Motivational and Cognitive Influences on Affective Priming in Adulthood

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This research examined age differences in the impact of affective primes on judgments about neutral stimuli. When participants were unaware that the primes had been presented, age differences were nonexistent, with individuals of all ages producing likability judgments consistent with the valence of the prime. In contrast, when awareness of the primes was maximized, prime influences were virtually nonexistent in the youngest participants, but prime influences increased with participants’ age. In addition, the impact of the primes was differentially affected by an individual’s need for simple structure. Need for structure did not influence the performance of young and middle-aged participants, but prime effects increased with need in the oldest participants. It is argued that the stronger predictive validity of need for structure with age is due to aging-related changes in personal resources (both social and cognitive) and/or a closer mapping of individual characteristics onto need with age. Regardless of source, the results argue for closer consideration of motivational factors in determining age differences in performance.

The role of nonconscious mechanisms in determining behavior has been a controversial subject in the field of psychology. There is increasing evidence, however, that such mechanisms operate in a variety of settings. The most common context in which such mechanisms have been discussed is in relation to cognitive skill (Hasher & Zacks, 1979; Schneider & Shiffrin, 1977), whereby certain operations (i.e., automatic processes) are hypothesized to occur without awareness and control on the part of the individual because of either in-built characteristics of the human information processing system or extensive practice. More recently, research has highlighted the role of nonconscious mechanisms in other contexts. For example, social psychologists have found that behaviors as diverse as trait attributions (e.g., Higgins, Rholes, & Jones, 1977; Martin, 1986), walking speed and rudeness (Bargh, Chen, & Burrows, 1996), and affective reactions (Murphy, Monahan, & Zajonc, 1995; Murphy & Zajonc, 1993) can all be manipulated through surreptitious exposure of individuals to relevant primes. For example, Bargh and colleagues (1996) found that young adults were more likely to interrupt a conversation if they had previously unscrambled a set of sentences relating to rudeness than if the sentences pertained to politeness. Importantly, in all of these situations, participants were unaware of the priming manipulation and its effect on their behavior.

Nonconscious mechanisms—in the form of automatic processes—have also played an important role in attempts to understand the impact of aging on cognition (e.g., Hasher & Zacks, 1979; Jennings & Jacoby, 1993). It is generally thought that aging has minimal effects on processes that can be characterized as automatic, whereas controlled or effortful processing mechanisms—associated with initiating operations, controlling ongoing processing, and monitoring the contents of working memory—are negatively affected by aging. Investigations of nonconscious processes and aging have taken place primarily within the context of studies of cognitive skills. In most of these situations, the interest has been in examining the preservation of automatic processes and the resulting performance benefits to older adults in situations reliant on these mechanisms (e.g., semantic priming and implicit memory tasks; cf. Laver & Burke, 1993; Howard, 1996).

Automatic functions can also lead to negative consequences, however, whereby they influence behavior in an unintended manner that may compromise an individual’s objectivity. For example, research has shown that younger adults’ evaluations of neutral stimuli can be biased in the direction of subconsciously presented stimuli that elicit positive or negative affective responses (Murphy et al., 1995; Murphy & Zajonc, 1993). Such effects can be counteracted if the individual is aware of the potential biasing effects and can act to control their influence. Given that aging is thought to be associated with problems in controlled processing mechanisms, however, it might be hypothesized that older adults will be more susceptible to these priming effects, even when awareness is high.

Several pieces of recent research appear to be consistent with this expectation. For example, Jacoby and colleagues (Dywan & Jacoby, 1990; Jennings & Jacoby, 1993) have shown that older adults are more likely than younger adults to falsely recognize nonfamous names as famous if they were presented earlier in the testing session. They hypothesize that this effect is due to older adults’ being less efficient in monitoring the source of the heightened perceptual fluency associated with processing these names, resulting in an overreliance on automatic activation effects in determining fame when compared with younger adults.

Hess, McGee, Woodburn, and Bolstad (1998) obtained related results when they examined the impact of trait priming on people’s judgments about others. They found that older adults were more likely than younger adults to inter-
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pret a person's behaviors in terms of traits to which they had been exposed in a prior, unrelated context, especially under conditions that highlighted the potential biasing effect of the prior task on their impressions. These results can be interpreted also in terms of age differences in controlled processing mechanisms. Specifically, older adults appeared to be less likely to recognize the source of the enhanced accessibility associated with prior activation of the trait constructs and/or to control the impact of this activation on subsequent judgments, causing their judgments to be biased more in the direction of trait primes than those of younger individuals. In contrast, the minimal prime influences on the judgments of younger adults can be viewed as a reflection of their use of efficient controlled processing mechanisms (e.g., effective source monitoring).

In the present research we intended to provide further evidence about how age differences in controlled processing mechanisms affect the impact of nonconscious processes on performance. The research of Hess, McGee, and colleagues (1998) represents a starting point, in that we were interested in investigating age differences in the impact of primes on subsequent judgments and the moderating effect of consciousness on their impact. Consistent with previous work, we hypothesized that adults of all ages would be susceptible to priming effects when the primes were presented in a nonoptimal manner designed to minimize conscious processing. In such cases, the ability to identify the source of activation associated with the primes should be reduced, resulting in attribution of the activation to the current stimulus. In contrast, we expected that age differences would be present when the prime was made readily available to consciousness. In this situation, the source of activation associated with the prime should be apparent, but identification of the source and the ability to control its influence should be associated with the use and/or efficiency of controlled processing mechanisms, resulting in greater priming effects with increasing age.

The present research extends the research of Hess, McGee, and colleagues (1998) in several ways. First, we examined affective influences rather than those associated with traits. Traits and other types of primes that have been studied in the aging literature, such as those used in semantic priming experiments, are assumed to impact performance because they share semantic content with the target stimuli. Thus, for example, when the word tiger is preceded by the word lion, accessibility to tiger is facilitated because those aspects of meaning that it shares with lion are activated. Similarly, trait primes have specific effects in that they influence the interpretation of applicable behaviors only. Thus, priming of the trait honesty would have little impact on impressions if the behavioral information presented about the target reflected intelligence.

In contrast, affective reactions are not dedicated in this manner. Whereas the sharing of affective information between stimuli (such as similar feelings toward two attitude objects) can facilitate processing (Bargh, Chaiken, Govender, & Pratto, 1992; Fazio, Sabonmatsu, Powell, & Kardes, 1986) in the same way as overlap in semantic content, such a relationship does not need to exist for an affective prime to influence judgments about a target. As Murphy and Zajonc (1993) have shown, an affectively laden prime can influence the perception of a neutral stimulus. As with semantic primes, however, consciousness does mediate the degree of influence of affective primes. Murphy and Zajonc (1993) found that young adults biased their likability ratings of Chinese ideograms in the direction of affective primes (happy vs sad faces) when the primes where presented too quickly (4 ms) for awareness. In contrast, when the primes were presented for 1,000 ms, there was little evidence of a priming effect. Similarly, Schwartz and Clore (1983) found that positive biases in well-being judgments associated with sunny days disappeared when participants were made aware of the weather.

In our research, we used a variant of the Murphy and Zajonc (1993) procedure to examine affective priming. Different-aged individuals were presented with neutral stimuli (e.g., Japanese Kanji characters) that were preceded by positive, neutral, or negative primes. The primes were presented either suboptimally, thereby hindering conscious processing, or optimally, in which case the probability of awareness was considerably higher. Participants made likability judgments for each stimulus, and priming influences were measured by the degree to which these likability judgments covaried with prime valence. Consistent with the ideas outlined previously, we hypothesized that age differences would be minimal under suboptimal priming conditions, with participants of all ages biasing judgments in the direction of the primes. In the optimal condition, where awareness of the source of the affective responses is maximized, we expected priming effects to increase with age.

We also used a within-subjects design where participants were exposed to each type of prime under both optimal and suboptimal presentation conditions. This allowed us to obtain individual estimates of the degree of priming (i.e., the difference in responses associated with positive and negative primes), which could then be examined in relation to independent measures of cognitive skill. If changes in cognitive efficiency are behind the expected age effects, then measures that reflect such efficiency should account for age-related variance in performance when prime awareness, and thus control, is possible.

Finally, we also examined the impact of motivation on performance. E. P. Thompson, Roman, Moskowitz, Chaiken, and Bargh (1994) have demonstrated that priming effects are associated with both external (e.g., instructions to produce accurate judgments result in less priming) and internal (e.g., personal need for structure, or PNS, is positively associated with degree of prime influence) motivational factors. Such findings imply a relationship between goals and the use of cognitive resources, which in turn suggests an alternative way to think about aging effects. Specifically, it may be that changes in available resources with aging influence goals, which in turn affect the manner in which the individual processes information (Hess, 1999). For example, Kruglanski and Webster (1996) have argued that conditions that make the use of cognitive resources difficult, such as fatigue or time pressure, result in inaccuracies or biases in representational processes (e.g., less extensive processing) because of changes in motivation (e.g., an increased desire to achieve closure quickly) rather than to resource reductions.
Extending these ideas, we hypothesized that age-related reductions in cognitive and physical resources may motivate older adults to engage in simpler, less accurate processing operations, helping to account for age differences in susceptibility to priming. This hypothesis suggests a slightly different interpretation of the impact of aging on controlled processing mechanisms in that it is not necessarily just the efficiency of such mechanisms that may change with age, but also the individual’s use (or initiation) of such processes. We investigated this hypothesis by measuring PNS and then examining its relationship to the expected age-related trend in priming susceptibility. Individuals who are high in PNS desire simple structures in organizing information in their worlds and reduce the demands on their cognitive resources by using easily accessible information sources for imposing simple structure on events rather than creating their own. Thus, for example, high-PNS individuals are more likely than those low in PNS to use irrelevant cues in the environment (e.g., primes; E. P. Thompson et al., 1994) or easily activated internal structures (e.g., stereotypes) for constructing likability judgments (Neuberg & Newsom, 1993).

There are two possible ways in which PNS might be related to age. First, changes in resources might lead to an increase in PNS with age, which in turn could account for age differences in prime susceptibility. We are unaware, however, of any supportive evidence for such a relationship (e.g., Hess, in press; Hess, Follett, & McGee, 1998). Alternatively, linkages between resources and motivational constructs such as need for structure might become stronger with age as individuals modify their goals to be consistent with life circumstances (e.g., Brandstätter & Greve, 1994). Thus, PNS might increase in predictive power with age as an expression of the strength of this linkage.

Two studies are presented here. In the first, a pilot study, we used an extreme groups design to provide preliminary data that was relevant to our hypotheses and to test our modified procedures for examining affective priming. In the second study we built on the information gained from the pilot data and provided a more powerful test of our ideas with a larger and more representative sample.

**Pilot Study**

**Methods**

**Participants**

The young adult group consisted of 17 women and 10 men (M age = 19.1 years, range = 18–24) who were students at North Carolina State University and participated for optional class credit. The older adult group consisted of 17 women and 15 men (M age = 70.0 years, range = 57–84) who were recruited through newspaper advertisements and received $10/h for participating.

**Materials**

Priming stimuli.—Three sets of 12 words were used as primes. One set contained positive words (e.g., happy, smile, good), one contained neutral words (e.g., main, pause, fact), and one contained negative words (e.g., hate, cruel, frown). Word selections were based on pleasantness norms contained in Toglia and Battig (1978), with mean pleasantness ratings (on a scale of 1–7) for the positive, neutral, and negative words of 5.77, 3.93, and 2.35, respectively. In addition, familiarity ratings from the same norm set indicated that the three sets were high and similar to each other in familiarity (Ms = 6.35, 6.26, and 6.20). Although Murphy and Zajone (1993) used faces as affective primes, research by Bargh, Litt, Pratto, and Spielman (1989) has suggested that the evaluative content of words is processed early in the perceptual process and prior to their semantic content. Thus, words should also serve as effective affective primes, particularly when presented too quickly to be identified.

**Target stimuli.**—Two sets of 36 consonant trigrams (e.g., CGK) were used as the neutral targets in the priming tasks. To ensure low meaningfulness, and thus relatively neutral evaluative content, trigrams consisted of letter sequences that had a low frequency of occurrence in the English language (Underwood & Schulz, 1960). We also eliminated meaningful three-letter sequences (e.g., CBS). Finally, we controlled the frequency with which individual letters and two-letter sequences occurred across the entire set of stimuli.

**Procedure**

Individuals were tested alone in a single session that lasted from 1.5 to 2 h. Presentation order of the optimal and suboptimal priming tasks was systematically varied within each age group. In addition, each set of trigrams was presented equally often in each presentation condition across age groups, and each individual trigram was paired equally often with positive, neutral, and negative primes across age groups and presentation conditions. For each task, participants were seated in front of a computer monitor with their arms resting on the table so that they were leaning slightly forward. The distance from their eyes to the center of the screen was approximately 46.5 cm. The participants were told that we were examining people’s snap judgments of novel stimuli and, in this study, the stimuli being used were three-consonant letter strings.

In the main judgment task, an asterisk appeared in the middle of the screen to focus the participant’s attention. After 500 ms, the asterisk was replaced by a positive, neutral, or negative prime word. In the optimal condition, the prime word was presented for 1,500 ms, after which it was immediately replaced by the target trigram, also displayed for 1,500 ms. This was followed by the appearance of the rating scale (1 = “not at all liked,” 5 = “liked a lot”), at which time the participant provided a likability rating for the trigram by pressing the appropriate number key on the computer keyboard. This sequence of events was repeated until all 36 targets plus 4 buffer items were judged by the participant. There was a 1,000-ms interval between the end of one trial and the beginning of the next. Participants were told to ignore the word that preceded each trigram because it was not relevant to the present task. The suboptimal condition was identical except that the prime words were presented for 30 ms. This speed was faster than that used in other stud-
ies (e.g., Levy, 1996) because the foveal presentation of the prime, and pilot testing suggested it was brief enough to prevent identification. Unfortunately, this presentation speed appeared too fast in that no priming effects were obtained in this condition. This timing issue was corrected in the main study. Given the lack of effects, the results from the suboptimal condition will not be discussed further.

After the first priming task, participants completed the Vocabulary Test 2 from the Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, Harman, & Derman, 1976). A version of La Pointe and Engle’s (1990) working memory span task was administered next. This task consisted of 18 sets of two to seven solved compound math problems (e.g., (2 × 3) − 5 = 1) followed by a one-syllable word (e.g., tree), which were presented individually on the computer monitor. For each pair, participants responded orally as to whether the answer provided for the math problem was true or false and then said the word following the math problem. At that point, the experimenter advanced the screen and another problem-word combination appeared. Whenever a question mark appeared on the screen, participants wrote down, in order, as many words as they could remember from the current set of items. Three pairs were presented at each set size, with presentation orders of individual sets being randomly determined. Participants saw a total of 81 problem-word pairs, and the score on this task consisted of the total number of words recalled given a correct response to the math problem associated with the word.

Participants next completed paper-and-pencil versions of Salthouse and Coon’s (1994) pattern and letter comparison tasks, which provided a measure of processing speed. The pattern comparison task consisted of 30 pairs of patterns on each of two pages, whereas the letter comparison task consisted of two pages of 21 pairs of letter sequences composed of three to nine letters. Participants were given 30 s to complete each page. Participants were instructed to write an S on the line between each pair if they were the same and to write a D on the line if the pairs were different. Performance was assessed by the total number of items correctly answered within the allotted time period. The scores for each task were converted to z scores, and a composite speed measure was obtained by taking the mean of these scores.

Following this task, participants completed the second priming task. Finally, they completed a background questionnaire that included self-reports of health, social engagement, the 11-item PNS questionnaire (M. M. Thompson, Naccarato, & Parker, 1992), and the 18-item abbreviated version of the Need for Cognition questionnaire (Cacioppo, Petty, & Kao, 1984).

Results and Discussion

Unless otherwise noted, all statistical tests in this article used an alpha of .05.

Background Measures

Table 1 presents measures obtained from the background questionnaire and independent ability assessments for each age group. The health measure reflects the mean response to six items adapted from the Older American Resources and Services (OARS) assessment tool (Duke University Center on Aging and Human Development, 1975) in which individuals reported (a) overall ratings of, (b) degree of change during the past 5 years in, and (c) the extent to which activities were limited by both physical and emotional health (Cronbach’s α = .64). We obtained a social engagement index by combining responses to four items—also from the OARS instrument—that assessed the size of the individual’s social network and frequency of social interaction and participation in social activities (Cronbach’s α = .63). Comparisons of the two groups revealed that the younger adults had significantly higher scores than the older adults on the memory span and comparison speed tasks, whereas older adults had higher vocabulary test scores. No differences between groups were observed on any of the other measures, including PNS. This latter finding suggests that any obtained age differences in the priming tasks cannot be accounted for by variations in levels of need for structure. Thus, we included PNS as a separate factor in the analyses to examine potential age-related differences in its impact on performance.

Optimal Priming Task

For the optimal priming task, likability responses were averaged across the 12 characters presented with each of the three types of primes. Because the midpoint on the rating scale was not labeled as neutral, we subtracted the mean ratings in the neutral prime condition from those in the positive and negative prime conditions to examine the influence of the prime relative to each participant’s neutral point on the scale. We then examined these corrected ratings for the impact of age and motivation with an Age Group × Task Order × PNS × Prime Valence analysis of variance (ANOVA), with PNS treated as a continuous variable.

The only significant effect obtained when ratings in the optimal task were examined was due to prime valence, \( F(1, 55) = 5.81, \text{MSE} = .23 \). Given our expectations regarding age effects and the exploratory nature of this study, however, we examined priming effects within each age group with separate PNS × Prime ANOVAs. For the younger adults, no significant effects were obtained due to prime: \( M^\text{positive} = .16, M^\text{negative} = .02 \). In contrast, a significant
The prime effect, $F(1,30) = 5.55, MSE = .24$, was obtained for the older adults ($M_{\text{positive}} = .04, M_{\text{negative}} = -.25$), and the PNS × Prime interaction approached significance, $F(1,30) = 3.80, MSE = .24, p = .06$. The differential impact of primes across groups is consistent with our expectation that older adults would be more susceptible than younger adults to primes in the optimal condition. Interestingly, inspection of the means suggests that the prime effect for the older adults was considerably stronger for negative than for positive primes. This asymmetry in priming effects is not an atypical result (see also Murphy & Zajonc, 1993, Studies 1 and 2) and may reflect the generally more powerful attentional effects associated with negative stimuli (e.g., Pratto & John, 1991). Of primary importance, however, is the fact that primes influenced judgments and that these influences varied across groups.

The trend toward greater impact of PNS in the older adults than in the young is also consistent with expectations. As can be seen in Figure 1, priming effects increased with need for structure in the older group, but not in the young group. The association between PNS and priming makes sense, in that individuals with high need for structure are likely to seek simple structure in the environment rather than create their own. The more intriguing question is why PNS was differentially related to performance across age groups, particularly because PNS itself was unrelated to participant age. The effect does not appear to simply reflect variations in cognitive efficiency. When our two measures of efficiency (working memory and speed) were used to predict the size of the priming effect (i.e., positive mean rating minus negative mean rating) within age groups, the only significant effect obtained was in the young group, where working memory was negatively correlated with the prime effect. In addition, neither the working memory nor the speed measure substantially altered the PNS × Prime interaction in the older group when included as a covariate.

The differential predictive power of PNS across groups may reflect variations in the strength of the linkage between need for structure and other characteristics of the individual, which in turn may increase the predictive power of this variable as a motivational construct. To examine this possibility, we conducted one-tailed significance tests within each age group on the correlations between PNS scores and (a) cognitive variables that reflect resource availability (working memory, comparison speed, and verbal ability), (b) contextual factors associated with the individual’s current life circumstances (self-reports of health status, social engagement, and education), and (c) the extent to which individuals enjoy engaging in cognitive activity (Need for Cognition; Table 2). None of these correlations was significant for the young adults. In contrast, PNS was significantly correlated with both health status and Need for Cognition in the older adults, with those reporting poorer health and less interest in cognitive activity also possessing higher PNS scores. In addition, the correlation between working memory and PNS approached significance in this group. The other correlations were in the expected directions, but the small size of the groups may have worked against our finding reliable relations. Thus, although it is not strong, there is the suggestion of a greater connection between resource-related factors and PNS in the older adults.

**Main Study**

Our pilot study served its primary purpose by (a) demonstrating that evaluatively laden words can act as affective primes and (b) providing preliminary evidence that was consistent with our expectations (i.e., older adults were more susceptible than younger adults to prime-based biases when awareness of primes was optimal, and the strength of this susceptibility was related to intrinsic motivational factors). We were unsuccessful in obtaining support for our prediction that individuals of all ages would exhibit affective priming effects when they were unaware of the source of their affective responses, a result that is necessary to support our argument that differential priming effects in the optimal condition are related to age differences in factors other than basic activation processes. The success of our priming...
manipulation in the optimal condition, however, suggested that the problems in obtaining suboptimal priming effects were not due to our task, but rather reflected problems in the presentation of the primes. Our main study was designed to provide a stronger test of these same hypotheses with a more powerful design that dealt with the problems identified in the pilot study. First, we included a larger group of individuals that spanned a fairly large age range across adulthood. This not only increased the power of our statistical tests to identify effects, but also allowed us to examine the developmental trajectory of the expected effects. In addition, participants of all ages were recruited entirely from the community. Although this does not eliminate selection effects in the sample, it should help deal with any biases associated with comparing young college students to community-dwelling older adults. We also made two major changes to the suboptimal priming task to deal with potential problems in presentation of the primes. First, presentation rate was adjusted for each individual so that prime exposure time would be just below that at which the participant could reliably report the identity of the words. Second, we presented the primes parafoveally, using a method similar to that of Bargh and Pietromonaco (1982). This allowed us to present the information outside of awareness (usually associated with foveal presentation) while allowing for a longer exposure time than if the stimuli had been presented within the foveal region. Levy (1996) successfully used a similar procedure to prime stereotypes in older adults.

**Methods**

Participants

One hundred and forty-nine adults (80 women, 69 men) from the Raleigh, NC, area participated in the study. The participants ranged in age from 20 to 81 and were relatively evenly distributed across the six represented decades ($n_s = 23–30$). In addition, women and men were also reasonably distributed across decades, with 10–17 women in each decade versus 10–13 men. All participants were recruited from the community through newspaper advertisements and were paid $10/h for their participation. Although we treated age as a continuous variable in most of our analyses in this study, we also grouped participants into three age groups to facilitate the illustration of specific effects: young ($n = 48$, range = 20–39), middle aged ($n = 53$, range = 40–59), and old ($n = 48$, range = 60–81).

**Materials**

**Priming stimuli.**—The same prime words used in the pilot study were also used in the main study.

**Target stimuli.**—To minimize associations that may have been made with our consonant trigrams, we used 72 Japanese Kanji characters as targets in the priming tasks. These characters were all rated as neutral in likability under nonpriming conditions by an independent group of raters.

**Procedure**

The procedure was similar to that in the pilot study with the following exceptions. First, all participants were sent and completed a background questionnaire that included the PNS and Need for Cognition scales prior to coming to the lab.

Second, we used the first task given in the testing session, which we identified as a perceptual identification task, to determine the slowest rate at which primes could be presented to the participant in the suboptimal task with minimal awareness. Participants were seated in front of the computer monitor with their arms resting on the table so that they were leaning slightly forward. The distance from their eyes to the center of the screen was approximately 46.5 cm. They were then presented with seven sets of 10 neutral words, one at each of the following speeds in descending order: 150 ms, 133 ms, 117 ms, 100 ms, 83 ms, 66 ms, and 50 ms. Words were presented 2.5 cm above or below (randomly determined) a central fixation point. This spacing was chosen so that the primes would be presented in the parafoveal region at a visual angle of approximately 4.3 degrees. Participants attempted to identify each word as it was presented. The suboptimal presentation rate for an individual participant was identified as the slowest rate at which he or she could correctly identify no more than 2 of the 10 words. We used this somewhat liberal criterion to ensure that the primes would not be presented too quickly for registration, as seemed to occur in the pilot study. We reasoned that the resulting presentation speed for an individual participant based on this criterion would be at the edge of awareness, but not too fast to prevent registration. Presentation rate was established in a task where specific instructions were given to identify the words. In the suboptimal priming task, instructions to ignore the light flashes were given, reducing the probability that attention would be diverted to the words and thus increasing the difficulty of conscious identification even further.

As expected, the exposure time necessary for ensuring minimal awareness of the prime word was negatively associated with age ($r = .56$). The percentage of participants receiving the 50-, 66-, 83-, 100-, 117-, 133-, and 150-ms presentation speeds by age group were (a) young—62.5, 12.5, 18.8, 0, 4.1, 2.1, and 0; (b) middle aged—20.8, 35.9, 18.9, 9.4, 11.3, 1.9, and 1.9; and (c) old—18.8, 6.3, 12.5, 8.3, 14.6, 6.3, and 33.3.

Third, the priming tasks were modified in the following ways: (a) primes were presented randomly in a parafoveal position either above or below the target (as in the pretest);

### Table 2. Pilot Study: Correlations Between Personal Need for Structure and Background Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Young Adults</th>
<th>Old Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>−.26*</td>
<td>−.27*</td>
</tr>
<tr>
<td>Health</td>
<td>−.13</td>
<td>−.36**</td>
</tr>
<tr>
<td>Social engagement</td>
<td>.13</td>
<td>.05</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>−.23</td>
<td>−.18</td>
</tr>
<tr>
<td>Working memory</td>
<td>−.13</td>
<td>−.24*</td>
</tr>
<tr>
<td>Speed</td>
<td>−.15</td>
<td>−.01</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>−.08</td>
<td>−.32**</td>
</tr>
</tbody>
</table>

*p < .10; **p < .05.
(b) the presentation rate identified in the initial task was used for prime presentation in the suboptimal task; and (c) the prime word was masked by a string of xs for 100 ms immediately following its offset.

Fourth, the working memory span task was modified slightly in that (a) the sets of different sizes were presented sequentially according to set size, beginning with the smallest (two) and proceeding to the largest, and (b) the largest set size was six rather than seven.

Finally, after the second priming task, we assessed whether an individual’s identification threshold for primes changed over the course of the experiment. In this task, participants were asked to identify 20 neutral words presented in the same manner as the initial task, but using the presentation rate that was used in the suboptimal priming tasks. The number of words correctly identified was recorded. We also assessed awareness of the primes in the suboptimal task immediately after the second priming task—regardless of presentation order—by simply asking participants if they noticed any words appearing on the screen during the task. If the answer was in the affirmative, we quizzed them about whether (and how) they influenced their likability judgments. We recognize that this is a relatively inexact means of assessing awareness, but we also believed that other means (e.g., assessing awareness following each trial or each task) would be too intrusive, potentially affecting responses in the current or subsequent task. This assessment at least provided some idea as to participants’ awareness of the stimuli.

**Results and Discussion**

**Background Measures**

Means, standard deviations, and zero-order correlations involving age and the various background measures are presented in Table 3. The only significant correlations involving age were with working memory, speed, and vocabulary. (Through a mix-up in communications, speed data were collected for only 113 participants.) Once again, age did not correlate with PNS, and therefore PNS was included as a between-subjects variable in our main analyses. In addition, age was treated as a continuous variable in these analyses.

<table>
<thead>
<tr>
<th>Measure</th>
<th>M(SD)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td>49.6(17.5)</td>
<td>0.02</td>
<td>0.04</td>
<td>0.14</td>
<td>0.37***</td>
<td>-0.43***</td>
<td>-0.60***</td>
<td>0.11</td>
<td>-0.13</td>
</tr>
<tr>
<td>2. Education</td>
<td>16.2(2.2)</td>
<td>0.09</td>
<td>0.33***</td>
<td>0.08</td>
<td>0.12</td>
<td>-0.14</td>
<td>0.33***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Health°</td>
<td>2.4(0.8)</td>
<td>0.26***</td>
<td>0.01</td>
<td>0.04</td>
<td>0.21**</td>
<td>-0.10</td>
<td>0.21**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Social engagement°</td>
<td>3.6(0.8)</td>
<td>0.11</td>
<td>-0.05</td>
<td>-0.06</td>
<td>-0.17**</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Vocabulary°</td>
<td>20.2(8.1)</td>
<td>0.19**</td>
<td>0.03</td>
<td>-0.17**</td>
<td>0.31***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Working memory°</td>
<td>40.3(7.9)</td>
<td>0.28***</td>
<td>0.11</td>
<td>-0.11</td>
<td>0.26***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Speed</td>
<td>0.0(0.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. PNS°</td>
<td>40.7(9.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.44***</td>
<td></td>
</tr>
<tr>
<td>9. Need for Cognition°</td>
<td>75.5(14.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** PNS = personal need for structure.
°Scores on the health and social engagement measures could range from 1 to 5, with higher scores reflecting better health and greater engagement.
°Vocabulary scores could range from 0 to 36.
°Working memory scores could range from 0 to 60.
°PNS scores could range from 11 to 66.
°Need for Cognition scores could range from 18 to 108.
**p < .05; ***p < .01.

**Affective Priming**

We began examination of performance in the priming task by first conducting an overall analysis comparing the optimal versus suboptimal presentation conditions. We then performed individual analyses within presentation conditions to examine specific hypotheses.

**Overall analysis.—** Mean likability responses following positive and negative primes were calculated as before and were examined with an Age × PNS × Presentation Condition (optimal vs suboptimal) × Prime Valence ANOVA, with both age and PNS treated as continuous variables. As expected, a significant effect was obtained for valence, \( F(1,145) = 36.02, MSE = .15 \), with likability responses associated with positive primes \( M = .08 \) being higher than those associated with negative primes \( M = -.12 \). Significant interactions between age and prime valence, \( F(1,145) = 6.93, MSE = .15 \), and between age, PNS, and prime valence, \( F(1,145) = 6.15, MSE = .15 \), were also obtained. In general, these interactions reflected the facts that the influence of prime valence on likability responses increased with age and that higher PNS scores were associated with greater priming effects, but only for the older participants in our sample. Although the expected Age × PNS × Prime Valence interaction was not significant, analyses within presentation conditions indicated that the aforementioned interactions were specific to the optimal priming condition. As such, they are discussed in more depth in that section.

**Suboptimal priming task.—** An Age × PNS × Prime Valence ANOVA on likability ratings revealed only an effect due to prime valence, \( F(1,145) = 20.48, MSE = .11 \), with responses associated with the positive prime \( M = .11 \) being greater than those associated with the negative prime \( M = -.08 \). (See Table 4 for mean ratings by age group.) No other effects were significant. In addition, regression analyses revealed that the degree of prime susceptibility (i.e., positive mean rating minus negative mean rating) was unrelated to any of the ability measures. These null findings are consistent with our hypothesis that prime-related biases in judgments in the suboptimal condition should be unrelated...
to variables that might reflect motivation or cognitive resources.

The regression lines relating to the positive and negative prime conditions as a function of age are presented in Figure 2 (left). Although no age effects were obtained in our analyses, this figure and the priming effects presented in Table 4 suggest greater susceptibility to priming with age. We hypothesized that this trend might reflect practice-related changes in perceptual thresholds over the course of the test session that in turn may have increased participants’ awareness of the primes. Subsequent analyses based on two separate indices of awareness supported this hypothesis. First, using a relatively liberal measure of awareness, we examined priming in participants who simply reported that they could see that some of the primes were words, regardless of their stated influence on judgments, versus those who did not. Aware participants (n = 30) exhibited little priming (M_{positive} = .03, M_{negative} = -.05), F < 1.0, whereas the priming effect was significant in unaware individuals (M_{positive} = .13, M_{negative} = -.08), F(1,115) = 24.92, and somewhat stronger than in the entire sample.

Given the potential fallibility of such retrospective reports, however, we also examined the impact of awareness using a more objective measure: performance on the posttest. Many participants exhibited performance above the pretest threshold criterion, suggesting some adaption to the presentation rate being used and thus an increased probability of prime awareness. An Age × Presentation Speed analysis on posttest performance indicated that changes in threshold were negatively associated with age, t = -6.84, and positively associated with presentation speed, t = 6.26. In addition, although speed was associated with performance across the entire age range, its impact on performance decreased with increasing age, t = -2.24. When participants were divided into two groups—those whose thresholds now exceeded the pretest criterion (n = 81) and those whose did not (n = 68)—effects similar to those with self-reported awareness were obtained. That is, in the no

### Table 4. Main Study: Mean Corrected Likability Ratings as a Function of Presentation Condition, Prime, and Age Group

<table>
<thead>
<tr>
<th>Prime</th>
<th>Optimal</th>
<th>All Participants</th>
<th>Unchanged Threshold</th>
<th>Changed Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Young Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>-0.02</td>
<td>.46</td>
<td>-0.04</td>
<td>.46</td>
</tr>
<tr>
<td>Negative</td>
<td>-0.08</td>
<td>.39</td>
<td>-0.04</td>
<td>.42</td>
</tr>
<tr>
<td>Effect*</td>
<td>0.06 (n = 48)</td>
<td>0.08 (n = 48)</td>
<td>0.22 (n = 15)</td>
<td>0.01 (n = 33)</td>
</tr>
<tr>
<td>Middle-Aged Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>0.07</td>
<td>.35</td>
<td>0.13</td>
<td>.49</td>
</tr>
<tr>
<td>Negative</td>
<td>-0.12</td>
<td>.47</td>
<td>-0.10</td>
<td>.45</td>
</tr>
<tr>
<td>Effect*</td>
<td>0.19 (n = 53)</td>
<td>0.23 (n = 53)</td>
<td>0.31 (n = 24)</td>
<td>0.17 (n = 29)</td>
</tr>
<tr>
<td>Old Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>0.13</td>
<td>.47</td>
<td>0.14</td>
<td>.37</td>
</tr>
<tr>
<td>Negative</td>
<td>-0.30</td>
<td>.48</td>
<td>-0.09</td>
<td>.35</td>
</tr>
<tr>
<td>Effect*</td>
<td>0.43 (n = 48)</td>
<td>0.23 (n = 48)</td>
<td>0.24 (n = 29)</td>
<td>0.23 (n = 19)</td>
</tr>
</tbody>
</table>

*The prime effect represents the mean likability scores following positive primes minus mean likability scores following negative primes.
change group, a strong priming effect emerged ($M_{positive} = .16$, $M_{negative} = -.10$), $F(1,66) = 19.71$, and the effect was clearly evident across the entire age range (Figure 2, middle). In contrast, in the changed threshold group, the prime effect was weaker ($M_{positive} = .06$, $M_{negative} = -.06$), $F(1,79) = 7.06$, and the $Age \times Prime$ interaction approached significance, $F(1,79) = 3.35$, $p = .07$ (Figure 2, right). This latter effect represented the fact that the prime effect was nonexistent for the young adults but was present in the middle-aged and older adults, as can be seen in Table 4. If we interpret the changed threshold as an increased accessibility of primes to consciousness, then this age effect is consistent with our expectations in showing that aging is associated with greater susceptibility to prime-related biases when awareness is high. The complication associated with changing perceptual thresholds may also be the reason that we failed to obtain the expected interactions between age and presentation condition in the overall analysis.

**Optimal Priming Task**

Mean ratings were once again obtained and examined in relation to age, PNS, and prime valence. Consistent with expectations, significant effects were obtained for prime, $F(1,145) = 21.28$, and its interaction with age, $F(1,145) = 6.14$, $MSE = .16$. (See Table 4 for group means.) In addition, a significant $Age \times PNS \times Prime$ interaction was obtained, $F(1,145) = 6.31$, $MSE = .16$. We decomposed this effect by performing a $PNS \times Prime$ Valence analysis within each of our three age groups (Figure 3). Specifically, ratings did not vary as a function of prime or PNS in the young group and were affected only by prime valence in the middle-aged group, $F(1,51) = 5.94$. In contrast, significant effects of prime valence, $F(1,46) = 14.93$, and its interaction with PNS, $F(1,46) = 5.54$, indicated that the ratings in the old group were not only affected by the prime, but that PNS was positively associated with the extremity of the priming effect. Thus, as in the pilot study, prime effects increased in strength with age as did the influence of PNS on performance. Communalities analyses indicated that variations in cognitive ability accounted for some of the age-related variance in the prime effect. In separate analyses, the working memory measure accounted for 32% of the age-related variance, whereas speed accounted for 59% in the reduced sample ($n = 113$) for which this measure was available. Importantly, however, the $Age \times PNS \times Prime$ interaction was still significant when we controlled for working memory, $F(1,144) = 6.06$, and speed, $F(1,108) = 6.21$, indicating that this age-related effect is not just due to age differences in basic cognitive processes.

To better understand the basis for the three-way interaction, we once again tested for significant negative correlations between PNS and our other cognitive and noncognitive measures within each of the three age groups (Table 5). The only significant correlations involving PNS for the two younger groups were with Need for Cognition (young and middle aged) and social engagement (middle aged). In contrast, significant negative correlations were found in the older group between PNS and education, social engagement, vocabulary, working memory, and speed. In addition, the correlation between Need for Cognition and PNS increased in strength with age. Thus, as in the pilot study, PNS was more closely linked with resource-related factors in older adults. The differential predictive power of PNS across groups does not appear to be due to variations in variability of scores: young—$SD = 8.8$, range = 20–55; middle aged—$SD = 9.7$, range = 18–63; old—$SD = 8.3$, range = 23–62.

Our interpretation of these data is that resources have an indirect impact on priming susceptibility through motivation and that the impact of motivation becomes stronger with age as the linkage between resources and motivation becomes stronger. This causal framework is illustrated through the use of path analyses in which the direct and indirect (through PNS) influences of the background variables (education, vocabulary, working memory, speed, social engagement, and health) on priming in the optimal condition are examined. In these analyses, the background variables were examined as a set in identifying influences on PNS.

![Figure 3. Optimal priming: Adjusted likability ratings as a function of PNS and prime valence for young (20–39), middle-aged (40–59), and older (60–81) adults in the main study. The solid line indicates the regression function for positive primes, and the dashed line is the function for negative primes.](image-url)
General Discussion

The results of our research provide potentially interesting insights into the nature of age differences in the impact of task-irrelevant information on affective judgments. Consistent with much past research, we demonstrated that individuals of all ages bias their judgments about previously neutral stimuli in the direction of primed affective information when the actual source of such information is difficult to ascertain. This was most evident in participants in the suboptimal prime presentation condition, especially for those whose detection thresholds remained stable over the course of the experiment, thereby limiting their awareness of the prime. These findings are consistent with several ideas about the processing of affective information and its relation to cognition. First, the fact that affective information was processed (as indicated by prime effects on likability judgments) under conditions designed to minimize priming awareness supports the affective primacy hypothesis (Zajonc, 1980), which argues that affective responses occur both earlier than cognitive responses (e.g., prime identification) during information processing and without cognitive input. Second, the results also support previous findings (Murphy & Zajonc, 1993; Murphy et al., 1995) in demonstrating that affective primes do not need to have a prior association with the target stimulus for affective priming to occur. In addition, the present results add to the literature by demonstrating that these effects occur across adulthood and that affective priming can occur with affectively laden words as well as with the faces used by Murphy and her colleagues.

The more intriguing results from the present research, however, have to do with the observed age differences in priming effects when the prime stimuli were readily available to consciousness (i.e., prime presentation under optimal conditions, aware participants in the suboptimal task). Replicating previous research, we found that the likability responses of younger adults were relatively unaffected by the primes under such circumstances. This finding can be interpreted as indicating that when these participants were able to identify the source of the activated affective information (i.e., when cognitive processing “caught up” with affective processing), they were also able to exclude this information from their evaluations of the target stimuli. As age increased in our sample, however, the impact of the primes also increased, with older adults being most likely to bias their evaluations in the direction of the prime. In addition, the strength of the priming effect in older adults was similar across conditions, regardless of presentation mode or awareness (see Table 4). Such results are consistent with the age-related priming effects associated with traits observed by Hess, McGee, and colleagues (1998) but extend this work to the affective realm.

We had predicted this age-related priming effect in the optimal condition, and we offered two potential explanations for it. The first is a purely cognitive explanation that states that the age-related increase in priming under conditions that optimize prime awareness is due to reductions in the efficiency of controlled processing mechanisms. We found some support for this hypothesis in our main study, where speed and working memory accounted for significant amounts of age-related variance in priming. Controlling for these variables, however, did not eliminate the observed age effects.

Our second explanation centered on motivational factors and suggested that age differences in resources may influence processing goals that underlie the expected age-related effects (Hess, 1999). We hypothesized that this might be manifested as a relationship between changes in resources that support functioning and an individual’s need for structure, with aging-related losses in resources associated with
an increase in the extent to which older adults seek structure in the environment rather than engage in the cognitive activities necessary for imposing their own. (This hypothesis is related to Craik’s, 1986, framework in which older adults rely on environmental factors to support memory because reductions in cognitive resources make it difficult for them to initiate the necessary cognitive operations.) We did not, however, observe this zero-order relationship between age and PNS. The failure to find such a relationship may be due to age-related selection effects in our sample, with positive selection increasing with increasing age. For example, in spite of cohort-related changes in educational levels in our society, the mean number of years of education in the sample was about 16 and age was unrelated to education in our sample. This suggests that, relative to younger participants, the older adults in this study may have been less representative of their cohort. The select nature of the older participants might also be reflected in the fact that ratings of overall health were unrelated to age and verbal ability was strongly correlated with age. Interestingly, a significant positive relationship does emerge between age and PNS ($r = .19$) when verbal ability is controlled, suggesting that a relationship between age and need for structure might emerge in a more representative sample.

Although we did not observe age differences in need for structure, we did find that PNS was more strongly predictive of priming with increasing age: Older adults with high PNS scores exhibited more prime-congruent evaluations than those with low PNS scores. What might account for this age-related variability? One potential explanation for the observed differential impact across age groups relates to variations in the underlying basis for PNS. Specifically, our analyses indicate that the linkage between PNS scores and cognitive, motivational, physical, and social resources increases substantially in strength with age. This suggests that the basis for variations in need for structure may change with age, with need for structure reflecting an adaptive pattern of functioning associated with other characteristics of the individual as background characteristics become more accurately mapped onto need with experience.

The differential predictive power of PNS across age groups may also reflect the fact that PNS becomes a more important determinant of performance when resources are low or difficult to use. This explanation is suggested by research by Schultz and Searleman (1998), who found that PNS was more predictive of performance (i.e., development of solution set on the Einstellung water-jar task) under high-stress conditions in which resources would presumably be taxed. Although age was not related to many of the noncognitive variables that might relate to resources (e.g., health, and social engagement), it was negatively correlated with the most obvious measures of cognitive resources (i.e., speed and working memory span), thereby providing some support for this interpretation. In addition, the noncognitive measures may need to be interpreted within the context of the age groups being assessed rather than as absolute measures. Thus, for example, the composite health rating is primarily composed of items assessing relative rather than absolute health. Thus, even though this measure was unrelated to age, it is inappropriate to assume there are no age differences in health in our sample. In fact, age was positively correlated ($r = .29$) with self-reports of medical problems. This increase in medical problems may, in turn, increase the importance of resources such as those relating to social support, accounting for the significant relationship observed in our older groups between PNS and social engagement.

These findings do not necessarily downplay the importance of age-related changes in basic cognitive resources in determining performance. Rather, they suggest an adjustment in the manner in which such resources have an effect. Instead of having a direct impact, the present results suggest that resources, broadly defined, also influence performance indirectly by determining motivation, which in turn affects the manner in which information is processed (Hess, in press). This conceptualization is similar to that proposed by Kruglanski and Webster (1996), who argued that conditions that put pressure on resources do not just influence the availability of resources, but also affect the individual’s use of resources. The more uncomfortable the situation, the more likely it is that the individual will process information in a cursory or heuristic manner to remove him- or herself from the situation.

In conclusion, the results of this research are generally consistent with the notion that aging is associated with changes in the impact of automatic and controlled processing mechanisms on performance. The younger participants engaged in controlled processing to control prime influences when they were aware of the primes and thus motivated to exclude such information in arriving at an accurate judgment. Older adults, on the other hand, were less likely to do so, even when awareness was optimized. The dependence on automatic processing mechanisms in these participants, however, was influenced by available cognitive resources, which in turn was related to the participants’ motivation to seek structure. The distinction between the younger adults and low-PNS older adults versus high-PNS older adults might be understood in terms of Forgas’s (1995) Affect Infusion Model. In this model, an attempt is made to determine the conditions under which affect will be infused into the decision-making process. The high-PNS older adults appear to use a heuristic-based strategy, which is associated with minimal cognitive resources, minimal accuracy motivation, simple stimuli, and low personal relevance. Such strategies are simplistic in nature, and participants will typically make decisions on the basis of any available information (e.g., affective states) that is easily accessed, regardless of its relevance. The younger and low-PNS older adults, however, appear to be using strategies that are more goal directed. Such strategies typically are associated with the availability of cognitive resources and accuracy motivation. Interestingly, Forgas hypothesized that the presence of irrelevant affective information may actually induce such goal-directed processing and minimize the impact of irrelevant information on judgments. Although there are no correct judgments regarding the ambiguous stimuli used in our study, this process might be manifested as an increase in accuracy motivation that takes the form of active attempts to exclude prime-related information in forming judgments. Models such as this highlight the conditions under which participants will employ different types
of strategies. They also emphasize the complex relation between performance and situational and personal characteristics, which may help researchers to understand aging effects on performance in everyday situations (see also Hess, 1999). Certainly, the present results argue against overly simplistic analyses of age differences in performance based solely on cognitive skills and argue for a more careful consideration of the role played by motivation.

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