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Intelligence 33 (2005) 143–159
INTELLIGENCE

Semantically meaningful and abstract figural reasoning in the context of fluid and crystallized intelligence

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Received 23 October 2002; received in revised form 24 August 2003; accepted 9 July 2004
Available online 23 November 2004

Abstract

Because figural reasoning tasks are often assumed to indicate fluid intelligence (gf), we investigated which aspect of figural reasoning tasks make that they tend to mark gf—the figural content itself or the high degree of abstraction in these tasks. To this end, the assessment of figural reasoning abilities by means of concrete figural task material was compared with the assessment of figural reasoning abilities using abstract figural task material, and the relations of the abstract and the concrete figural reasoning tasks to fluid (gf) and crystallized intelligence (gc) were investigated. The central hypothesis was that figural reasoning tasks containing semantically meaningful objects would show higher gc-loadings than abstract figural reasoning tasks. Three newly developed figural reasoning tasks with semantically meaningful material were administered to 144 German subjects, along with the German intelligence test I-S-T 2000 R (Amthauer, R., Brocke, B., Liepmann, D., & Beauducel, A. (2001). *Intelligenz-Struktur-Test 2000 R*. Göttingen: Hogrefe) containing abstract figural reasoning tasks as markers for gf and knowledge items as markers for gc. Confirmatory factor analysis revealed that concrete figural reasoning tasks exhibited larger gc-loadings than abstract figural reasoning tasks.

Keywords: Fluid intelligence; Crystallized intelligence; Figural reasoning tasks

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doi:10.1016/j.intell.2004.07.011

1. Introduction

According to Cattell (1987), the material used to assess fluid intelligence (gf) should be either equally overlearnt by all, or equally new to all. Traditionally, abstract geometric stimuli have played an important role in the measurement of gf because this material is thought to be equally familiar to all subjects. In some tests, exclusively abstract figural reasoning tasks are regarded as pure measures of reasoning and are used to indicate gf (see, e.g., CFT-3; Cattell & Weiß, 1971), and, in some cases, tests containing just one type of abstract geometric reasoning tasks are used to assess gf (see, e.g., APM, Raven, Court, & Raven, 1976). However, whether the APM can be regarded as a pure measure of reasoning has already been called into question (see Burke, 1958).

Abstract figural tasks are thought to enable a context-free or culture-fair assessment of intellectual abilities. However, the abstract figural–spatial content is not part of Horn's (1988, p. 660) definition of gf: "The factor is a fallible indicator of reasoning of several kinds, abstracting, and problem solving, when these qualities are acquired outside the acculturational process, through personal experience, and through learning that is not selectively restricted." Although abstract figural spatial material may help to assess abilities acquired outside the acculturational process, gf must not be exclusively related to the abstract geometric material itself. Sternberg (1984, p. 280) addressed problems in the assessment of gf with nonverbal tasks, pointing to "the by-now well-known finding that nonverbal reasoning tests, such as the Raven Progressive Matrices or the Cattell Culture-Fair Test of g (general intelligence), actually yield greater differences between members of different sociocultural groups than do the verbal tests they were designed to replace (Jensen, 1982). The nonverbal tests, contrary to the claims that have often been made for them, are *not* culture-fair (and they are certainly not culture-free)." Thus, figural or nonverbal tasks may sometimes be related to cultural factors and may therefore be related to crystallized intelligence (gc).

Current gf–gc theory, as presented by Horn and Noll (1997), is based on a simple structure organization of nine to ten broad abilities including gf, gc, visual processing (gv), auditory processing, and processing speed. McGrew (1997) classified the individual tests of major test batteries in the English-language test literature at the narrow-ability level of current gf–gc theory. The batteries considered include the Differential Ability Scales (DAS; Elliott, 1990), the Kaufman Adolescent and Adult Intelligence Test (KAIT; Kaufman & Kaufman, 1993), the Stanford–Binet Intelligence Scale: Fourth Edition (SB-IV; Thorndike, Hagen, & Sattler, 1986), the three Wechsler Batteries (Wechsler, 1981, 1989, 1991), and the Woodcock–Johnson Psycho-Educational Battery—Revised (WJ-R; Woodcock & Johnson, 1989). The classification "was guided by a review of results of joint confirmatory analysis studies conceptualized from the modern gf-gc framework" (McGrew, 1997, p. 154). About 67 of the tests considered were classified under gc and 36 under visual processing (gv). Surprisingly, only 17 individual tests represented gf, although gf is often considered to be the core of general intelligence (Carroll, 1993; Gustafsson, 1984). According to McGrew (1997, p. 168), this was "due to the fact that tests that have been historically considered to be good measures of gf abilities are now found to primarily be measures of other constructs. In particular, many nonverbal visual-spatial tasks are measures of narrow abilities in the broad domain of gv and not gf." It seems that much of the variance in figural reasoning tasks is probably represented by gv, and not by gf, when current versions of gf–gc theory are considered.

Beauducel, Brocke, and Liepmann (2001) addressed the issue of construct irrelevant variance in the context of gf–gc theory. Gf is often assessed by means of figural reasoning tasks, whereas gc is often measured using verbal scales. Assuming that the difference between gf and gc should primarily represent