a higher-order model of cognitive abilities, Irwing, Booth, Nyborg, and Rushton (2012) found that the Rey-Osterrieth Complex Figure test was associated with *g* at .32 and .19 (Schmid–Leiman decomposed) as a cross-loading indicator of *GvGf* and *Gsm*/*Glr*, respectively. Thus, visual memory, as measured by the Rey–Osterrieth Complex Figure test, shared approximately 14% of its variance with *g* ($.32^2 + .19^2 = .14$). In another investigation, Reynolds, Keith, Flanagan, and Alfonso (2013) reported the results associated with a cross-battery higher-order model of intelligence, which included the Picture Recognition subtest from the Woodcock–Johnson III (Woodcock et al., 2001). Picture Recognition was found to load onto an associative memory lower-order factor at .58. The associative memory lower-order factor loaded onto *g* at .82. Thus, based on a Schmid–Leiman decomposition of the higher-order effects, Picture Recognition was found to be associated with *g* at .48.

Given that face recognition ability may be, at least qualitatively, classified as a construct relevant to memory and visual cognitive processes, it may be suggested that individual differences in performance on face recognition ability tests (e.g., the CFMT) would be a representative of cognitive ability, at least to some degree. Theoretically, in order for face recognition ability to be classified as a cognitive ability, it would arguably have to be demonstrated to correlate positively with other well-known cognitive abilities (e.g., *Gf*, *Gc*, *Gsm*). Additionally, and relatedly, it would be expected that face recognition ability would share variance with *g*. To-date, only a relatively small amount of empirical investigations have examined the association between face recognition ability and other cognitive abilities.

1.3. Short-term face recognition and intelligence

Davis et al. (2011) examined the association between face recognition ability and intelligence through administration of the CFMT and the Culture Fair Intelligence Test (CFIT; Cattell, 1963). Based on a sample of university students ($N = 63$), Davis et al. reported a correlation of −.08 between the CFMT and the CFIT. Thus, individual differences in face recognition ability were interpreted to be unrelated to non-verbal fluid intelligence. It will be noted, however, that the sample was found to be associated with a CFIT mean of 122 (the CFIT normative sample mean is 100 with an SD of 15). Consequently, performance on only a small number of items would have discriminated between many of the participants, as the CFIT subtests consist of only 10 to 14 items. Additionally, an estimate of intelligence based on, essentially, a single test

[1] The Kaufman Assessment Battery for Children — II (KABC; Kaufman & Kaufman, 2004) and the Wechsler Memory Scale III (Wechsler, 2008) include face recognition subtests. However, these subtests have been criticised as invalid indicators of face recognition ability, because the images include non-intrinsic characteristics such as hair, clothes, and a mixture of races (Dalrymple & Palermo, 2016).Consequently, research relevant to these subtests is not reviewed here.