



Individual differences in general intelligence correlate with brain function during nonreasoning tasks

Richard J. Haier*, Nathan S. White, Michael T. Alkire

College of Medicine, University of California, Irvine, Med Sciences I, B140, Irvine, CA 92697, USA

Received 3 September 2002; received in revised form 16 January 2003; accepted 23 January 2003

Abstract

Brain imaging can help identify the functional neuroanatomy of general intelligence (i.e., “*g*”) and indicate how brain areas salient to *g* relate to information processing. An important question is whether individual differences in *g* among subjects are related to brain function even when nonreasoning tasks are studied. If so, this would imply that individuals with high *g* scores may process information differently even when no reasoning or problem solving is required. To further investigate this, we administered the Raven’s Advanced Progressive Matrices (RAPM) test, a strong correlate of *g*, to 22 normal subjects and then measured cerebral glucose metabolic activity with PET while the subjects viewed videos on two occasions, tasks with no inherent reasoning or problem solving. Individual RAPM scores were correlated with regional brain activity using statistical parametric mapping (SPM99) conjunction analysis to combine both video conditions. Results showed greater activation in specific posterior brain areas (left BA37/19) in high RAPM scorers ($P=.02$, corrected for multiple comparisons). Subsequent analyses revealed a high/low RAPM group difference in functional connectivity between left BA37/19 activity and the left anterior cingulate/medial frontal gyrus. These data provide evidence that individual differences in intelligence correlate to brain function even when the brain is engaged in nonreasoning tasks and suggest that high and low *g* subjects may preferentially activate different neural circuits, especially nonfrontal areas involved in information processing.

© 2003 Elsevier Science Inc. All rights reserved.

Keywords: General intelligence; Nonreasoning task; Individual differences

* Corresponding author. Tel.: +1-949-824-4268; fax: +1-949-824-9059.

E-mail address: rjhaier@uci.edu (R.J. Haier).

1. Introduction

Brain imaging studies using PET, fMRI, and EEG-evoked potentials are helping establish the functional neuroanatomy of general intelligence, typically defined as the “*g*” factor determined psychometrically by factor analysis of multiple tests of cognitive abilities (Spearman, 1904). Since the neural basis of *g* may well involve the integration of complex cognitive processes, one primary question is whether the neuroanatomy of intelligence is generally distributed across multiple brain areas or relatively localized in a small number of areas. So far, the data are mixed. Imaging studies that compare high versus low *g*-loaded tasks generally show a common finding of increased activation in parts of the frontal lobes during a variety of high *g* tasks (Deary et al., 2001; Duncan et al., 2000; Esposito, Kirkby, Van Horn, Ellmore & Berman, 1999; Kroger et al., 2002; Prabhakaran, Smith, Desmond, Glover, & Gabrieli, 1997; Risberg & Ingvar, 1973). Other studies, however, have examined differences in *g* among subjects as they relate to brain function during the performance of tests with high *g*-loadings. These studies commonly show *inverse* correlations between some frontal lobe activity and task performance (Ghatan et al., 1995; Haier, 1993; Haier, Siegel, MacLachlan, et al., 1992; Haier et al., 1988; Haier, Siegel, Tang, Abel, & Buchsbaum, 1992; Lamm, Bauer, Vitouch, & Gstattner, 1999; Neubauer, Freudenthaler, & Pfurtscheller, 1995; Neubauer, Fink, & Schrausser, 2002; Parks et al., 1988; Reichle, Carpenter, & Just, 2000; Seidman et al., 1998; Van Rooy, Stough, Pipingas, Hocking, & Silberstein, 2001) or correlations with task performance in areas other than frontal lobes (Haier & Benbow, 1995; Larson, Haier, Lacasse, & Hazen, 1995) or an increase in cortical activity in low *g* groups (Haier et al., 1995). Typically, all neuroimaging studies of either complex task performance or of comparisons between high and low *g* groups show the involvement of multiple areas, consistent with the view that higher-order cognition involves circuits throughout the brain rather than only those localized in the frontal lobes (Carpenter, Just, & Reichle, 2000), although a case can be made for primary frontal lobe involvement (Duncan et al., 2000).

One possible approach to help clarify salient brain areas involved in *g* is to examine how individual differences in *g* among subjects correlate with brain function during the performance of nonreasoning tasks without high *g*-loadings. Boivin et al. (1992), for example, did PET with 33 subjects at “rest” (i.e., no specific *g* task) and found inverse correlations between frontal lobe activity and scores on the RAPM and the WAIS, consistent with earlier studies using high *g* tasks (Haier et al., 1988; Haier, Siegel, Tang, et al., 1992; Parks et al., 1988). They also reported other inverse and positive correlations between subject *g* differences and brain activity throughout the cortex. The findings of Boivin et al. suggest that *g* differences among subjects are related to brain function even without performing a reasoning or problem-solving task. However, the relatively uncontrolled nature of the “resting” condition for the 32 min required for the 18F-fluorodeoxyglucose (FDG) technique and older anatomical localization procedures limits this interpretation.

To further test whether individual differences among subjects in *g* correlate to brain function during nonreasoning tasks, we examined whether differences in *g* among normal subjects interacted with brain function during processing of a task with no explicit reasoning or problem-solving component.

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات