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Using the Implicit Association Test to Measure Age Differences in Implicit Social Cognitions

Mary Lee Hummert, Teri A. Garstka, and Laurie T. O'Brien
University of Kansas

Anthony G. Greenwald and Deborah S. Mellott
University of Washington

Two studies investigated the use of the Implicit Association Test (IAT; A. G. Greenwald, D. E. McGhee, & J. L. K. Schwartz, 1998) to study age differences in implicit social cognitions. Study 1 collected IAT (implicit) and explicit (self-report) measures of age attitudes, age identity, and self-esteem from young, young-old, and old-old participants. Study 2 collected IAT and explicit measures of attitudes toward flowers versus insects from young and old participants. Results show that the IAT provided theoretically meaningful insights into age differences in social cognitions that the explicit measures did not, supporting the value of the IAT in aging research. Results also illustrate that age-related slowing must be considered in analysis and interpretation of IAT measures.

In their review of the research on attitudes, stereotypes, and self-esteem, Greenwald and Banaji (1995) presented persuasive evidence that these social cognitions often operate implicitly (i.e., unconsciously or automatically) to affect judgments and behaviors. Age stereotypes and attitudes are no exception (Levy, 1996; Levy, Hausdorff, Hencke, & Wei, 2000; Perdue & Gurtman, 1990). However, the ways in which implicit age attitudes and stereotypes affect behavior may vary with participant age. Levy (1996), for instance, reported that priming with traits of positive (e.g., wise) or negative (e.g., senile) old-age stereotypes affected memory performance of older participants but not that of young participants. Levy suggested that differences in the applicability of old-age stereotypes to the two groups might account for these results. In other words, an implicit youthful age identity may have buffered young participants from the effects of the priming manipulation, whereas an implicit old age identity made older participants susceptible to the priming. Alternatively, differences between the two groups in the strength of implicit age stereotypes could account for the results: Older individuals may have stronger implicit positive and/or negative age stereotypes than young persons and may therefore be more susceptible to the effects of the priming manipulation.

Empirically testing these alternative explanations and similar issues involving age group differences in implicit cognitions requires a measure of implicit attitudes that can be reliably compared across age groups. The two studies reported here investigated a promising candidate for such a measure, the Implicit Association Test (IAT), developed by Greenwald, McGhee, and Schwartz (1998).

The IAT

Measuring implicit cognitions is challenging because they are by definition "introspectively inaccessible" (Greenwald & Banaji, 1995, p. 19). As a result, the explicit (direct self-report) measures commonly used to assess attitudes and stereotypes are inadequate for the task, primarily because explicit measures may be influenced by participants' self-presentational goals (Greenwald & Banaji, 1995; Greenwald et al., 1998). For example, in a study of racial prejudice, Devine (1989) found that indirect measures of attitudes revealed implicit racial prejudice among participants who reported low prejudice on a direct measure of prejudice. Greenwald et al. (1998) introduced the IAT as a way of meeting this measurement challenge.

Explicit measures of age attitudes ask participants directly to indicate their evaluation of older people (or young people) (e.g., on a semantic differential scale, *unpleasant–pleasant*, *good–bad*, etc.). In contrast, the IAT approaches attitude assessment indirectly by collecting response latencies to category judgment tasks. Greenwald et al. (1998) argued that by focusing participants' attention on making correct category membership judgments rather than on making evaluations, the IAT avoids self-presentational influences that can affect responses on explicit attitude measures. The IAT is based on the logic that judgments congruent with participants' implicit associations of a target category, such as older people, with an evaluative category, such as unpleasant, will be easier and thus will be made more quickly than those that are incongruent, such as older people and pleasant (or

Mary Lee Hummert, Communication Studies Department, University of Kansas; Teri A. Garstka, Gerontology Center, University of Kansas; Laurie T. O'Brien, Department of Psychology, University of Kansas; Anthony G. Greenwald and Deborah S. Mellott, Department of Psychology, University of Washington.

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Correspondence concerning this article should be addressed to Mary Lee Hummert, Communication Studies Department, 102 Bailey Hall, 1440 Jayhawk Boulevard, University of Kansas, Lawrence, Kansas 66045. E-mail: mlhummert@ku.edu

young people and unpleasant). Stronger implicit associations should lead to faster congruent and slower incongruent judgments, increasing the disparity between congruent and incongruent response times (RTs). As a result, a measure of the strength of implicit associations can be obtained by looking at the difference in the time it takes to make these two types of judgment, termed "the IAT effect."

To illustrate, consider the Age Attitude IAT, which involves judgments about targets from two bipolar categories: young-old, represented by photographs of young and older persons, and pleasant–unpleasant, represented by drawings of pleasant and unpleasant objects. Figure 1 provides a schematic of the five judgment tasks included in the IAT. Tasks 1, 2, and 4 are single-category tasks. Each provides practice with the target items and response key assignments for one of the categories: older person–young person in Tasks 1 and 4 (with key assignments reversed on the two tasks), and unpleasant–pleasant in Task 2. Tasks 3 (congruent) and 5 (incongruent) are combined-category tasks that constitute the critical judgments for the IAT. Each requires participants to concentrate on the two bipolar categories simultaneously (i.e., young person–older person and pleasant–unpleasant). On the congruent trials in Task 3, the right-hand and left-hand assignments of the category poles are consistent with expected attitudes. In the case of the Age Attitude IAT, target items that fit in either the young person or pleasant category are responded to with the right hand, and those that fit in either the older person or unpleasant category are responded to with the left hand. On the incongruent trials in Task 5, the pairings conflict with expected attitudes: young person or unpleasant with left hand and older person or pleasant with right hand. The IAT effect is computed as the difference in mean RT to the incongruent (Task 5) and congruent (Task 3) trials. As noted above, the size of this difference, or IAT effect, is interpreted as indicating the strength of the individual's implicit associations (larger IAT effect = stronger implicit attitude).

A growing body of research attests to the reliability (internal and test–retest) and validity (convergent, discriminant, and predictive) of the IAT as a measure of the strength of implicit attitudes, implicit stereotypes, and implicit self-perceptions and shows that the IAT is distinct from explicit (direct self-report) measures of the same constructs (Dasgupta & Greenwald, 2001; Dasgupta, McGhee, Greenwald, & Banaji, 2000; Greenwald & Farnham, 2000; Greenwald et al., 1998; Greenwald & Nosek, 2001; Rudman, Greenwald, & McGhee, 2001; see Greenwald & Nosek, 2001, for a review based on over 30 published or in-press articles using the IAT). The IAT holds promise as a measure of implicit attitudes in the aging domain as well. A potential difficulty, however, is the IAT's reliance on a metric, response latency, which itself varies with age (Salthouse, 1985). In the two studies described here, we used the IAT to assess age differences in implicit attitudes, considering both the IAT's relationship to explicit attitude measures and the implications of age-related slowing for its use in aging research.

Study 1

For our initial investigation of age differences, we collected IAT (implicit) and explicit measures of age attitude, age identity, and self-esteem from young (18–29), young-old (55–74), and old-old (75+) participants. These constructs offered two advantages. First, they provided different expectations about age differences on the implicit and explicit measures. One construct (age attitude) allowed the prediction of age differences on explicit but not implicit measures; another (age identity) suggested that the nature of the construct would differ across explicit and implicit measures, even though age differences should emerge on both; and the third (self-esteem) was expected to remain stable across age groups and measures. Second, each had been investigated in prior IAT research, although not with a focus on age differences (Dasgupta &

Sequence	**Task 1:** Category I Discrimination	**Task 2:** Category II Discrimination	**Task 3:** Categories I + II Congruent Task	**Task 4:** Reversed Category I Discrimination	**Task 5:** Categories I + II Incongruent Task
Hand Assignment	Left Hand / Right Hand	Left Hand / Right Hand	Left Hand / Right Hand	Left Hand / Right Hand	Left Hand / Right Hand
Age Attitude IAT	• Old / Young •	• Unpleasant / Pleasant •	• Old / • Unpleasant / Young • / Pleasant •	• Young / Old •	• Young / • Unpleasant / Old • / Pleasant •
Age Identity IAT	• Old / Young •	• Other / Self •	• Old / • Other / Young • / Self •	• Young / Old •	• Young / • Other / Old • / Self •
Self-Esteem IAT	• Other / Self •	• Unpleasant / Pleasant •	• Other / • Unpleasant / Self • / Pleasant •	• Self / Other •	• Self / • Unpleasant / Other • / Pleasant •

Figure 1. Implicit Association Test (IAT) tasks for Age Attitude, Age Identity, and Self-Esteem IATs. Tasks 1, 2, and 4 are single-category tasks introducing target items (photographs of young and older persons). Tasks 3 and 5 are combined-category tasks that provide the critical trials for the IAT. Category poles (e.g., young, old) are assigned to a left or right response key, indicated by the black circles. Participants use the designated key to indicate the category membership of items. The IAT effect is the response time (RT) to Task 5 (incongruent) trials minus the RT to Task 3 (congruent) trials. Positive IAT effect scores indicate for Age Attitude, more positive toward young than old; and for Self-Esteem, stronger association of self with pleasant than unpleasant.

Greenwald, 2001; Greenwald & Farnham, 2000; Karpinski & Hilton, 2001; Mellott, Greenwald, Hummert, & O'Brien, 2001).

Implicit and Explicit Age Attitudes

Although positive age stereotypes seem to be shared as widely as negative ones (Heckhausen, Dixon, & Baltes, 1989; Hummert, Garstka, Shaner, & Strahm, 1994), reviews of the age attitude research conclude that general attitudes toward older persons are more negative than those toward young persons (Crockett & Hummert, 1987; Kite & Johnson, 1988). Implicit measures reveal the same age bias. Perdue and Gurtman (1990), for example, found that after subliminal priming with *old*, young participants made faster judgments about negative traits, whereas those primed with *young* made faster judgments about positive traits. Research using the IAT to measure implicit age attitudes of young participants provides evidence that the age bias against older people is quite robust (Dasgupta & Greenwald, 2001; Karpinski & Hilton, 2001). These studies collected implicit age attitudes (as measured by IAT scores) of participants following manipulations designed to eliminate the age bias, either exposure to positive older exemplars such as Mother Teresa (Dasgupta & Greenwald, 2001) or to a series of word pairs that linked *elderly* with "good" concepts and *young* to "bad" concepts (Karpinski & Hilton, 2001). In both studies, the IAT revealed that the age bias in implicit attitudes remained, although the manipulations did reduce the magnitude of the IAT effect.

The evidence is mixed regarding the degree to which age attitudes of young and older individuals differ. Several studies suggest that older persons share conceptions of aging similar to those of younger individuals (Heckhausen et al., 1989; Hummert et al., 1994; Zebrowitz & Montepare, 2000). A developmental explanation for this similarity posits that as people progress across the life span, their age schemas become more elaborated, including a greater variety of traits, and more differentiated, including a greater number of subcategories, but retain core elements. Research supports this developmental perspective: Although older persons have more complex views of aging than do younger people, those views are not necessarily more positive (Heckhausen et al., 1989; Hummert et al., 1994). For example, Hummert et al. (1994) found that older participants had more age stereotypes than did younger participants, but those stereotypes included more negative categories as well as more positive ones.

However, some studies report that older persons judge their age group more positively than do young people, even though both age groups have generally negative attitudes toward old age (Harris, 1975; Kite, Deaux, & Miele, 1991; Rothbaum, 1983, Study 3). These findings suggest an in-group bias on the part of older individuals consistent with social identity theory (Tajfel & Turner, 1979).

One reason for these conflicting findings may be that age attitudes are jointly influenced by developmental and social identity processes, but the design of a particular study or its attitude measure taps into one set of processes more than the other. Comparing IAT and explicit measures of age attitudes may help to untangle which of these processes is primary—in the sense of being accessed first, without conscious awareness—when age categories are activated, or it may perhaps demonstrate that they are linked even at the implicit level. Relevant to this issue, the research suggesting in-group bias has largely used explicit measures (e.g., Harris, 1975), whereas that supporting the developmental perspective has tended to use more indirect measures such as trait-sorting tasks (Hummert et al., 1994) or ratings of changes in personality traits over the life span (Heckhausen et al., 1989). Although these indirect measures are not equivalent to the IAT as measures of implicit (automatic, unconscious) attitudes, they do suggest that measurement strategies are related to support for these two theoretical perspectives and that developmental processes may be the strongest influence on implicit age attitudes.

In Study 1, we therefore tested the hypothesis (Hypothesis1; H1) that developmental processes are primary, with that primacy reflected in IAT (implicit) age attitudes that are (H1a) more positive toward young people than older people and (H1b) similar across participant age groups. Social identity processes should affect attitudes only on the explicit measures, with the attitudes of the two older groups of participants revealing in-group bias. Specifically, Hypothesis 2 (H2) predicted that the explicit attitudes of all three age groups would be more positive toward young people than older people but that the attitudes of the two older groups of participants would be less biased against older people than the attitudes of the young participants.

An alternative hypothesis for explicit attitudes derives from the work on implicit and explicit measures of racial prejudice described earlier (Devine, 1989; see also Greenwald & Banaji, 1995). That research suggests that responses on explicit measures may be influenced by self-presentation goals, that is, the desire to appear unprejudiced or unbiased. Consistent with this research, a few studies have reported instances in which the explicit age attitudes of young respondents were more positive toward older than toward young people (Dasgupta & Greenwald, 2001) or were less biased than those of older respondents (Thorson, Whatley, & Hancock, 1974; Tuckman & Lorge, 1954). Hypothesis 3 (H3) was that if self-presentation goals affect the young participants in Study 1, their explicit attitudes would be more positive toward older people than young people (out-group favoritism), whereas the explicit attitudes of the two older groups would favor young people. Critically, both hypotheses regarding explicit attitudes predicted age differences deriving from social motivations (H2, H3), whereas the hypothesis about implicit attitudes predicted no age differences (H1).

Implicit and Explicit Age Identity

Social identity and developmental processes also are implicated in the research on age identity. Explicit measures of age identity such as the Cognitive Age Scale (Barak, 1987) ask respondents to choose an age range (e.g., 20s, 30s) that best describes their subjective age on various dimensions (e.g., physical, social). Consistent with social identity theory, responses of young, middle-aged, and older individuals on such measures reveal distinct age identities, with chronological age accounting for 60%–80% of the variance in age identity (Henderson, Goldsmith, & Flynn, 1995). Although the correlations of age identity and chronological age vary across the age groups, with young adults endorsing age identities slightly older than their chronological ages, and middle-aged and older persons endorsing somewhat younger age identities, clear age divisions corresponding to chronological age groups are evident (Goldsmith & Heiens, 1992; Montepare & Lachman,

1989). That is, 70-year-old adults may report age identities of about 60 or so, and 20-year-old adults may report age identities of about 25 or so, but these age identities do not overlap and generational boundaries remain evident.

Evidence that developmental processes influence age identity comes from investigations of age-specific aspects of the self-concept (Mueller, Johnson, Dandoy, & Keller, 1992) and the "bump" phenomenon in autobiographical memory (Fitzgerald, 1988, 1996; Rubin, Wetzler, & Nebes, 1986). In general, these studies show that persons of advanced age retain youthful identities as core, though not exclusive, components of their self-concepts. For example, Fitzgerald (1988) found that older adults' self-narratives included vivid memories from both their recent and distant past but that a disproportionate number of those memories (the "bump") were from their young adulthood.

As with the age attitude research discussed earlier, research supporting the social identity perspective on age identity (i.e., distinct age identities correspond to chronological age groups) emphasized explicit measurement by using chronological age ranges, whereas the research supporting the developmental perspective on age identity (i.e., central youthful identity even for those of advanced age) used more indirect measures such as self-narratives. Accordingly, Hypothesis 4 (H4) was that developmental processes would be the primary influence on implicit age identity, with (H4a) participants in all three age groups showing a stronger implicit identification with youth than with old age on the Age Identity IAT but with (H4b) the strength of that identification (the IAT effect) decreasing with participant age. In contrast, Hypothesis 5 (H5) was that explicit age identities should reflect the chronological age divisions defining the participant age groups, with young participants endorsing a youthful age identity (e.g., 20–30), young-old participants endorsing a late middle-aged age identity (e.g., 50–60), and old-old participants endorsing an older age identity (e.g., 65+). The critical distinction between our expectations for the implicit and explicit identity measures is that although both should suggest that identity varies with participant age, the former should reveal the centrality of a youthful identity to young and older participants (Mellott et al., 2001) and the latter should reflect the chronological age differences between the groups.

Implicit and Explicit Self-Esteem

Self-esteem was included in this study because, unlike age attitudes and age identity, it should not vary across participant age groups or implicit and explicit measures. Although self-esteem levels vary across individuals, a nearly universal tendency toward positive self-evaluations is well established in the literature (see Taylor & Brown, 1988, for a review). This tendency may derive from or be related to many social psychological processes, including the developmental and social identity processes discussed earlier (Brandtstädter, Wentura, & Greve, 1993; Tajfel & Turner, 1979), but Taylor and Brown (1988) suggested that its primary function is adaptive in that positive self-esteem enables individuals to cope with their daily lives. Generally high levels of self-esteem have been found with self-report scales such as the Rosenberg Self-Esteem Scale (Rosenberg, 1965), as well as with an IAT measure of implicit self-esteem (Greenwald & Farnham, 2000). Further, self-esteem does not diminish with age. Cross-sectional and longitudinal research shows that older individuals are successful in maintaining their self-esteem and sense of personal well-being, despite experiencing the losses that often accompany old age (Brandtstädter & Greve, 1994; Brandtstädter et al., 1993; Ryff, 1991; Zebrowitz & Montepare, 2000). As a result, Hypothesis 6 (H6) was that the implicit self-esteem IAT and explicit self-esteem measures would reveal equivalent, and positive, self-perceptions across the three age groups.

In establishing the validity and reliability of the IAT measure of self-esteem, Greenwald and Farnham (2000) found that the self-esteem IAT and explicit self-esteem scales were positively, but weakly, correlated and reflected distinct self-esteem dimensions. Small, positive correlations between IATs and explicit measures have been found consistently in IAT research (Greenwald & Nosek, 2001); we expected these small, positive correlations in this study as well, even when the IAT and explicit measures supported the same pattern of age differences among the groups.

Method

Participants. Study 1 involved 114 participants from three age groups: 36 young adults (mean age = 21.9 years; range = 18–29 years; 12 men, 24 women), 38 young-old adults (mean age = 69.4 years; range = 55–74 years; 11 men, 27 women), and 40 old-old adults (mean age = 80.4 years; range = 75–93 years; 12 men, 28 women). Young adults were students enrolled in a basic communication course and were given course credit for their participation. Older adults were recruited from the community and received nominal payment for their time.

Materials and procedures. This study used IAT items and procedures developed by Mellott et al. (2001) in their test of the unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept (Greenwald et al., 2002). Figure 1 presents the target categories for the Age Attitude, Age Identity, and Self-Esteem IATs. Target items for these categories were (a) age: eight black-and-white photographs of smiling young adults (perceived age 18–27; 4 male, 4 female) and eight of smiling older adults (aged 60–90; 4 male, 4 female); (b) pleasantness: eight black-and-white drawings of unpleasant objects (beetle, gun, bomb, reptile, spider, snake, fly, cigarettes) and eight of pleasant objects (balloon, cherries, puppy, flowers, trumpet, teddy bear, bird, bells); and (c) self: 4 *self* words (*me*, *mine*, *my*, *self*), and four *other* words (*other*, *them*, *their*, *they*). The photographs of young persons were selected from noncopyrighted Web pages on the Internet by Mellott et al. (2001). The photographs of the older individuals were from Hummert, Garstka, and Shaner (1997). Pilot testing revealed that the young and older persons pictured were perceived as moderately happy (young: $M = 4.7$; old: $M = 4.4$, on a 7-point scale, 1 = *not at all happy*; 7 = *extremely happy*).

The IAT tasks were presented on Pentium-III personal computers with color monitors. Target items appeared in the center of the screen on a light blue background. Category labels (e.g., *young*, *old*) appeared in boxes (black letters on white background) in the upper right and left corners of the screen, corresponding to the left- and right-hand assignments in Figure 1. A blue dot marked the *a* key on the computer keyboard, and a green dot marked the *5* key on the number pad. Participants were instructed to press the left (blue dot) key if the target item belonged to the category on the left and the right (green dot) key if the target item belonged to the category on the right. They were to make these judgments as quickly but as accurately as possible. If the incorrect key was pressed, the word *ERROR* appeared in the center of the screen and the next item did not appear until the correct key had been pressed. For each trial, the computer recorded RT in milliseconds from the initial appearance of the target to the correct response.

All participants completed 23 blocks of category judgments. Blocks 1 and 2 provided instructions and practice with a single-category and com-

bined task to introduce the procedures to participants. These categories were not connected with the three IAT measures. The remaining 21 blocks required judgments on the categories and dimensions of the age attitude, age identity, and self-esteem IATs. For all IATs, Tasks 1, 2, and 4 (see Figure 1) involved judgment blocks of 20 trials each. Following standard practice in IAT research (e.g., Dasgupta & Greenwald, 2001; Dasgupta et al., 2000; Greenwald & Farnham, 2000), the combined judgment Tasks 3 and 5 included a practice block of 20 trials and an experimental block of 40 trials. For the 40 experimental trials, each of the four target categories (e.g., pleasant–unpleasant, young–old for the Age Attitude IAT) was programmed to appear 10 times. Within the categories, items were randomly selected without replacement until all items were selected once, and then the entire pool was refilled. This was repeated as necessary to complete the block of trials. Thus, over the course of a mixed-category block, 40 target items appeared so that 10 items represented each of the four categories, with some items appearing more than once because of random selection.

Order of the three IATs was counterbalanced across participants within each age group. In addition, within IAT order, half the participants were randomly assigned to complete the incongruent (Task 5 in Figure 1) blocks first and the congruent (Task 3 in Figure 1) blocks second. The Inquisit computer program (Millisecond Software, 2000) controlled presentation of items, order of blocks, and recording of RTs.

Participants also completed a questionnaire either before or after the computer tasks on the basis of random assignment. The questionnaire included demographic items as well as explicit measures of age attitudes, age identity, and self-esteem.

Explicit attitude measures. Explicit attitude measures were the same as those used by Mellott et al. (2001). To assess age attitudes, participants chose specific "temperatures" on two feeling thermometer scales (one for feelings about young people and one for feelings about older people) in which 0° = *cold or unfavorable*, 50° = *neutral*, and 99° = *warm or favorable*. Participants also completed two 5-item (ugly–beautiful, bad–good, unpleasant–pleasant, dishonest–honest, awful–nice) semantic differential measures by using a 7-point scale. They rated young people on one semantic differential and older people on the other. Attitudes toward young and older people were computed as the mean across the 5 items (Cronbach's $\alpha = .86$, attitude to young; .90, attitude to older), with higher means indicating more positive attitudes.

Participants also completed the Rosenberg (1965) Self-Esteem Scale. The scale contained 10 items about the self (e.g., having good qualities, a positive attitude toward oneself, satisfaction with the self, etc.) that participants evaluated by using a 4-point Likert scale, ranging from 0 (*strongly disagree*) to 3 (*strongly agree*). Self-Esteem scores were computed by summing across the 10 items (Cronbach's $\alpha = .80$), with higher scores indicating higher self-esteem (maximum score = 30).

For age identity, participants completed the Cognitive Age Scale (Barak, 1987). This 4-item scale assessed age identity by asking participants to circle an age decade (preteens, teens, 20s, 30s, 40s, 50s, 60s, 70s, 80s) that best described their interests, looks, feelings, and activities. Following Barak, the midpoint of the decade selected (e.g., 25 for 20s) for each item was recorded, and the average of the four items (Cronbach's $\alpha = .98$) served as the age identity measure.

Response latency data preparation. Following procedures used in prior research with the IAT (e.g., Dasgupta et al., 2000; Greenwald & Farnham, 2000; Greenwald et al., 1998; Rudman et al., 2001), (a) the first two trials of each data collection block were dropped and (b) trial latencies were transformed to their natural log values to moderate the positive skew associated with response latencies.

Earlier IAT research (e.g., Dasgupta et al., 2000; Greenwald & Farnham, 2000; Greenwald et al., 1998; Rudman et al., 2001) has used 300 ms as the lower limit and 3,000 ms as the upper limit for trial latencies, with all latencies below or above these limits recoded accordingly. Latencies below 300 ms were rare in the Study 1 data but, consistent with evidence for age-related slowing (Salthouse, 1985), the majority of the older participants had several latencies of 3,000 ms or above. As a result, we screened the data for outliers within age groups instead of recoding to 3,000 ms. Data were excluded from 2 young-old and 3 old-old participants with (a) at least one experimental block (i.e., Task 3 [congruent] and Task 5[incongruent] blocks for the three IAT measures; see Figure 1) with a mean latency ≥ 2.5 *SD* from the group mean and (b) an additional two or more IAT blocks in which the means were at least 1.5 box lengths above the upper interquartile mean. Data from 1 other old-old participant were dropped because of a testing problem in one block. Additional participants were recruited to replace these 6 individuals. Error rates were also examined, but the only individual with a high error rate (25% or more on five of the six IAT blocks) was in the group of outliers. In general, error rates were low in all three age groups (young: $M = .04$; young-old: $M = .02$; old-old: $M = .03$). Given this low error rate and standard practice in the analysis of IAT data (Dasgupta & Greenwald, 2001; Dasgupta et al., 2000; Greenwald & Farnham, 2000; Greenwald et al., 1998; Karpinski & Hilton, 2001; Rudman et al., 2001), RTs for trials with errors were retained in the data set.[1]

Results

To review, we predicted that Age Attitude, Age Identity, and Self-Esteem IATs would show implicit attitudes favoring the young (H1), youthful age identities (H4), and positive self-esteem (H6) for participants of all ages. We expected age differences only on the Age Identity IAT, with young-old and old-old participants showing less (though still significant) implicit identification with youth (i.e., a weaker IAT effect) than the young participants. We also predicted that results for the explicit measures of age attitude (H2 and H3) and age identity (H5)—but not explicit self-esteem (H6)—would differ from the IAT results. We advanced two alternative hypotheses about age differences on the explicit age attitude measure, with H2 predicting in-group bias in the age attitudes of the two older participant groups and H3 predicting out-group favoritism in the age attitudes of young participants. On the explicit age identity measure, we expected that cognitive age scores would show distinct age identities across the participant age groups consistent with their age group classifications (H5).

Implicit association test results. Participants' means for the six IAT blocks (the blocks in which the congruent and incongruent RTs were gathered for the three IAT measures; see Tasks 3 and 5 in Figure 1) were analyzed in a 3 (age group) × 3 (IAT order) × 2 (congruency order) × 3 (IAT type) × 2 (task congruence) mixed-model analysis of variance, with IAT type and task congruence as within-subjects factors. Results revealed significant main effects of IAT type, $F(2, 180) = 6.99$, $MSE = 0.01$, $p = .001$, $\eta^2 = .07$; task congruence, $F(1, 90) = 234.64$, $MSE = 0.04$, $p = .000$, $\eta^2 = .72$; and age group, $F(2, 90) = 54.92$, $MSE = 0.22$, $p = .000$, $\eta^2 = .55$. Two interaction effects were also significant, the two-way IAT Type × Congruence interaction, $F(2, 180) = 13.29$, $MSE = 0.01$, $p = .000$, $\eta^2 = .13$, and the three-way interaction between age

[1] Although inclusion of error latencies is standard in the analysis of IAT data, it is not standard in the cognitive aging literature. As a result, all analyses in Study 1 were also conducted with error trials removed. These analyses yielded the same significant effects as those for the full data set, including the significant three-way interaction among age group, IAT type, and task congruence for both log latencies, $F(4, 180) = 5.39$, $p = .000$, and *z*-score latencies, $F(4, 180) = 3.49$, $p = .009$.

group, IAT type, and task congruence, $F(4, 180) = 5.48$, $MSE = 0.01$, $p = .000$, $\eta^2 = .11$.[2]

To investigate the three-way interaction, we first analyzed the effects of task congruence (incongruent versus congruent RTs) within IAT type within age group. This analysis showed that mean RT to incongruent trials was significantly longer than that to congruent trials for the three IATs for participants in all age groups (see Table 1). That is, participants of all ages had faster response latencies to young–pleasant/old–unpleasant trials than to old–pleasant/young–unpleasant trials (implicit age attitude favoring youth as predicted in H1a), to self–young/other–old trials than to other–young/self–old trials (youthful implicit age identity as predicted in H4a), and to self–pleasant/other–unpleasant trials than to other–pleasant/self–unpleasant trials (positive implicit self-esteem as predicted in H6).

Next, we computed Age Attitude, Age Identity, and Self-Esteem IAT effect measures for each participant by subtracting mean RTs for congruent trials from means for incongruent trials. These IAT effects were then used as interaction contrasts to examine age group differences (Green, Salkind, & Akey, 1997). Because the IAT effects represent differences between mean response latencies, we use the adjectives *larger* and *smaller* (rather than adjectives associated with speed) to describe significant differences between age groups.

As shown in Table 1, old-old participants had significantly larger Age Attitude IATs than did young participants, $F(1, 90) = 7.99$, $MSE = 0.05$, $p = .006$. The Age Attitude IAT for young-old participants fell between those of the other two age groups but did not differ significantly from either ($ps > .14$). These results suggest that the oldest group of participants had stronger implicit positive attitudes toward youth (and negative ones toward the old) than did young participants, contrary to H1b.

Results also failed to support H4b. There were no significant differences between old-old, young-old, and young participants on the Age Identity IAT ($ps > .09$), suggesting that participants of all ages identified equally as young (see Table 1).

Finally, this analysis identified an unexpected age difference in implicit self-esteem (see Table 1). Contrary to H6, young participants had smaller Self-Esteem IATs (less positive self-esteem) than did young-old, $F(1, 90) = 4.24$, $MSE = 0.05$, $p = .04$, and old-old participants, $F(1, 90) = 3.52$, $MSE = 0.05$, $p = .06$, although the latter difference was only marginally significant.[3]

Explicit attitude results. To create an explicit attitude measure comparable to the age attitude IAT, we subtracted each participant's attitude-to-older-people rating from their attitude-to-young-people rating on (a) the feeling thermometer and (b) the semantic differential scale. Next, to create a common metric, we transformed these difference scores into *z* scores by using the sample means and standard deviations. Finally, we computed a composite age attitude measure for each person as the mean of the two attitude *z* scores (Greenwald et al., 2002). We also transformed each participant's Cognitive Age and Rosenberg Self-Esteem scores into *z* scores by using the sample mean and standard deviation so that they could be compared with the composite age attitude variable. Thus, positive *z* scores on the attitude, identity, and self-esteem variables indicated, respectively, more positive attitudes toward young adults, an older age identity, and higher self-esteem.

Table 1
Means and Standard Deviations for Log Latencies by Implicit Association Test (IAT), Task Congruence, and Age Group

	Congruent		Incongruent		IAT effect	
Participant age	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age Attitude IAT						
Young adults	6.37	0.13	6.59	0.22	0.22_a	0.18
Young-old adults	6.66	0.20	6.95	0.32	0.29_{ab}	0.26
Old-old adults	6.75	0.15	7.11	0.35	0.36_b	0.27
Age Identity IAT						
Young adults	6.40	0.16	6.61	0.22	0.22_a	0.17
Young-old adults	6.76	0.28	6.99	0.32	0.23_a	0.28
Old-old adults	6.88	0.25	7.03	0.30	0.14_a	0.27
Self-Esteem IAT						
Young adults	6.39	0.14	6.61	0.21	0.22_a	0.16
Young-old adults	6.69	0.25	7.01	0.29	0.32_b	0.26
Old-old adults	6.80	0.17	7.12	0.33	0.31_b	0.27

Note. For all age groups, congruent and incongruent means differ significantly at $p < .05$. The IAT effect is the difference between the incongruent mean and the congruent mean. Because of rounding, the mean IAT effect may not exactly equal the difference between the tabled values. Larger IAT effects indicate more positive attitude to young over old, younger age identity, and higher self-esteem. Within IAT types (age attitude, age identity, self-esteem), IAT effect means with different subscripts differ between age groups at $p < .05$.

These variables were analyzed in a 3 (age group) × 2 (questionnaire order) × 3 (attitude type) mixed-model analysis of variance, with attitude type as a within-subjects factor. The analysis identified a significant main effect of age group, $F(2, 96) = 41.27$, $MSE = 0.51$, $p = .000$, $\eta^2 = .47$, and a significant two-way interaction involving attitude type and age group, $F(4, 186) = 21.30$, $MSE = 0.58$, $p = .000$, $\eta^2 = .31$. Interaction contrasts supported our hypotheses regarding explicit attitudes. Although the contrast statistics presented were computed on the

[2] Effects involving the procedural variables (IAT order and congruent order) are not discussed here for two reasons. First, they were similar to those identified in prior IAT research (see Greenwald & Nosek, 2001), showing (a) that the size of the IAT effect (i.e., the difference between the latencies for incongruent and congruent tasks) was smaller when the incongruent task preceded the congruent task than when it followed the congruent task and (b) that participants became faster across the three IATs. Second, the effects of these procedural variables did not differ with participant age.

[3] A parallel analysis of the raw latencies produced a similar pattern of significant effects and age group differences as log data: (a) Old-old participants ($M = 495.4$) had a significantly larger Age Attitude IAT than did young ($M = 175.2$), $F(1, 90) = 20.17$, $p < .001$, and young-old participants ($M = 314.9$), $F(1, 90) = 6.41$, $p < .05$; but the difference between young-old and young participants was only marginally significant, $F(1, 90) = 3.84$, $p < .06$; (b) old-old ($M = 453.1$), $F(1, 90) = 13.10$, $p < .001$, and young-old participants ($M = 345.4$), $F(1, 90) = 4.91$, $p < .05$, had significantly larger Self-Esteem IATs than did young participants ($M = 175.6$), but the Self-Esteem IATs for the two older groups of participants did not differ significantly, $p = .16$; and (c) there were no significant differences between old-old ($M = 191.8$), young-old ($M = 261.2$), and young participants ($M = 172.8$) on the Age Identity IAT ($ps > .20$). These effects were the same with the error trials removed.

standardized data, raw means are used in describing the results for self-esteem and cognitive age to facilitate interpretation.

Two alternative hypotheses were proposed for age attitudes, with H2 predicting in-group bias on the part of the two older groups of participants and H3 predicting out-group favoritism on the part of the young participants. Results supported H3. Attitudes of young-old adults ($M = 0.18$, $SD = 0.68$), and old-old adults ($M = 0.19$, $SD = 0.54$) favored young over old. However, attitudes of young participants ($M = -0.31$, $SD = 0.74$) favored old over young, differing significantly from attitudes of young-old, $F(1, 96) = 9.53$, $MSE = 0.44$, $p = .003$, and old-old participants, $F(1, 96) = 9.37$, $MSE = 0.44$, $p = .003$.

Consistent with H5, age identity differed significantly across the three age groups, with young adults endorsing a younger age identity ($M = 30.76$, $SD = 8.39$) than young-old adults ($M = 63.21$, $SD = 7.80$), $F(1, 96) = 273.62$, $MSE = 0.17$, $p = .000$, and young-old adults endorsing a younger age identity than old-old adults ($M = 73.41$, $SD = 8.02$), $F(1, 96) = 25.48$, $MSE = 0.17$, $p = .000$. Finally, supporting H6, participants in all age groups reported similarly high levels (maximum possible score = 30) of self-esteem (ps $> .45$)—young: $M = 24.20$, $SD = 4.01$; young-old: $M = 24.55$, $SD = 3.89$; old-old: $M = 23.81$, $SD = 3.77$.

As in prior IAT research, the correlations between the implicit and explicit measures were low and nonsignificant: age attitude $r = .17$; age identity $r = -.18$; and self-esteem $r = -.06$. However, two of the correlations were negative, which is inconsistent with prior IAT research (Greenwald & Nosek, 2001).

Discussion

On the one hand, the IAT results provided support only for our basic hypotheses regarding the direction of implicit associations, revealing more positive implicit attitudes toward the young than the old, a youthful implicit age identity, and positive implicit self-esteem in participants of all ages. On the other hand, our hypotheses regarding age similarities and differences in implicit attitudes, identities, and self-esteem were rejected. Although we had expected no age differences in implicit age attitudes and implicit self-esteem, the IAT results suggested that the old-old participants were more biased in favor of youth (and against their own age group) than the young participants, and that those in the two older age groups had higher implicit self-esteem than young participants. Similarly, we had predicted that implicit identification with youth would decrease from young to young-old, to old-old participant groups. Instead, no age differences were found in implicit age identity, suggesting that a youthful age identity was equally salient to young and older participants. These results provide mixed support for our prediction that developmental processes may be the primary influence on implicit age attitudes and age identities. Although the basic pattern of IAT effects was consistent with the developmental perspective, the more negative attitudes of the older participants toward their age group and the equally strong identification with a youthful identity across the participant age groups were not.

Our predictions regarding explicit attitudes, age identity, and self-esteem received more support. Consistent with the second of the alternative hypotheses for explicit attitudes, young participants favored older people over young people, and attitudes of older participants exhibited the expected bias toward the young over the old. As expected, explicit age identities increased significantly across the three participant age groups, and self-esteem scores revealed equivalent, positive, self-perceptions in the three groups. In general, results for the explicit measures supported our expectation that social motivations (self-presentation and social identity) are implicated in direct assessments of age attitudes and identities.

IAT results and validity of the hypotheses. Why were our expectations regarding age differences more accurate for explicit than for implicit perceptions? One possibility is that our hypotheses regarding the centrality of developmental processes in implicit attitudes were drawn primarily from research that used indirect, but not truly implicit, measures. As a result, these hypotheses may have been off the mark with respect to implicit perceptions (Greenwald & Banaji, 1995; Greenwald et al., 1998). For instance, the prediction of similar high levels of implicit self-esteem across the age groups may have underestimated the potential for developmental processes—perhaps successful coping over the life span (Ryff, 1991)—to lead to increased implicit self-esteem in older persons. Similarly, the hypothesis that age attitudes would be similar across the age groups may have underestimated the contribution of social identity processes to implicit attitudes: The more negative implicit attitudes of the oldest participants toward their own age group may serve to buffer their personal identities from negative age stereotypes, an instance of the "black sheep effect" (Marques, Yzerbyt, & Leyens, 1988). However, the hypotheses were strongly grounded in the social psychological literature, and these post hoc explanations could be challenged from within that literature. The black sheep effect, for example, has emerged only in judgments of specific negative representatives of the in-group, not in general attitudes, and only on explicit attitude measures. In addition, it seems unlikely that all three predictions regarding age differences on the implicit measures would be rejected whereas those for the explicit measures were supported.

Age-related slowing and the IAT. Another possibility is that the IAT results reflect not only implicit perceptions but also age group differences in speed of processing. A substantial body of research has demonstrated that older adults are slower relative to young adults on cognitive tasks and that the degree of slowing is affected by task complexity (see Cerella, 1990, and Salthouse, 1985, for reviews). In general, older persons show a larger increase in RT from simple to complex tasks than do younger persons (Cerella, 1994; Faust, Balota, Spieler, & Ferraro, 1999; Hultsch, Hertzog, & Dixon, 1990). Like many of the experimental tasks used to study cognitive aging, the IAT involves a simple (congruent) and a complex task (incongruent). As outlined earlier, task complexity is central to the logic behind the IAT: Response latencies are expected to be faster to the congruent judgments than to the incongruent because the former are consistent with participants' social schemas (i.e., simple) and the latter are not (i.e., complex). The pattern of age group differences on the age attitude and self-esteem IATs in this study corresponds to age group differences in response latencies to simple and complex tasks in the cognitive aging literature. Therefore before concluding that older persons have stronger implicit attitudes favoring youth and higher implicit self-esteem than young people, we conducted a second analysis of the IAT data, using a z-score transformation

recommended by Faust et al. (1999) to control for the effects of age-related slowing on RTs.

Study 1: Analysis 2

Several statistical transformations have been applied to response latencies to control for general age-related slowing. These include natural logs (as in the first analysis of Study 1), proportion (dividing each individual's mean latency on one task by the person's mean latency on all tasks), task-level *z* scores (converting each individual's mean latency on trials for one task into a *z* score on the basis of the person's mean latency and standard deviation on all tasks), and trial-level *z* scores (using each person's overall mean and standard deviation to convert each trial into a *z* score) (Faust et al., 1999). On the basis of the analysis of Faust et al. (1999), we selected the trial-level *z*-score transformation as the most appropriate for this data set. Advantages of this transformation over the others include (a) its ability to adjust response latencies not only for the individual's mean or base RT but also for the variability (standard deviation) in the individual's RT; (b) its ease of computation; and (c) its suitability for data sets like the one in this study, which include only a few means from each individual.

Transformation procedures for trial level z scores. To complete this transformation, each participant's mean and standard deviation were computed across all trials in the six experimental blocks ($N = 228$, or 6 blocks $\times$ 38 trials). These statistics were then used to convert his or her trial latencies into *z* scores prior to computing the congruent and incongruent task means for the three IATs. We examined Brinley plots (Brinley, 1965; Cerella, 1994) to evaluate the effectiveness of the transformation in converting the latencies from young and older participants to a common information-processing scale. Brinley plots are simple regression slopes produced by using young adult means on cognitive tasks to predict older adult means on the same tasks. Brinley plots of raw latencies typically have slopes greater than 1.00 and negative intercepts, and a transformation that produces a slope of 1.00 and an intercept of 0.00 would indicate success in controlling for speed of processing differences between age groups (Faust et al., 1999). Figure 2 presents Brinley plots for three Study 1 data sets: raw latencies, natural logs, and *z* scores. The *z*-score transformation (Graph C of Figure 2) produced slopes closest to 1.00 and intercepts closest to 0.00 for both young-old and old-old participants, providing support for our selection of this transformation.[4]

Results for z-score-transformed IAT data. Participants' means for the six IAT blocks were analyzed in a mixed-model analysis of variance by using the same design as for the log data. Results revealed significant main effects of IAT type, $F(2, 180) = 5.92$, $MSE = 0.10$, $p = .003$, $\eta^2 = .06$; and task congruence, $F(1, 90) = 288.62$, $MSE = 0.16$, $p = .000$, $\eta^2 = .76$; as well as a significant IAT Type $\times$ Congruence interaction, $F(2, 180) = 8.56$, $MSE = 0.08$, $p = .000$, $\eta^2 = .09$, and a significant three-way interaction between age group, IAT type, and task congruence, $F(4, 180) = 2.89$, $MSE = 0.08$, $p = .02$, $\eta^2 = .06$.[5]

Analysis of the three-way interaction showed that mean RT to incongruent trials was significantly longer than that to congruent trials for the three IATs (age attitude, age identity, and self-esteem) for participants in all age groups, establishing that the IAT effect was present for all IATs. Means are presented in Table 2 and show that the direction of the Age Attitude, Age Identity, and Self-Esteem IAT effects were the same as in the analysis of the log data and predicted in H1, H4, and H6. Interaction contrasts (Green et al., 1997) comparing the size of the IAT effect across age groups showed there were no significant differences between old-old, young-old, and young participants on the Age Attitude IAT ($ps > .20$), as expected (H1b). Contrasts for the Age Identity IAT revealed that old-old participants had a significantly smaller Age Identity IAT effect (i.e., an older age identity) than did the young participants, $F(1, 90) = 5.79$, $MSE = 0.22$, $p = .02$, partially supporting H4b. However, young-old participants did not differ significantly from either young ($F < 1$) or old-old participants on the Age Identity IAT ($p > .11$). Finally, results supported our prediction (H6) that the three age groups would have similar Self-Esteem IATs ($ps > .33$).

As with the log IATs, correlations between the *z* score IATs and explicit measures were low and nonsignificant, with two of the three negative in direction: age attitude $r = .17$; self-esteem $r = -.14$; and age identity $r = -.15$.

Summary of Study 1

Table 3 provides an overview of the hypotheses and results for Study 1. As this table reveals, the IAT results of our second analysis provided support for our basic hypotheses regarding the direction of implicit associations (i.e., more positive implicit attitudes toward the young than the old, a young implicit age identity, and positive implicit self-esteem), as had our first analysis but, unlike the first analysis, also supported the majority of our expectations regarding similarities and differences in the strength of implicit associations across age groups. As expected age differences were found only on the Age Identity IAT, showing that the oldest participants identified less with youth than did the youngest participants (although the young-old group did not differ in age identity from the other two age groups). Also as predicted, Age Attitude and Self-Esteem IATs indicated equivalent implicit attitudes and self-esteem across the three age groups. With the *z*-score

[4] As a further check on our choice of transformation, we evaluated proportion and task-level *z* scores in comparison to the trial-level *z* scores (Faust et al., 1999). The proportion scores were calculated by dividing participants' means for each of the six IAT blocks by their grand mean across blocks. The task-level *z*-score transformation converted participants' means for each of the six IAT blocks to *z* scores on the basis of their grand mean and standard deviation across blocks. Brinley plots (Brinley, 1965) showed that in comparison to trial-level *z* scores (slopes in Graph C of Figure 2), proportions undercorrected for age-related slowing (slopes of 1.23 for both young-old and old-old) and the task level *z* scores overcorrected for age-related slowing (slopes of 0.87 for young-old and 0.85 for old-old). Note that each of these transformations was applied to data from young and older participants alike. Readers may speculate that transforming only latencies from older adults by using the Brinley plot slope and intercept for raw data would be a simpler strategy. However, this strategy would not take into account the individual differences in RT that underlie group differences (Faust et al., 1999). Further, Ratcliff, Spieler, and McKoon (2000) caution that a Brinley plot slope may signal age differences in RT but it should not be interpreted as a measure of age-related slowing.

[5] Effects involving the procedural variables (IAT order and congruent order) were the same as those found with the log data and described in Footnote 2.

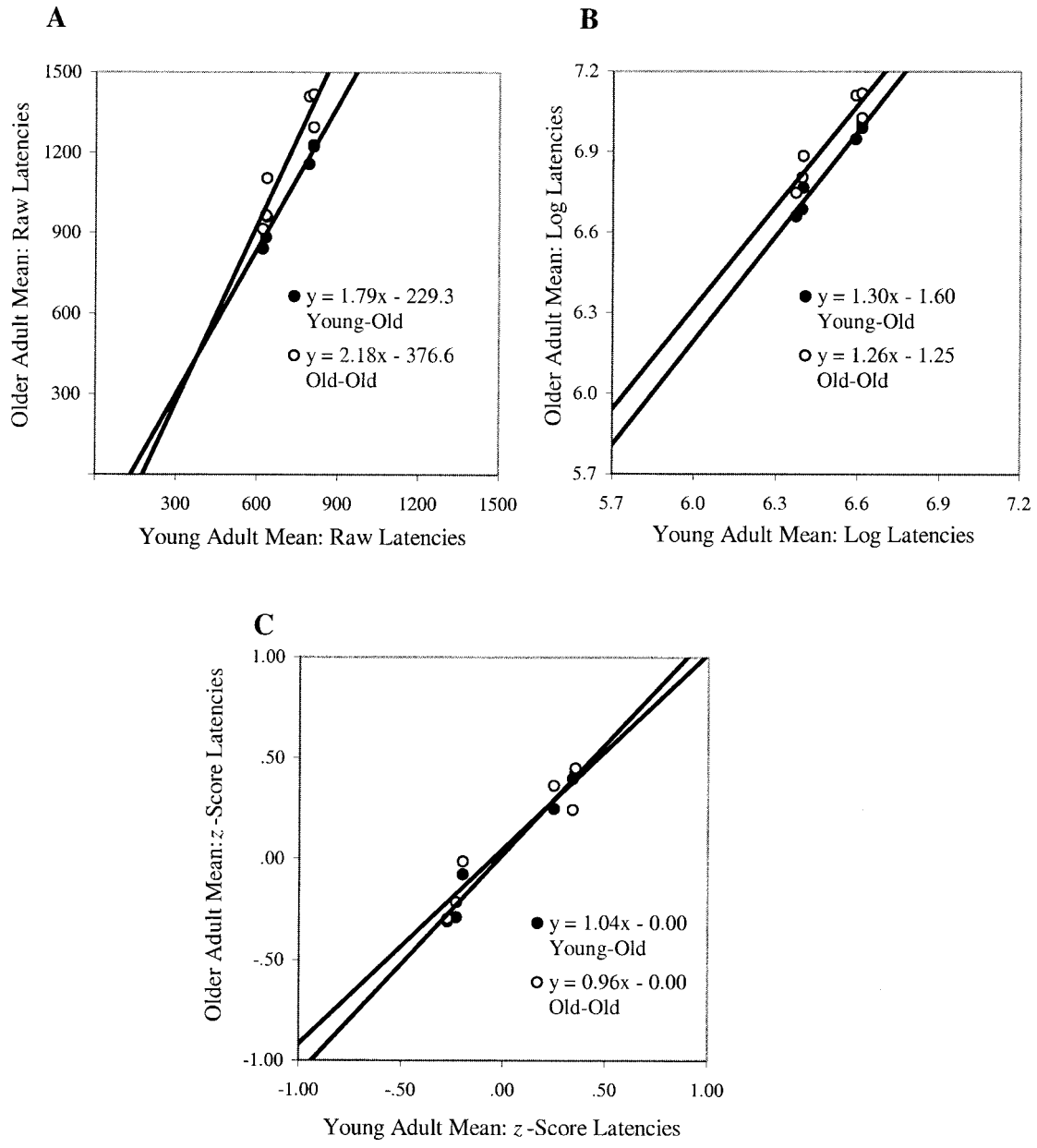

Figure 2. Brinley plots for raw latencies from Study 1 (Graph A), and two transformations of those latencies: log (Graph B) and trial-level *z* scores (Graph C). All include scatter plots and regression lines for two equations: (a) IAT experimental block means for old-old participants predicted by young participant means and (b) IAT experimental block means for young-old participants predicted by young participant means.

transformation, the hypotheses regarding implicit measures received the same level of support as the hypotheses about explicit measures.

These findings not only confirm our expectations regarding the primacy of developmental processes in implicit associations but also suggest that age-related slowing contributed to the age differences that emerged in the analysis of the log data. Although the effects identified in the log data might describe patterns of associations for some individuals within age groups (Greenwald et al., 2002) or attitudes toward negative representatives of one's group (Marques et al., 1988), they are not consistent with current psychological theory regarding age group differences and similarities in age attitudes, age identity, or self-esteem. When we used a *z*-score transformation to control for age differences in processing speed, however, results were consistent with theory.

Study 2

To verify the validity of our conclusions regarding the effects of age-related slowing on IAT responses and the usefulness of the

Table 2
Means and Standard Deviations for z Score Latencies by Implicit Association Test (IAT), Task Congruence, and Age Group

	Congruent		Incongruent		IAT effect	
Participant age	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age Attitude IAT						
Young adults	−0.31	0.26	0.21	0.28	0.53_{a}	0.44
Young-old adults	−0.36	0.25	0.18	0.43	0.55_{a}	0.56
Old-old adults	−0.37	0.22	0.30	0.38	0.67_{a}	0.49
Age Identity IAT						
Young adults	−0.24	0.30	0.30	0.29	0.53_{a}	0.47
Young-old adults	−0.14	0.35	0.30	0.40	0.44_{ab}	0.60
Old-old adults	−0.13	0.30	0.14	0.32	0.27_{b}	0.51
Self-Esteem IAT						
Young adults	−0.27	0.20	0.31	0.31	0.57_{a}	0.41
Young-old adults	−0.33	0.30	0.35	0.46	0.68_{a}	0.60
Old-old adults	−0.29	0.25	0.34	0.36	0.63_{a}	0.51

Note. For all age groups, congruent and incongruent means differ significantly at $p < .05$. Negative *z* scores indicate faster response times (RTs); positive *z* scores indicate slower RTs. The IAT effect is the difference between the incongruent mean and the congruent mean. Because of rounding, the mean IAT effect may not exactly equal the difference between the tabled values. Larger IAT effects indicate more positive attitude to young over old, younger age identity, and higher self-esteem. Within IAT types (age attitude, age identity, self-esteem), IAT effect means with different subscripts differ between age groups at $p < .05$.

z-score transformation in controlling for those effects, we conducted a second study with categories that participants of all ages should perceive similarly: insects and flowers. Prior research suggested that participants would exhibit more positive implicit and explicit attitudes toward flowers than insects (Greenwald et al., 1998; Karpinski & Hilton, 2001), but no theory predicted age group differences in these attitudes. However, age-related slowing would predict larger differences between response latencies to congruent (simple) and incongruent (complex) tasks (i.e., larger IAT effect) for older than young participants (Cerella, 1990; Salthouse, 1985). Because age-related slowing provided the only plausible theoretical explanation for any age differences in the size of the IAT effect, using these age-neutral categories allowed us to test the hypothesis that the *z*-score transformation would be superior to the log transformation in controlling for the effects of age-related slowing on IAT data. Specifically, we predicted that log-transformed IAT data would show that older participants had more positive attitudes toward flowers over insects (larger IAT effect) than young participants, but that *z*-score-transformed IAT data and explicit attitude ratings would show that the age groups did not differ in their attitudes.

Method

Participants. Forty individuals participated in Study 2, 20 young adults (mean age = 20.1; range = 19–22 years; 6 men, 14 women) and 20 older adults (mean age = 75.1; range = 63–91 years; 3 men, 17 women). Young adult participants were students enrolled in a basic communication course and were given course credit for their participation. Older adults were recruited from the community and received nominal payment for their time.

Materials and procedures. Following Greenwald et al. (1998), the IAT categories were flower–insect and unpleasant–pleasant. Target items for each were words: (a) flowers—*marigold*, *poppy*, *daffodil*, *rose*, *iris*; (b) insects—*flea*, *spider*, *maggot*, *fly*, *roach*; (c) pleasant—*friend*, *cheer*, *lucky*, *love*, *peace*; and (d) unpleasant—*abuse*, *crash*, *filth*, *cancer*, *death*. The computer presentation specifications, judgment procedures, and trials per block were the same as for Study 1. The IAT effect was computed as the mean RT to the incongruent trials (insects–pleasant; flowers–unpleasant) minus the mean RT to the congruent trials (insects–unpleasant; flowers–

Table 3
Summary of Hypotheses and Results for Study 1

Measure and general hypothesis	Primary process(es)	Age differences predicted?	Hypotheses supported?
Age attitude			
Implicit (IAT): positive toward young	Developmental	No	*Log IAT:* No, old-old had more positive attitudes toward young than young participants *z-score IAT:* Yes
Explicit: Will vary with process and participant age	Social identity, self presentation	Yes, either in-group bias from older groups or out-group favoritism from young	Yes, out-group favoritism from young
Age identity			
Implicit (IAT): Youthful age identity	Developmental	Yes, less youthful (but not old) in two older age groups	*Log IAT:* No, equally youthful identities across age groups *z-score IAT:* Yes, for old-old
Explicit: Age identity increases with age	Social identity	Yes, age identities mirror chronological age divisions	Yes
Self-esteem			
Implicit (IAT): Positive self-esteem	Adaptive, developmental, social identity	No	*Log IAT:* No, higher implicit self-esteem in two older groups *z-score IAT:* Yes
Explicit: Positive self-esteem	Adaptive, developmental, social identity	No	Yes

Note. IAT = Implicit Association Test.

pleasant). Within the two age groups, half the participants were randomly assigned to complete the incongruent combined blocks first and the congruent combined blocks second.

Participants also completed a brief questionnaire before or after the computer task on the basis of random assignment. This questionnaire included demographic items and explicit measures of attitudes toward flowers and insects. We measured attitudes toward flowers and insects separately by using two feeling thermometer scales and two semantic differential scales (Cronbach's $\alpha = .70$, flowers; .91, insects) and used the same format as in Study 1.

Results and Discussion

Implicit attitude toward flowers and insects. Prior to analysis we examined the data for outliers by using the same criteria as in Study 1. No participants were identified as outliers in this study. As before, the first two trials in each experimental block were not used in computing the block means. Error rates were low for both age groups (young: $M = 0.07$; old: $M = 0.02$).

As in Study 1, two data sets were created from the response latencies: log transformed and *z* score transformed. Brinley plots were not used to examine the effects of the transformations because this study included only two experimental means. The mean latencies for the two IAT blocks were analyzed in a 2 (age group) × 2 (congruency order) × 2 (task congruence) mixed-model analysis of variance, with repeated measures on the last factor. Results for the log-transformed data included significant main effects of participant age, $F(1, 36) = 46.29$, $MSE = 0.05$, $p = .000$, $\eta^2 = .56$; and task congruence, $F(1, 36) = 216.61$, $MSE = 0.02$, $p = .000$, $\eta^2 = .86$; as well as a significant interaction between those two factors, $F(1, 36) = 5.23$, $MSE = 0.02$, $p = .03$, $\eta^2 = .13$.[6] Means and standard deviations are presented in Table 4. Following the procedures outlined for Study 1, interaction contrasts (IAT effect) showed that older participants had a significantly larger insects–flowers IAT effect (see Table 4) than did young participants, as predicted by age-related slowing. (Note that with only two levels of the Age Group and Task Congruence factors, the *F* test for the interaction contrasts was the same as the *F* for the interaction effect.) Consistent with our hypothesis, the log data suggested that the older participants had significantly more positive attitudes toward flowers than did younger participants.

The analysis of variance for the *z* score latencies, however, revealed a significant main effect of Task Congruence, $F(1, 36) = 267.40$, $MSE = 0.07$, $p = .000$, $\eta^2 = .88$, but no significant Age × Congruence interaction, $F(1, 36) = 2.64$, $MSE = 0.07$, $p = .11$, $\eta^2 = .07$. As predicted, when the latencies were transformed into *z* scores, results fit a meaningful pattern in social psychological terms: They showed that both older and younger participants had equivalent positive attitudes toward flowers in comparison to insects (see Table 4).

Explicit attitudes toward flowers and insects. As in Study 1, composite attitude scores from the thermometer and semantic differential scales were computed for participants, with positive scores indicating more positive attitudes toward flowers than insects. As expected, young adults ($M = 0.14$, $SD = 1.01$) and older adults ($M = -0.14$, $SD = 0.87$) had equivalent attitudes, $F(1, 36) = 0.80$, $MSE = 0.88$, $p = .38$, $\eta^2 = .02$. As in Study 1, the correlations between the implicit and explicit attitude measures were low and nonsignificant: explicit with log IAT $r = .08$; explicit with *z* score IAT $r = .24$.

Table 4
Means and Standard Deviations for Implicit Attitudes Toward Flowers Versus Insects by Transformation Method, Age Group, and Task Congruence

	Congruent		Incongruent		IAT effect	
Participant age	*M*	*SD*	*M*	*SD*	*M*	*SD*
Log latencies						
Young adults	6.37	0.12	6.73	0.22	0.36_a	0.18
Old adults	6.65	0.22	7.14	0.18	0.49_b	0.22
z-score latencies						
Young adults	−0.43	0.16	0.43	0.16	0.87_a	0.32
Old adults	−0.53	0.22	0.53	0.22	1.06_a	0.45

Note. For both age groups, congruent and incongruent means differ significantly at $p < .001$. The IAT effect is the difference between the incongruent mean and the congruent mean. Because of rounding, the mean IAT effect may not exactly equal the difference between the tabled values. Larger IAT effects indicate more positive attitude to flowers over insects. Within transformation approach (log, *z* score), IAT effect means with different subscripts differ between age groups at $p < .05$. IAT = Implicit Association Test.

General Discussion

These two studies show that the IAT may be effectively used to test theoretical explanations about age group differences in implicit attitudes, but they also illustrate that age-related differences in processing speed must be considered in analyzing and interpreting IAT results. IAT research, like most social psychological research using response latencies, routinely uses log transformations to normalize distributions (e.g., Dasgupta & Greenwald, 2001; Dasgupta et al., 2000; Greenwald et al., 1998, 2002; Greenwald & Farnham, 2000; Rudman et al., 2001). Our studies show that this common practice may not control sufficiently for group differences in processing speed. For example, in Study 1, the log IATs indicated that older individuals had implicit age attitudes more strongly favoring the young, and more positive implicit self-esteem than did the young participants, but that their implicit age identification with youth was similar to that of young persons. None of these results were consistent with hypotheses derived from psychological theory. Similarly, in Study 2, the log IATs suggested that older participants had more positive implicit attitudes toward flowers over insects than young participants, a conclusion also without theoretical support. When a *z*-score transformation was applied to control for age group differences in

[6] For both log and *z*-score data, effects involving the procedural variable of congruency order were the same as those found in Study 1 and earlier IAT research (see Footnote 2). As in Study 1, deletion of trials with errors did not affect the pattern of results reported in the text, and analysis of the raw latencies revealed the same pattern as that of the log data.

[7] To rule out the possibility that target items for the Age Attitude, Age Identity, Self-Esteem, and Flowers–Insects IATs differed in their degree of association with their respective categories, additional analyses compared RTs of young adults on the congruent tasks. These revealed that mean congruent RT was equivalent across the three IATs in Study 1 ($p = .49$). The *t* tests comparing Study 1 and Study 2 participants showed that mean RT to the congruent flowers–insects task was equivalent to that for age attitude ($p = .86$), age identity ($p = .42$), and self-esteem ($p = .46$) congruent tasks.

processing speed (Faust et al., 1999), IAT results in both studies supported theoretically meaningful predictions.[7] Providing additional support for our conclusion regarding age and IAT performance, Greenwald and Nosek (2001) reported that analysis of IAT Web site data on several implicit attitudes showed that the magnitude of the IAT effect increased slightly (but significantly) with subject age. However, Study 1 shows that with appropriate controls for effects of age-related slowing, the IAT can provide an important tool for studying social psychological processes across the lifespan.

The IAT and Research on Social Cognition and Aging

In discussing the implications of our Study 1 results for aging research, we draw on the effects identified on the *z*-score IATs (see Table 3) in comparison to the explicit attitude, age identity, and self-esteem results. The IAT and explicit measures provided conflicting information about the age attitudes of young participants and the age identity of older participants. Although young adults rated older people more favorably than young people on the thermometer and semantic differential scales, their Age Attitude IATs indicated stronger implicit attitudes favoring the young. Dasgupta and Greenwald (2001) found a similar disjunct between implicit and explicit age attitudes on the part of young participants. This finding confirms the value of the IAT in assessing attitudes that participants may hesitate to express on direct measures.

The differential responses of older participants on the Age Identity IAT and the Cognitive Age Scale are of more theoretical importance. The ages selected by older participants on the Cognitive Age Scale indicated identities more "old" than "young," as suggested by most studies of age identity (Goldsmith & Heiens, 1992; Montepare & Lachman, 1989). However, their responses on the Age Identity IAT suggested an implicit identity that was more "young" than "old" (though less young than that of young participants). Prior research had suggested that the traits and experiences of youth may be an important part of older individuals' self-concepts (e.g., Fitzgerald, 1988, 1996; Mueller et al., 1992), but the Age Identity IAT provides evidence that youthful identities may be central to their self-concepts, even though they themselves may be unaware of this centrality.

The age identity results reveal the IAT's value in verifying the content of self-perceptions. Rudman et al. (2001) have shown that the IAT can be used to study the content and strength of stereotypes as well. The IAT could be usefully applied in the study of age stereotypes to assess the relative strength of positive age stereotypes (e.g., wise, loving) versus negative age stereotypes (e.g., forgetful, dependent). Such research may clarify why negative stereotypes appear to affect perceptions more than do positive ones (Hummert, 1999).

Our studies agreed with other IAT research (e.g., Dasgupta & Greenwald, 2001; Dasgupta et al., 2000; Greenwald & Farnham, 2000; Greenwald et al., 1998) in demonstrating low correlations between explicit and implicit attitudes, even when the explicit and IAT measures indicated similar attitudes at the group level, as was the case with self-esteem. These results support the conclusion that IAT and explicit measures address distinct dimensions of social cognitions (Greenwald & Farnham, 2000; Greenwald & Nosek, 2001). More important, the implicit dimension assessed by the IAT may be more strongly linked to behavior than the dimension tapped by self-report attitude scales. The research suggesting this link is limited, but intriguing. For example, Greenwald and Farnham (2000) found that the self-esteem IAT predicted subjects' responses to an experimental manipulation of success and failure but explicit self-esteem measures did not (although explicit measures have predicted responses in other studies).

The predictive or explanatory potential of IAT measures of social cognitions is of particular value in aging research. Consider Levy's (1996) finding that implicit priming with age stereotypes affected the behavioral responses of older persons, but not young persons, as an illustrative example. The Age Attitude and Age Identity IATs of this study may be useful in clarifying why the priming affected only older individuals. Likewise, those two IATs in combination with the self-esteem IAT may predict individual differences in sensitivity to priming effects within the older adult population (Greenwald et al., 2002). Although these applications of the IAT are speculative, they illustrate the types of questions that it could effectively address.

Limitations and Future Directions

The evidence from these studies regarding the efficacy of the *z*-score transformation for studying age differences in IAT performance must be replicated in additional research. Although current research suggests that the *z*-score transformation is best-adapted to the small number of conditions included in IAT studies (Faust et al., 1999), superior options for controlling for age-related slowing may be developed in the future. Our use of the *z*-score transformation was also based on the assumption of general age-related slowing, but some cognitive aging research shows that older individuals are differentially slowed in lexical and nonlexical domains (Faust et al., 1999; Myerson, Wagstaff, & Hale, 1994). The three IATs in this study varied from involving only pictorial (nonlexical) stimuli (Age Attitude IAT), to only lexical stimuli (Self-Esteem IAT), to both lexical and pictorial stimuli (Age Identity IAT). Although the patterns of mean differences in this study do not indicate that domain-specific slowing affected results, future research may consider whether differential slowing emerges in IAT research. We do believe that our results illustrate the necessity of considering the influence of age-related slowing in IAT studies.

Two limitations of the IAT must be noted. Greenwald and Nosek (2001) pointed out that a theoretical model of the cognitive processes underlying the IAT has yet to emerge, although several have been proposed. The lack of a theoretical model may hamper researchers trying to account for IAT performance. At the same time, this may serve as an opportunity for those focusing on age differences in cognitions. Applying theories of cognitive aging to the IAT may help in understanding its underlying mechanisms. For example, Chee, Sriram, Soon, and Lee (2000) showed with magnetic resonance imaging data that inhibitory processes, which have been linked to cognitive aging in other research, may be involved in IAT responses.

A second limitation of the IAT is its reliance on associations between pairs of concepts. On the Age Identity IAT, for example, older participants may find it difficult to associate self with "old" when "young" is their comparison point because of the strong positive evaluations of youth in comparison to old age rather than a true "young" identity. Developing an IAT that allows assessment of attitudes toward one group (e.g., positive attitudes toward older people) without requiring a comparison to another group (i.e., young people) is a useful goal for future research. At the same

time, the paired associations of the IAT have a certain ecological validity in that many of our evaluations involve implicit social comparisons (Tajfel & Turner, 1979).

In conclusion, these studies suggest that the IAT provides useful insights into age differences (and similarities) in implicit age attitudes, age identity, and self-esteem that are not available through direct assessment. IAT procedures have the potential to make a contribution to aging research by enabling us to test theoretical predictions about relationships between implicit social cognitions (e.g., attitudes, self-perceptions, stereotypes) and behaviors of adults of different ages. At the same time, these studies illustrate the importance of considering the implications of age-related slowing for analysis and interpretation of IAT results.

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