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Racial equality in intelligence: Predictions from a theory of intelligence as processing

Joseph F. Fagan [a,*], Cynthia R. Holland [b,1]

[a] Department of Psychology, Case Western Reserve University, Cleveland, OH 44106-7123, United States
[b] Liberal Arts, Cuyahoga Community College, 11000 West Pleasant Valley Road, Parma, OH 4130, United States

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Abstract

African-Americans and Whites were asked to solve problems typical of those administered on standard tests of intelligence. Half of the problems were solvable on the basis of information generally available to either race and/or on the basis of information newly learned. Such knowledge did not vary with race. Other problems were only solvable on the basis of specific previous knowledge, knowledge such as that tested on conventional IQ tests. Such specific knowledge did vary with race and was shown to be subject to test bias. Differences in knowledge within a race and differences in knowledge between races were found to have different determinants. Race was unrelated to the *g* factor. Cultural differences in the provision of information account for racial differences in IQ.

Keywords: Intelligence and race; Equal opportunity; Culture and IQ

1. Introduction

Are racial differences in IQ due to differences in intellectual ability or to differences in exposure to information? Recent reviews published in the *American Psychologist* (Anderson & Nickerson, 2005; Cooper, 2005; Rowe, 2005; Sternberg, Grigorenko, & Kidd, 2005) and in *Psychology, Public Policy, and Law* (Gottfredson, 2005; Nisbett, 2005; Rushton & Jensen, 2005; Sternberg, 2005; Suzuki & Aronson, 2005) indicate that there is no agreed upon answer to the controversial issue of the source of racial differences in IQ. As Sternberg, Grigorenko, and Kidd note, we first need to know what intelligence is to understand the source of racial differences in IQ. Cooper agrees that new theoretical and empirical approaches to the question of the sources of racial equality in IQ are needed. The present study offers a theoretically guided, experimental approach to the question of the basis of racial differences in IQ.

The interpretation of the fact that racial groups differ in IQ depends on one's theory of intelligence. Jensen (1998) assumes that Blacks and Whites have had equal opportunity for exposure to the information underlying the knowledge asked for on an IQ test. Thus, Jensen's interpretation is that any racial disparity in IQ is due to a difference in basic intellectual ability between races, specifically, in what he calls the general or *g* factor. The existence of *g* is inferred from the fact that scores on the

* Corresponding author. Tel.: +1 216 368 6476; fax: +1 216 368 4891.
E-mail addresses: jff@case.edu (J.F. Fagan), cindy.holland@tri-c.edu (C.R. Holland).
[1] Tel.: +1 216 987 5144; fax: +1 216 987 5066.

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various tests which make up an IQ score are intercorrelated.

Fagan (1992, 2000) assumes that the IQ score is a measure of knowledge. Knowledge depends on information processing ability and on the information given by the culture for processing. The term *intelligence*, in Fagan's theory, means information processing ability. Fagan assumes that not all have had equal opportunity for exposure to the information underlying the knowledge being quizzed on standard tests of IQ. Given such assumptions, if group differences in IQ are not accompanied by group differences in information processing ability, then group differences in IQ are due to differences in access to information.

In a series of five experiments (Fagan & Holland, 2002), adult African-Americans and Whites were compared for their knowledge of the meanings of words, a task that typically results in racial differences in IQ, and a task that is a good estimate of *g* (Jensen, 1980, 1981, 1998). Fagan and Holland (2002) experimentally insured that members of both racial groups had equal opportunity to be exposed to new information. The tests of a person's knowledge of newly learned words were intermixed with similar tests for knowledge of words typical of those used on IQ tests of word meaning. In accord with the literature, Whites were more apt than African-Americans to know the meanings of words typical of those used on standard IQ tests. The question was whether knowledge for newly learned words would differ. It did not. Fagan and Holland (2002) concluded that racial groups do not differ in their ability to process new information (i.e., in intellectual ability) and that the search for racial differences in knowledge (IQ) should be directed toward differences in exposure to information.

Fagan and Holland (2002) also considered three additional questions. Are standard IQ test items biased against members of a minority group? To what degree do factors that produce IQ differences among members of a racial group also produce IQ differences between racial groups? Are IQ differences between racial groups due to the *g* factor? A meta-analysis of the Fagan and Holland data provided evidence for test bias. Specifically, subsamples of African-Americans and Whites, matched as to their knowledge of meanings of words typically used on IQ tests, differed in their knowledge of the meanings of newly learned words. African-Americans now knew more than did Whites, indicating that standard IQ tests based on word knowledge may be biased.

The study also provided no support for Jensen's (1998, p. 443) default hypothesis which suggests that group differences in IQ have the same genetic and environmental bases, in the same ratio, that underlie individual differences within a racial group. Specifically, in the Fagan and Holland studies, individuals within each racial group who differed in their comprehension of word meanings also differed in their knowledge of newly learned word meanings.

Finally, the question of whether racial differences in IQ are due to differences in the *g* factor was limited by the fact that only one measure of IQ, word knowledge, was administered. Fagan and Holland (2002) noted, however, that the ability to acquire the meanings of novel terms, an ability shown to be equal for African-Americans and Whites in their study, is related to vocabulary knowledge, a knowledge tested on standard IQ tests and known to be highly *g* loaded.

The present study explored the generality of the Fagan and Holland (2002) findings. In an initial study, African-Americans, foreign students studying in America, and White Americans were tested for their knowledge of the meanings of words from an IQ test written in English. They were also tested for their information processing ability by asking how well they recognized faces to which they had recently been exposed. In three additional studies, African-Americans and Whites were tested for their knowledge of sayings, analogies, or similarities. Material was presented in such a way that knowledge of the concepts and terms employed in each test were commonly available for individuals of either race. Participants were also tested for their understanding of sayings, similarities, and analogies as typically given in assessments of IQ. Knowledge of sayings, similarities, and analogies are commonly used measures of IQ, are highly related to the *g* factor, and vary with race (Jensen, 1980, 1981). In addition, some participants were given tests commonly used to assess IQ such as vocabulary knowledge, knowledge of matrices, or spatial knowledge. Performance on these items was used to estimate *g*.

2. Experiment 1

Knowledge of word meanings is a common subtest of standard IQ tests. The information that people receive about what words mean may be different, thus influencing their score on an IQ test. In the present study, African-Americans who had grown up exposed to standard English as well as to Black English, students from other countries, who were studying in America but for whom English was not their native language, and White Americans exposed to standard English were tested for their knowledge of the meanings of words from an IQ test based on English. They were also tested for their information processing ability by asking how well they could process information to which they had

been equally exposed. Specifically, they were asked to recognize previously unfamiliar faces. Such recognition memory has been shown to be related to IQ throughout the lifespan (see reviews by Fagan, 2000; Fagan & Haken-Vasen, 1997). Based on the findings of Fagan and Holland (2002), we expected that information processing ability, race, and native language would each be predictive of word knowledge. We further expected that both race and native language would bear no relationship to information processing ability (i.e. to intelligence).

2.1. Method

2.1.1. Participants

The participants included 77 college students (44 Whites and 33 African-Americans, 32 males and 45 females, 56 for whom English was their native language and 21 for whom English was not their native language). The average age of the participants was 22.5 years (S.D. 5.2). The mean years of schooling were 14.8 years (S.D. 1.42).

2.1.2. Tasks

All were tested for their knowledge of the meanings of words drawn from the Peabody Picture Vocabulary Test-Revised or PPVT-R (Dunn & Dunn, 1981, items 140–175). They were also tested for their information processing ability by asking them to recognize 48 previously unfamiliar faces to which they had recently been exposed.

2.2. Results

2.2.1. Task difficulty and metric

The recognition memory task at a mean percent correct of 64% (*SD* 11%) and the PPVT-R (mean 60%, S.D. 17%) proved to be of moderate difficulty. To provide a common metric, test scores for all participants were converted into *z* scores.

2.2.2. IQ varies as a function of processing and culture

If IQ is determined by both information processing ability and by culture, the expectation would be that memory, race, and native language would all be predictive of IQ. As revealed by a step-wise multiple regression, Multiple R (3/69)=.51, $P<.0001$, such was the case with beta values of .28 ($t=2.6$, $P<.009$), .32 ($t=3.0$, $P<.004$), and .26 ($t=2.4$, $P<.02$) for the influences of processing ability, race, and language background, respectively, on IQ. The influence of race and language on IQ, was shown by the fact that the American Whites (mean *z* of .7, S.D. .7) were superior in word knowledge to both the African-Americans (mean *z* of −.4, S.D. 1.0, a difference equivalent to about 16 IQ points, $t(54)=4.8$, $P<.0001$) and to the foreign students (mean *z* of −.5, S.D. .8, a difference of about 18 IQ points, $t(48)=5.6$, $P<.0001$). African-Americans and foreign students did not differ in word knowledge.

The fact that African-Americans and non-native speakers of English both differ from American Whites in their knowledge of the meanings of English words used on an IQ test is neither new nor surprising. Nor is it new or surprising to find that information processing ability (indexed here by incidental recognition memory) is a significant predictor of knowledge. Specifically, in the present study, a significant correlation of $r=.39$ ($P<.001$) was obtained between the participant's *z* scores for the PPVT-R (knowledge) and the participants' recognition memory scores (information processing). This coefficient is attenuated by the less than perfect reliabilities of the estimates of processing and knowledge. A correction for unreliability was computed based on KR21 reliability estimates of .65 and .78, respectively, for the recognition test items and the PPVT-R items employed in the present study. The more accurate relationship between information processing and knowledge thus obtained was .55.

2.2.3. Processing does not vary as a function of culture

The theory guiding the present study (Fagan, 2000), however, assumes that the information provided by one's culture for processing, along with one's processing ability accounts for one's knowledge (one's IQ). Theoretically any group will be more knowledgeable than another if that group has been given more relevant information than has the other, even though the groups may be equal in information processing ability. Thus, the more interesting theoretical question with regard to group differences in IQ is whether information processing ability itself varies with race and native language. In the present study, the answer is "No". Information processing ability did not vary with race or language status. Specifically, a stepwise multiple regression in which the independent variables of race, native language, and PPVT-R scores were used to predict recognition memory ability revealed that knowledge (PPVT-R scores) was the only significant predictor of processing ability (recognition memory) with a Multiple R of .36 ($F(1/71)=10.4$, $P<.002$) and a beta value of .36 ($t=3.2$, $P<.002$). If PPVT-R scores are omitted from the analysis, and race and native language are the only independent variables employed to predict information processing, no significant variance is obtained ($F(2/70)=1.9$, $P>.15$). Thus, African-Americans, White Americans, and those for whom English is a second language

process information equally well (i.e. they are equally intelligent) when the information to be processed has been made equally available to all groups.

3. Experiment 2

In a second and a third experiment reported here, we tested African-Americans and Whites for their comprehension of sayings. Some sayings were based on generally available information (e.g. "An apple a day keeps the doctor away" as meaning "Eating good food helps you to stay healthy") others required past exposure to specific information (e.g. "Home of the bean and the cod" as meaning "Boston"). We assumed that African-Americans and Whites, equally able to process information, would be equally able to comprehend the meanings of sayings based on generally available information but would differ in their comprehension of sayings requiring specific past information.

3.1. Method

3.1.1. Participants

The participants in the second experiment were 65 community college students (42 Whites and 23 African-Americans; 52 females and 13 males). The average age of the group was 26.5 years. Students were seen, in groups, in their classrooms.

3.1.2. Materials

They were given a series of 58 sayings and were asked to circle one of four possible explanations that best explained the saying. Comprehension was based on generally available knowledge for 36 sayings and comprehension was depended on specific knowledge for 22 sayings.

3.1.3. Design

The design employed in the second experiment was a between subjects design with 37 students (25 Whites and 12 African-Americans) tested for comprehension of the sayings based on general knowledge and 28 (11 African-Americans and 17 Whites) tested for comprehension of sayings based on specific knowledge. Each of the 65 students was also given a series of 16 items from the PPVT-R to get an estimate of their performance on a standard test of intelligence. PPVT-R scores were obtained to insure that the Whites and African-Americans were not of comparable IQ. They were not. The Whites averaged 82% correct on the PPVT-R items and the African-Americans averaged 67%, $t(63)=4.0$, $P<.001$).

3.2. Results

An ANOVA based on percent correct comprehension with two between subjects factors, race (White and African-American) and type of knowledge upon which comprehension could be based (general or specific) was conducted. The important effect was a highly significant interaction involving race and the type of knowledge necessary for comprehension, $F(1/61)=8.2$, $P<.006$. The significant interaction was due to the fact that comprehension based on specific knowledge on the part of the Whites at 65% correct (S.D. 20.7) was superior, $t(35)=2.7$, $P<.01$, to the comprehension of the African-Americans at 48% (S.D. 10.0). Thus, when opportunity for exposure to information is allowed to vary, Whites are more apt to know the meanings of sayings than are African-Americans. But the same was not true when opportunity for information about the meanings of the sayings was generally available. Specifically, The performance of the Whites at 72% correct (S.D. 16.5) was, if anything, somewhat inferior to that of the African-Americans at 80% correct (S.D. 13.1), although not significantly so, $t(26)=1.4$.

In asking people about their comprehension of sayings, did the tasks used simply bear little or no relationship to a standard estimate of IQ? In fact, the tasks chosen to measure comprehension of sayings were related to PPVT-R IQ. Such relationships were the same for each type of comprehension task employed (tests based on general or specific information at $r=.53$ and $r=.53$, respectively) and for each racial group tested (African-Americans at $r=.57$ and Whites at $r=.50$) with $P<.01$ in each case. Thus, consistent with the results obtained from the Fagan and Holland (2002) experiments on word knowledge, when given equal opportunity for exposure to information, African-Americans and Whites were equal in comprehension of the meanings of sayings.

4. Experiment 3

4.1. Method

4.1.1. Participants and materials

The third experiment differed from the second by employing a within subjects design in which the same 86 participants (70 Whites and 16 African-Americans, 24 males and 52 females with an average age of 21.4 years and a mean educational level of 14.8 years) were tested for comprehension of sayings based on general or specific prior knowledge. All students were asked to complete a 36 item version of the PPVT-R. Again, Blacks and

Whites differed in IQ. The Whites averaged 23.1 items correct (S.D. 4.8) while the Blacks averaged 18.3 items correct (S.D. 4.4) or 64% to 51%, $t(84)=3.7$, $P<.0001$). The students were also asked to complete two additional, brief versions of common intelligence tests: an 18 item spatial relations test and a 16 item matrices test. General comprehension was based on a 22 item test and specific comprehension on another 22 items.

4.2. Results

As was the case in the second experiment, an interaction involving race and the type of knowledge necessary for comprehension (general or specific) was significant, $F(1/84)=3.9$, $P<.05$). The interaction again was due to the fact that comprehension based on specific knowledge on the part of Whites (a mean of 16.2 items correct, S.D. 3.4) was superior, $t(84)=2.6$, $P<.01$) to that of Blacks (13.9 items, S.D. 3.3) while general comprehension was equal for Whites and Blacks at 17.8, S.D. 3.1 and 17.1, S.D. 3.3, respectively, $t(84)=0.8$. Thus, consistent with the results of the previous experiment, when information was generally available to Whites and Blacks for the comprehension of sayings, Whites and Blacks were equal in knowledge. Again one might ask whether the ability to comprehend sayings based on specific information has anything at all to do with the ability to comprehend sayings based on general knowledge. They are related. In the third experiment (as in the second) individual differences in general comprehension were significantly related to individual differences in specific comprehension at $r=.57$, $P<.0001$.

5. Experiment 4

A fourth experiment explored the generality of the Fagan and Holland (2002) findings and of the findings from the first three experiments of the present series in two respects. We asked, first, if the same findings would be obtained if African-Americans and Whites were tested for their knowledge of analogies, and of similarities as well as of sayings. Again, material was presented in such a way that knowledge of the concepts and terms employed in each test were commonly available for individuals of either race. All participants were also tested for their understanding of sayings, similarities, and analogies as typically given in assessments of IQ. Secondly, all participants in the present study were given three tests commonly used to assess IQ: vocabulary knowledge, knowledge of matrices, and spatial knowledge. Performance on these items was used to derive a *g* score.

5.1. Method

5.1.1. Participants

The sample included 223 students with a mean age of 21.4 years (S.D. 3.7), 60 males and 163 females, 155 Whites and 68 African-Americans. Of the 223 students, 130 attended a private university and 88 attended a public community college. African-Americans and Whites did not differ in the ratio of males to females and were equal to each other in educational level at 14.1 mean years of schooling (S.D. 1.6) for the African-Americans and 14.4 years (S.D. 1.3) for the Whites.

5.1.2. Materials

Students were given a series of sayings, similarities, and analogies and were asked to circle one of four possible explanations that best explained each saying, similarity, or analogy.

The printed instructions for the test of knowledge of sayings were as follows:

> "We would like to find out what people know about the meanings of sayings. For example: AN APPLE A DAY KEEPS THE DOCTOR AWAY means a. Eating good food helps you to stay healthy b. Pay your debts That's right. The answer is a. 'Eating good food helps you to stay healthy'. Here's another example: THE FOREST CITY means a. Cleveland b. Las Vegas That's right. The answer is a. 'Cleveland'. On the following pages are a number of sayings. Please circle what you believe to be the correct answer for each question. Please answer each question."

The printed instructions for the test of knowledge of similarities were:

> "On the following pages we will be asking how one word is most like another word. You will be putting a circle around the letter in front of the correct answer. For example: MAN and WOMAN a. Human b. Living c. American The answer is a. 'Human'. Why? Because 'Human' is the way in which 'Man' and 'Woman' are MOST alike. True, they are both living, but so are snakes, plants and many other things. So living is too general a way to say how man and woman are most alike. Similarly, a man and a woman could be American, but they could just as well be French, Spanish or any other nationality. So, American is too specific a way to say how man and woman are most alike.Let's try another one. ROBERTO ALOMAR and OMAR VISQUEL a. Cartoon characters b. Baseball players c. Cleveland Indians The answer is c. 'Cleveland

Table 1
Sayings, similarities, and analogies with solutions based on exposure to general information or on exposure to specific information

Sayings	Similarities	Analogies
General		
RICHES MAKE THEMSELVES WINGS	EYES and EARS	_____ is to TEND as MEN is to MEND
(a) Money goes fast	(a) Body parts	(a) Net
(b) Invest	(b) Start with E	*(b) Ten*
(c) Fly away	(c) Relatives	(c) Met
(d) Bank your money	*(d) Senses*	(d) End
Specific		
BENEDICT ARNOLD	SEINE and THAMES	XX is to FEMALE as ___is to MALE
(a) President	(a) Desserts	(a) ZZ
(b) Patriot	*(b) Rivers*	(b) YZ
(c) Monk	(c) France	(c) YY
(d) Traitor	(d) England	*(d) XY*

Indians'. Why? True, they are both baseball players, but many people are baseball players. So baseball players is too general a way in which these two are most alike. In fact Roberto Alomar and Omar Visquel were both baseball players for the Cleveland Indians and that is how they are MOST alike. Neither, of course, is a cartoon character. On the following pages you will see a number of such pairings. Please circle the letter you consider to be the best answer to how the two words are MOST alike. Please don't skip any questions."

The printed instructions for the test of knowledge of analogies were:

"On the following pages we will be asking how one pair of words is similar to another pair of words. You will be putting a circle around the letter in front of the correct answer. For example: HIGH is to TALL as LOW is to _____. a. Short b. Red That's right. The answer is 'Short'. Why? Because 'High' and 'Tall' mean the same thing. You know that. So you would have put a circle around a.Here's another example: JOSEPH is to MARY as _____ is to EVE. a. Chuck b. Adam Right! The answer is 'Adam'. You would circle b.Thank you! On the following pages you will see a number of such pairings. Please circle the letter you consider to be the correct answer. Don't skip any questions."

Examples of sayings, similarities, and analogies whose comprehension was assumed to be based on generally available information along with sayings, similarities, and analogies whose comprehension was assumed to depend on prior exposure to specific information are given in Table 1. The correct answers are italicized in Table 1 for illustrative purposes.

Of the 223 participants, a sample of 179 (60 African-Americans and 119 Whites) were tested as illustrated in Table 1. The other 44 participants (8 African-Americans, 36 Whites) learned the meanings of 22 sayings, 20 similarities and 20 analogies based on rare or nonsense words. For example, participants learned that the saying *FRYASPARAGUS* means get lost, take a hike. They also learned, for example, that "An ancient animal has been found who saw with one ESTON and listened with one EWOT." Later they were asked how "ESTON and EWOT" were most similar. They also learned that "a BRILLIG is easily picked from a low branch and a CIDY from off a vine. Both a BRILLIG and a CIDY are juicy and delicious." Later they were asked "BRILLIG is to CIDY as TREE is to _____. These 44 participants were also tested on the same items requiring previous specific information as had the other students. These procedural differences between groups were taken into account in the analyses of data. All participants were also given selected items of intermediate difficulty level for their age from standard intelligence tests: the Peabody Picture Vocabulary Test-Revised, a spatial relations test (Serebriakoff, 1988) and tests of matrix solution (Raven, 1988; Serebriakoff, 1988).

5.2. Results

Obtained scores for all participants (African-Americans together with Whites) were converted to standard (z) scores within the conditions in which they were tested as to information generally available, equal opportunity to learn new information prior to test, and past exposure to specific information. A conversion to z scores, while equating for absolute level of performance due to differences in number of items or experimental format, left any variance in knowledge due to racial group membership free to vary. Preliminary analyses indicated that the main effects and interactions noted below were the same for the type of item tested (sayings, similarities, or analogies), thus the total score across all items was the main dependent variable. They also indicated that the two conditions of testing (groups of 179 and 44 tested under different circumstances) contributed no significant variance (either as a main effect or in interaction with other variables).

The main findings of interest emerged from an analysis of variance which again yielded a significant interaction involving race and the type of information required for solution , $F(1/217)=12.5$, $P<.001$). As expected, knowledge based on information not assured to be equally

available was higher for Whites, $t(221)=5.6$, $P<.000$, at mean $z=.24$ (S.D. 0.9) than for African-Americans (mean $z=-.51$, S.D. 1.0). Given that an S.D. of 15 is typical of standard IQ tests, the difference of .75 standard deviation units between the African-Americans and Whites in the present sample for knowledge based on specific information would be equivalent to about 11.3 IQ points. The reliable interaction was due to the fact that knowledge based on equally available information did not differ, $t(221)=1.4$, for African-Americans (mean $z=-.10$, S.D. 1.0) and Whites (mean $z=.10$, S.D. 1.0). Thus, consistent with the results of Fagan and Holland (2002) and with our previous three experiments, when information is equally available, Whites and African-Americans are equal in knowledge.

6. Psychometric and theoretical issues

The results of the present experiments, and those of Fagan and Holland (2002), indicate that differences in knowledge between African-Americans and Whites for items tested on an intelligence test can be eliminated when equal opportunity for exposure to the information to be tested is likely. The data support the view that cultural differences in the provision of information may account for racial differences in IQ. Three additional issues that are typically associated with the question of racial differences in IQ will now be considered. These issues include the psychometric issue of test bias, and two theoretical issues: the default hypothesis, and the role of *g* or the general factor as the basis of intelligence.

Test Bias based on predictive validity is inferred from data from randomly selected African-Americans and Whites who have the same test scores on a test where African-Americans are, typically, inferior to Whites. Nonetheless, the African-Americans and Whites so selected now have different outcomes, favoring the African-Americans, on a second test, a measure that the original test predicts. Herrnstein and Murray (1994, pp. 625–627) point out that such an analysis and pattern of results is the "ultimate criterion" for test bias. Evidence of test bias may be inferred from the results of the present studies. In the second, third, and fourth experiments, African-Americans and Whites were given tests measuring their comprehension based on generally available knowledge. They were also tested for their comprehension based on specific information. The test suspected to be biased is the test measuring specific comprehension, the test that shows differences between African-Americans and Whites. If we select African-Americans and Whites who have the same scores on tests of specific comprehension would the African-Americans so chosen be superior to the Whites on tests of general comprehension, thus indicating test bias?

In the second experiment in this series, a between subjects design was employed in which students were tested for either general or specific comprehension of sayings. All however, had been tested on the PPVT-R. To explore test bias, given the between subjects design, within each group (tested for general or specific comprehension) we matched African-Americans and Whites for their PPVT-R performance. In so doing we obtained a sample of 12 African-Americans and 12 Whites whose comprehension of specific sayings did not differ at 53.3% (S.D. 8.3) and 55.3% (S.D. 5.2), respectively. However, Whites and African-Americans, also matched for PPVT-R scores, differed significantly in general comprehension, $t(16)=2.0$, $P<.03$, one-tailed test. The African-Americans at 85.4% (S.D. 8.2, $N=9$) were superior to the Whites at 75.7% (S.D. 12.4, $N=9$). Such a result indicates that the test of comprehension of specific sayings was biased.

Similar results were obtained in the third experiment. In this case all participants had been tested for comprehension of sayings based on general or specific information which allowed us to match African-Americans and Whites for their comprehension of specific sayings and to see if their performance varied on knowledge of sayings based on generally available knowledge. A sample of 16 African-Americans and 17 Whites were closely matched on their comprehension of sayings requiring specific knowledge with mean scores of 60% (13.9 items correct out of 22, S.D. 3.3) and 62% (13.6 items, S.D. 2.9), respectively. Again, as in the second experiment, on general comprehension, the African-Americans were superior to the Whites, $t(31)=2.1$, $P<.05$, with 77.3% correct (17.1 items correct, S.D. 3.3) for the African-Americans and 66% correct (14.6 items, S.D. 3.4) for the Whites.

In the fourth experiment, again, a within-subjects design, a sample of 45 African-Americans and 49 Whites were closely matched for their knowledge of sayings, similarities, and analogies based on specific information with mean *z* scores of −.08, S.D. 0.71 and mean $z=-.06$, S.D. .82, respectively, $t(92)=-0.1$. Given such equality, the African-Americans were now greater than the Whites, $t(94)=5.0$, $P<.0001$, in knowledge based on general information with a mean *z* for the African-Americans of .29 (S.D. .81) and a mean *z* for the Whites of −.62 (S.D. .92). This *z* difference of .91 would translate into an IQ advantage of about 13.7 points for these particular African-Americans over these particular Whites. In brief, the present study finds repeated evidence of test bias for tests of intelligence employing knowledge of sayings, similarities, and analogies.

The Default Hypothesis of Jensen (1998) assumes that differences in IQ between races are the result of the same environmental and genetic factors, in the same ratio, that underlie individual differences in intelligence test performance among the members of each racial group. If Jensen is correct, higher and lower IQ individuals within each racial group in the present series of experiments should differ in the same manner as had the African-Americans and the Whites. That is, in our initial experiment, individuals within a racial group who differed in word knowledge should not differ in recognition memory. In the second, third, and fourth experiments individuals within a racial group who differed in knowledge based on specific information should not differ in knowledge based on general information. The present results are not consistent with the default hypothesis.

In an initial test of the default hypothesis, participants in the first experiment were placed into two groups based on their PPVT-R scores. One group (composed of American Whites, American Blacks and others whose native language was not English) consisted of 37 participants who, within their respective cultural groups, were proficient on the PPVT-R with a mean PPVT-R score of 25.8 items correct (S.D. 3.7). Another group of 36 participants was composed of the remaining members of the sample, who, within their respective racial-cultural groups, were less proficient on the PPVT-R with a mean of 18.5 items correct (S.D. 5.1). Thus selected, the groups differed significantly in their PPVT-R scores at $t(71)=7.1$, $P<.0001$. Were these two groups the same in recognition memory, as the default hypothesis would predict? No, they were not. Those with higher PPVT-R scores were also better able to recognize faces with a mean score of 32.4 (S.D. 5.3) items correct than those with lower PPVT-R scores with a mean of 29.4 items correct (S.D. 5.3) at $t(71)=2.4$, $P<.018$.

In a similar vein, the participants in the second experiment were chosen, within each race, to form groups whose average PPVT-R scores were equivalent to the average PPVT-R differences between the African-Americans and Whites in that study. Performance was then compared for high and low IQ groups within races as to comprehension based on general or specific knowledge. Participants varying in IQ indeed varied in specific comprehension, $t(35)= 3.0$, $P<.02$, at 68.7% (S.D. 21.3, $N=18$) for the students with high PPVT-R scores and 51.4% (S.D. 13.5, $N=19$) for the students with low PPVT-R scores. This within racial group variation in specific comprehension was as great as the between racial groups variation in specific comprehension with Whites at 65.4% and African-Americans at 48.1% noted earlier. However, students within racial groups differing in PPVT-R scores also differed in their general comprehension scores at 81.8% (S.D. 12.2, $N=15$) for high PPVT-R participants and at 68.1%, (S.D. 16.0, $N=13$) for low PPVT-R students with $t(26)=2.6$, $P<.02$.

The same results were obtained in the third experiment. Within races, students' scores were divided to create groups varying in mean PPVT-R scores (high PPVT-R at 23.7 items correct, S.D. 5.2, $N=43$ and low PPVT-R at 20.8, S.D. 4.6, $N=43$). These within race groups varied to about the same degree as had the PPVT-R scores for Whites and African-Americans in that experiment at 23.1, S.D. 4.8, $N=70$ and 18.3, S.D. 4.4, $N=16$, respectively. As one would expect, specific comprehension varied between the within race high and low PPVT-R groups at 16.9 items correct, S.D. 2.7 and 14.6, S.D. 3.8, respectively with $t(84)=3.3$, $P<.001$. Again, contrary to the default hypothesis, these same within race groups varying in PPVT-R scores and in specific comprehension also varied in their general comprehension with a mean of 18.9 correct, S.D. 1.8 for those with higher PPVT-R scores and 16.4, S.D. 3.7 for those with lower PPVT-R scores, $t(84)=3.9$, $P<.0001$.

A final test of the default hypothesis was provided by the data from the fourth experiment. Again, participants were divided, within each race, into groups whose average scores on the PPVT-R, the matrix tests, and the spatial ability tests were equivalent to the average differences between the African-Americans and Whites on those tests. Comprehension based on general or specific information was then compared for these groups who differed not in race but in functioning on standard IQ test items. The difference in knowledge based on specific prior information between the two within-race groups differing in IQ was, as one would expect, highly significant at $t(221)=4.7$, $P<.0001$, with the higher IQ group ($N=113$) having a mean z of 0.3 (S.D. 0.9) and the lower IQ group ($N=110$) having a mean z of −0.3 (S.D. 1.0). However, contrary to the default hypothesis, these same groups also varied in their knowledge based on general information with a mean z of 0.3, (S.D. 0.9) for those with higher IQ scores and a mean z of −0.3, (S.D. 1.0) for those with lower IQ's, $t(221)=4.4$, $P<.0001$.

Thus, contrary to what Jensen's default hypothesis would predict, individuals within a racial group, in the present studies, who differed in knowledge of the meanings of words, sayings, similarities, or analogies of the type typically given to measure IQ also differed in recognition memory or in comprehension when information necessary for the understanding of words sayings, similarities, and analogies was generally available. The present results say, once more (Fagan & Holland, 2002), that the average difference in IQ between Blacks and

Whites is not due to the same genetic and environmental factors, in the same ratio, that account for IQ differences among individuals within a racial group.

The g factor: Jensen (1998) assumes that IQ differences between African-Americans and Whites are due to differences in the *g* factor. Thus, Jensen would predict that the tests of general knowledge employed here, because they were solved equally well by African-Americans and Whites, should have little, if any, relation to the *g* factor derived from standard IQ tests. In accordance with the manner in which Jensen (1998) derives *g*, estimates of *g* were obtained by performing a principle factor analysis (un-rotated) on the three types of IQ tests given in the third and fourth experiments in the present study and extracting the first principle factor in each case which accounted for 47% to 59% of the common variance from study to study. The *g* scores obtained for each of the two experiments and the two scores computed earlier in each experiment for the test or tests based on general knowledge and the test or tests based on specific knowledge along with demographic variables such as race, age, sex, educational level (which varied from 12 to 20 years of schooling), family size, and birth order, were entered into two multiple regression analyses, one for each experiment. We did so to discover which variables would or would not contribute independent variance to the prediction of *g*. The regression analyses yielded identical multiple *R*'s of .62 and .62 for the data from the third and fourth experiments, each of which were highly significant, $F(6/85)=8.9$, $P<.0001$ and $F(8/214)=16.8$, $P<.00001$. Each regression analysis also showed that general and specific knowledge had separate, independent, and statistically significant influences on *g*. Specifically, the Beta value for the scores on general knowledge were .38 ($t=3.7$, $P<.0001$ and .30 ($t=4.7$, $P<.00001$) in the third and fourth experiments, respectively, and the beta values based on specific knowledge scores were .24 ($t=2.3$, $P<.02$) and .37 ($t=5.6$, $P<.00001$), respectively. Moreover, and most importantly, none of the demographic variables, including, and in particular, race, played any significant role in the determination of *g* in either analysis. The theoretical import of these findings as to Jensen's (1998) view that racial differences in IQ are due to differences in *g* will be discussed below.

7. Discussion

7.1. Racial differences in IQ as due to culture

Differences in knowledge between representative groups of African-Americans and Whites for items tested on an intelligence test can be eliminated when equal opportunity for exposure to the information to be tested is assured. The data support the view that cultural differences in the provision of information may account for racial differences in IQ. This conclusion is based on a sample of 925 participants (451 in the current study and 474 in the Fagan & Holland, 2002 study). The 925 participants include 620 White Americans and 305 African-Americans representative of the general US young adult population in terms of age and educational level (Fagan & Holland, 2002, Experiment 5).

The present findings are consistent with other studies which have attempted to provide equal opportunity for exposure to information to people of different races. In an early study, Bridgeman and Buttram (1975) found that training in verbal strategies erased the differences between African-American school children and White school children on nonverbal tests of analogy solution. More recently, Sternberg et al. (2002) showed that teaching cognitive skills and strategies to African children in Tanzania increased their scores (relative to children not so trained) on tests of syllogisms, sorting, and 20 questions. Skuy et al. (2002) found that Black college students in South Africa given a mediated learning experience reaped significantly more benefit from such training on tests of matrix solution than did their similarly trained White peers. Interestingly, tests of matrix solution, such as those employed by Skuy et al., are typically thought to be measures of fluid intelligence and not much subject to cultural influence (Flanagan, McGrew, & Ortiz, 2000). The fact that culture influences such tests of matrix solution was also noted by Fagan (2000) who points out that the fact that a child is born before or after an arbitrary date has nothing to do with how well that child processes information but may have a great deal to do with whether that child is attending one grade or the next by a particular age and, consequently what that child knows by that age. He cites Cahan and Cohen (1989) who administered portions of 12 different standard IQ tests to 11,000 fourth, fifth and sixth graders. Their question was whether cutoff dates for school entry would affect intelligence test scores. The results were clear. Children of the same age who found themselves in one grade or the other depending on the school systems cut-off dates for admission differed on their raw intelligence test scores on all 12 tests. It is important to note that one of the tests employed by Cahan and Cohen was the Raven's Progressive Matrices (Raven, Court, & Raven, 1975). We mention the Raven's test because it is highly *g* loaded (Jensen, 1993) and is considered to be a good measure of fluid intelligence, yet in the Cahan and Cohen study, an obvious cultural factor, cut-off dates for school

admission, had a strong influence on performance on the Raven's.

The findings of the present study, and those just noted, are interpretable on the basis of a theory of intelligence (Fagan, 1992, 2000) which assumes that the IQ score is a measure of knowledge, and that knowledge depends on information processing ability (intelligence) and on the information provided for processing. In a similar vein, Sternberg (2000, 2004) notes that the processes of intelligence may be the same from culture to culture, but that a person is called more or less intelligent based on what a particular society says is important to know. Naglieri (2003) and Naglieri and Das (1990, 1997) also assume that intelligence is best conceptualized in terms of a small number of basic cognitive processes.

The present study also sheds light on the issues of test bias underlying standard tests of intelligence, how best to assess the contributions of genes and the environment to intelligence, and on whether the IQ score has a single or multiple determinants.

7.2. Test bias

Evidence for *test bias* based on race was demonstrated in the present study. A similar bias, for tests based on knowledge of vocabulary, was reported for African-Americans and Whites by Fagan and Holland (2002) and by Naglieri and Rojhan (2001) who matched White students and African-American students for their performance on a standard test of intelligence and found that the African-Americans scored significantly higher that the Whites on a test of information processing. In a previous report (Fagan & Holland, 2002) we noted that such demonstrations of test bias are unusual (Jensen, 1980). The present studies tell us that test bias can be consistently demonstrated.

7.3. The default hypothesis and genetic/environmental influences

The present results, along with those of Fagan and Holland (2002), do not support Jensen's *default hypothesis*, on the contrary, they indicate that the average difference in IQ between African-Americans and Whites is not due to the same genetic and environmental factors, in the same ratio, that account for IQ differences among individuals within a racial group. Such findings raise the more general question of how best to explore the contribution of genes and experience to intelligence. A debate about these sources of variance in IQ is currently very active (Cooper, 2005; Rowe, 2005; Sternberg et al., 2005). As Sternberg et al. (2005) point out, research based on IQ scores has not identified the genes for intelligence and studies of heritability using IQ scores do not allow us to conclude anything about the heritability of between-population variation in IQ. Cooper (2005) agrees and notes that there is no theoretical reason, within the evolutionary model, to expect racial differences in intelligence. He goes on to point to the historical inequity of cultural circumstance between African-Americans and Whites, an inequity that makes a biological explanation of racial differences in IQ implausible. Rowe (2005) calls for an impartial treatment of genetic and environmental hypotheses of racial differences in IQ. He notes that not showing statistically significant differences between two racial groups "can be regarded as accepting the fact that an effect size is trivial" (p. 69). The results of the present study and those of Fagan and Holland (2002) support the null hypothesis that there are no differences between African-Americans and Whites in the processing of equally available information. In so doing, the present results, theoretically and experimentally based, point to an environmental rather than to a genetic source for racial differences in IQ.

More broadly, the results of the present study support the suggestion of Fagan and Holland (2002) that accurate estimates of the genetic and the environmental contributions to intelligence must involve the application of behavior genetic models to measures of information processing where equal opportunity for exposure to information has been experimentally assured. Such an approach might allow us to explain, for example, why socioeconomic status modifies heritability estimates of IQ. Turkheimer, Haley, Waldron, D'Onofrio and Gottesman (2003) analyzed data from a national sample of 7-year-old twins and reported that the IQs of poor children are primarily influenced by the environment, while the IQs of children from affluent families are largely determined by genetics. Our theory, as noted earlier, assumes that measures of knowledge (the IQ score) have two determinants. One is information processing ability which is determined by genetics (assuming no unusual insult to neurological functioning due to non-genetic, biophysical causes). The other is the culture's provision of information to be processed. Any computation of the genetic influence on "intelligence" based on IQ scores reflects both of these influences. Such estimates of genetic influence will be altered to the extent that equal opportunity for exposure to the information underlying the knowledge to be measured by performance on the IQ test varies among the participants. The Turkheimer et al. study, in which a group of upper SES children and a group of lower SES children (including a high proportion of racial

minorities in the latter) were tested, is a case in point. We would assume that the upper class children were apt to have had equal opportunity, among them, to a good provision of information from the culture. If so, differences among them in IQ would largely be due to the influence of genetics on information processing ability. Such was the case. The cultural circumstances of the lower class children provided less information in general and the provision of relevant information within the group was apt to be much more variable than it was within the upper class group. Such circumstances would magnify the effects of the environment on IQ and lower the estimates of genetics on IQ. Such was the case. The empirical question is would such findings emerge from a similar study where intelligence was measured by information processing ability rather than by the IQ score? That is, does SES make a difference in the processing of information? Or does SES reflect differences in access to information, differences so severe as modify heritability estimates of IQ? A study by Smith, Fagan, and Ulvund (2002), for example, found that information processing ability and variations in SES each contributed significant independent variance to the prediction of the IQ scores of 8-year-olds. In effect, conclusions regarding the heritability of intelligence are invariably linked to how intelligence is theoretically and operationally defined.

7.4. What about Flynn?

We know from the now classic work of Flynn (1984, 1987) that IQ scores have increased from generation to generation over the past 80 years or so. Makers of IQ tests have long been aware of such increases and have periodically come up with new items because the older tests have become too easy for a new generation and must be re-written. The point we wish to make is that such generational changes in IQ cannot be used to discount the contribution of genetics to intelligence or to necessarily explain racial differences in IQ. We can not assume that if the Flynn effect is due to culture so must all group differences in IQ be due to culture. To do so would be to adopt the same reasoning underlying Jensen's default hypothesis which says that the same genetic and environmental differences underlying individual differences in IQ underlie group differences in IQ. Nettleback and Wilson (2004) provide the clearest answer to the nature of the Flynn effect. They compared inspection time scores (a measure of information processing) and PPVT IQ scores for children 6–13 years old in 1981 to children of those ages who attended the same primary school as had the previous cohort, but in 2001. Inspection time performance was the same for the 1981 group and the 2001 group. IQ scores were greater for the 2001 group. In other words, the 2001 group knew more, but they did not process information any more quickly, than had the 1981 group. It would appear that the Flynn effect has to do with increases in knowledge over the generations that are not due to increases in information processing ability. Does this mean that contemporary differences in IQ associated with race can be automatically explained by the Flynn effect? No. In a recent investigation of the nature of the Flynn effect, Wicherts et al. (2004, p. 531), conclude that "…the nature of the Flynn effect is qualitatively different from the nature of B [lack]–W[hite] differences in the United states. Each comparison of groups should be investigated separately. IQ gaps between cohorts do not teach us anything about IQ gaps between contemporary groups…"

In the present study, contemporary groups of African-Americans and Whites who differed in IQ did not differ in information processing ability, leading us to conclude that IQ differences between African-Americans and Whites are due to cultural differences in the provision of information. Nettlebeck and Wilson found that cohorts from different generations varied in IQ but not in information processing ability, suggesting that generational differences in IQ are due to differential availability of information from generation to generation. Thus, we arrive at a converging explanation of two kinds of group differences in IQ. Could either study have explained or substituted for the other? No. The studies are not interchangeable. What the studies do have in common, however, is an emphasis on information processing as the heart of intelligence and an experimental approach to examining questions as to group differences in IQ.

7.5. *g*

The present data offer no empirical support for Jensen's (1998) view that racial differences in IQ are due to differences in *g*. Our results do not stand alone. Helms-Lorenz, Van de Vijver, and Poortinga (2003), in a study of majority-group children and second-generation migrant children in the Netherlands, found that performance differences between majority and minority-group members were best predicted by a cultural factor rather than by a general cognitive factor. Moreover, a series of investigations by Dolan (2000), Dolan and Hamaker (2001), Dolan, Roorda, and Wicherts (2004), Lubke, Dolan, and Kelderman (2001) have used multi-group confirmatory factor analysis to ask if differences in IQ between minority groups and majority groups from various cultures can be shown to be due to differences in

g. The general import of the Dolan re-analyses is that it is impossible to draw any clear conclusion on the basis of such studies as to racial group differences in IQ being due to differences in *g*.

With regard to the *g* theory of intelligence, the present studies do not support Jensen's (1998) basic assumption that a single factor always underlies performance on IQ tests. We must bear in mind that, empirically, the *g* factor simply reflects any systematic variance in the data whether or not that variance is due to one or more causes. The only way to find out if one or more factors are determining a particular outcome is by developing and fitting models to data. If we interpret the present results in terms of Fagan's theory of intelligence, then in situations where information has been made equally available to all, knowledge (or IQ) will indeed have one determinant i.e., intellectual or information processing ability. But, in situations where equal opportunity for exposure to information cannot be assumed, knowledge will be determined by both intellectual ability and by access to information. In the present study, in which both Whites and African-Americans participated, multiple regression analyses revealed that there are two influences on IQ, the influence of processing ability (intelligence) and the degree to which exposure to the information to be processed has been provided to individuals. In so doing, the analysis confirms the theoretical view that an IQ score can have multiple determinants.

7.6. Single vs. multiple intelligences

Are we saying that because an IQ score has multiple determinants that there are multiple intelligences? No we are not. We believe that the historical controversy surrounding the issue of single vs. multiple intelligences arose and persists because of the assumption that people taking tests of knowledge have had equal opportunity to be exposed to the information upon which those tests of knowledge are based.

In general, people who do well on one test of knowledge tend to do well on other tests of knowledge. An estimate of the similarities people show in performance over tasks is known as the general factor or *g*. We must bear in mind that *g* is simply a mathematical term used to label whatever the influence is (or whatever the influences are) that causes (or that cause) a person's performance on one test of knowledge to be related to that person's performance on another test of knowledge. As we have noted, there are those, most notably Jensen (1998), who believe that there is a single intellectual factor underlying performance on tests of knowledge and that this single factor can be indexed by *g*. Others feel that there are "multiple intelligences". They suggest that there may be one kind of "intelligence" underlying your ability to learn the meanings of words, another kind of "intelligence" which allows you to form spatial concepts, and so forth. The proponents of multiple intelligences point to the fact that it is sometimes possible to find low correlations among various tests of knowledge. They assume the correlations are low because each test of knowledge or small sets of tests requires their own intelligence and these various intelligences are unrelated. Thus, the multiple intelligences theorists assume that low correlations among tests of knowledge are not possible if a single intellectual factor underlies performance on each test of knowledge. Gardner (1993), for example, suggests that there are separate linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, and intrapersonal intelligences. Robert Sternberg assumes that intelligence can be analytical, creative, or practical and he draws a distinction between academic and practical intelligence citing low correlations between IQ tests (academic knowledge) and tests of practical knowledge to support his position (Sternberg, 1985, 1997). Those in the classic tradition of Horn (1968) who initially proposed a fluid intelligence called Gf and a crystallized intelligence called Gc now assume an additional set of seven "narrow" intellectual abilities as well (Flanagan et al., 2000).

In contrast to both the single intelligence and the multiple intelligences positions, we assume that the opportunity for exposure to the information being tested is not the same from one individual to another. If opportunity for exposure is not equal, then any interpretation of the meaning of the degree of the inter-correlations among subtests becomes highly problematic. We believe, in sympathy with the multiple intelligences position, that there is, indeed, more than one thing going on in the determination of an IQ score across tests of various kinds of knowledge. But it is not that there are many kinds of intelligence. The present theory suggests that any correlation among subtests on an IQ test will be due to two factors. The first is the information processing ability being used to solve the problems from one subtest to another. Some people are better able to process information than are others. A good processor is a good processor whether she is thinking about what a word means, how to solve a puzzle or how to do a math problem. A second source of correlation among subtests, however, is the similarity in training each person has experienced across the areas of knowledge being tested. People who have been given more or less information in one area are likely to also have been given more or less information in other areas. Teaching would be consistent,

for example, if the child's mother talks to her a great deal, also helps her with puzzles, and also tutors her in math. Thus, the correlation among tests of knowledge (what Jensen calls the *g* score) will increase when both information processing ability and what the provision of information by the culture are each contributing consistently to how much a person knows.

Hence, we caution against any reliance on the size of the correlations among tests of knowledge as either proof or disproof of whether or not there is a single intelligence or whether there are multiple intelligences. It is quite possible to find low correlations among tests of knowledge even though the same level of processing is being applied to each test. All one would need to obtain such a low correlation across tests is for the teaching a person has received to vary from one domain of knowledge being tested to another. Similarly, high correlations among tests of knowledge, which proponents of a single intelligence cite in their support, are also logically suspect. Such high correlations may be due to a combination of a single intellectual ability across tests of knowledge *along with* similarities in how well the person has been taught in each area of knowledge.

To summarize, we hold that there is a single intelligence, information processing. We also assume that knowledge is not determined solely by processing but also by the information one has been given by one's culture to process. We caution against relying on the size of the correlations among tests of knowledge for verification of any theory of intelligence. We hold that there is, indeed, a unity to intelligence. This intelligence is measured by how well one processes information. We do not, however, equate information processing ability with the *g* score. We also agree with the general assumption of the multiple intelligences positions that there is more to the determination of knowledge than a single intellective factor. We do not agree, however, that different domains of knowledge are driven by separate intelligences. We believe that the additional determinant of knowledge is not more intelligences but access to information, access driven by the culture.

7.7. Implications for intervention research

Does training or intervention or adoption produce lasting effects on IQ? Yes. Programs of intervention can cause changes in average IQ ranging, over studies, from 3 to 15 points (Jensen, 1998; Ramey & Ramey, 1998). But, the scope and interpretation of such effects depend on a number of factors. The first factor is who are the children undergoing intervention being compared to? A recent meta-analysis by Van IJzendoorn and Juffer (2005), for example, of six studies conducted in Holland which included 253 participants showed that the cognitive development of adopted children is much more advanced than is that of children unrelated to them who remained in institutional care or than that of their genetic siblings in their birth family, the difference being 1.2 deviation units (about 18 IQ points). However, those same adopted children were disadvantaged by 3–4 IQ points compared to their siblings in the adoptive family and their peers in their adoptive culture. In addition to whom the adopted children are being compared to, e.g. their genetic sibs or their adoptive sibs, there are many other factors which influence the interpretation of outcomes in adoption studies. The classic reports based on the Minnesota Trans-racial Adoption Study (Scarr & Weinberg, 1976; Weinberg, Scarr, & Waldman, 1992) on upper class families who adopted low SES African-American children found, in general, that both IQ scores and achievement were greater for these adopted children being reared in the predominant culture than they would have been when compared to population averages. They also found, however, that very early influences in the child's life also played a role in determining the size of such IQ gains. These influences, which were encountered in the child's first two years of life, included age at placement (the earlier the better), time in adoptive home prior to test (the longer the better), number of pre-adoptive placements (the fewer the better) and quality of pre-adoptive placements (the higher the better). Compared to White adopted children, The African-American adopted children tended to be placed later, had spent less time in the adoptive home, had a higher number of pre-adoptive placements, and the pre-adoptive placements tended to be of lower quality. In a similar vein, in studies where children were raised by their birth parents but were given additional training, Ramey and Ramey (1998) note that IQ gains depend on the timing, intensity, and duration of the training. Intervening early in life and providing long-term intervention results in more change.

The theory which guides the present study assumes that intelligence is information processing ability and that the IQ score is a measure of knowledge, knowledge gained by the processing of information. Providing the child with relevant information as soon as possible, as often as possible, as long as possible, and as clearly as possible, results in more knowledge. Delay and failure to provide knowledge will result in a poor knowledge base and, hence, a lower IQ score.

In what ways are African-Americans deprived of access to information? Differences in exposure to information on the parts of African-Americans and Whites

are an empirical fact. As noted by Fagan (2000), Hart and Risley (1995) conducted a longitudinal study on the frequency of verbal stimulation and the resulting language development of children from 1 to 3 years of age. They found that amount of exposure to language predicted the vocabulary development and the IQ scores of the children at three years. They also found that the children of professionals (typically, Whites) were exposed to five times the amount of words than were children of parents on welfare (typically, African-Americans). The Hart and Risley results tell us that the child's exposure to words in their homes during their first few years influences their later IQ. Whites and African-Americans differ in IQ by as early as 3 years (Montie & Fagan, 1988; Peoples, Fagan, & Drotar, 1995). Numerous studies (e.g. see reviews by Bjorklund, 2005; Courage & Howe, 2002) have focused on the knowledge gained by infants through the infants' ability to process information and how that processing ability during the first year of life is predictive of later IQ (Fagan, 1992). All of these findings tell us that the search for racial differences in the kind of knowledge required to solve items on conventional IQ tests must begin in the first months and years of life. In doing so, as Fagan (2000) points out, we must search for specific techniques that caretakers use to direct an infant's attention to relevant information. For example, infants, by 8 months, can segment words from ongoing speech solely on the basis of the relation between neighboring speech sounds (Saffran, Aslin & Newport, 1996). Long before 8 months, mothers speak in an informative manner to their infants by emphasizing particular speech sounds (Kuhl et al., 1997). Do differences in how a mother speaks to her infant aid the infant in segmenting speech and, thus, alter the amount of knowledge of word meanings the child has by 3 years? These and many other studies of the external factors that influence the infant's knowledge along with the measurement of the infant's ability to process information will ultimately lead us to the cultural sources of racial-group differences on standard tests of intelligence.

8. Conclusions

The present study serves as an example of how a long lived and currently much debated issue such as that of racial differences in IQ can be addressed by a theory which defines intelligence as information processing and by experimental studies guided by such a theory. Ceci (2000, p. 242) notes that "By shifting the discourse from knowledge based measures of intelligence to processing measures, Fagan has …offered a fundamental change in the way we conceive of and assess ability". How fundamental is this change from viewing intelligence as the IQ score to viewing intelligence as information processing? The study of information processing is currently a focus of scientists in a number of areas of psychology, neurology, and microbiology. Thus, defining intelligence as information processing not only aids in understanding racial equality in intelligence, it creates the possibility of a multidisciplinary, comprehensive understanding of intelligence.

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