Effects of Aging on Associative Memory for Socially Meaningful Information

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ABSTRACT

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An extensive body of research exists detailing the decline in memory that occurs with healthy aging. Specifically, episodic memory has been shown to degrade over time in a wealth of paradigms varying in retrieval methods and cognitive load. One type of episodic memory that is particularly impaired with age is associative memory. Recent research investigating the discrepancies between memory for single items of information and memory for the association of such items has led to the Associative Deficit Hypothesis (ADH). Though this research has been extended to social associations such as face-name pairs, no studies to date have explored how personally meaningful social information at encoding impacts recognition. Our study aimed to address how aging affects memory for socially meaningful information using a face-word association. Younger and older adults were asked to encode three conditions of associative pairs (non-social, names, and traits) and their memory was immediately tested in a yes-no recognition task. Signal detection measures were used to explore recognition accuracy and decision making.
processes. Testing effects of age on hits, false alarms, discrimination and response bias measures revealed that associative memory was not preserved for the socially meaningful condition (traits) in older adults. Rather, the non-social condition enhanced hit rates across both age groups. Participants also better discriminated socially meaningful stimuli in comparison to social only (name) stimuli, however this finding was marginal, while response bias analyses revealed that young and older adults adopted a more conservative decision criterion for socially meaningful pairs, compared to social and non-social pairs. The implications of these findings are discussed and potential pitfalls in the methodology that could be addressed in future research are considered.
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**Introduction**

In the field of aging research, extensive empirical evidence suggests an age related decline in memory. Early work discusses several aspects of memory that may decline, namely in episodic memory (Old & Naveh-Benjamin, 2008a). In comparison to younger adults, older adults’ performance declines for retrieval tasks that include free and cued recall (Craik and Jennings, 1992). Similarly, this age group experiences a deficit in semantic processing and deliberate recall, which can be described as an individual’s conscious attempt to ‘remember’ rather than being prompted to do so (Light, 1991). It is further thought that onset of decline may be due to natural degradation in cognitive functions, such as processing speed or inhibitory control (Salthouse, 1996; Zacks 1989), or as a result of divided attention where comprehension and attentional resources at encoding are compromised (Craik & Broadbent, 1983; Craik 1986).

One domain of episodic memory of particular interest is associative memory. It has been suggested that through aging, associative memory declines. Older adults not only encounter a decline in binding items of information into associations at encoding, but also experience difficulty in retrieving the associations. This has recently been described as the Associative Deficit Hypothesis, or ADH (Chalfonte & Johnsons, 1996; Naveh-Benjamin, 2000). However, empirical evidence concerning ADH leaves gaps in potentially important manipulations and novel systems that may, or may not, be affected with aging, including social processing. Given these gaps, we investigated how the content of information at encoding affects retrieval of an associative memory.
Associative memory can be described as the binding of at least two pieces of information together in memory (Naveh-Benjamin, 2000). Item binding includes the encoding of item features or the context in which the item is found, and uniting those pieces of information with the item itself. This process is important for successful retrieval of memories. For example, if attempting to recall the location of an object, memory would have to be intact for item features (content) and for the object location (context). To successfully retrieve a memory of the placement of the object, memory would also have to be intact for the association of the object in its location. By binding the content (features) of the object to its context, an individual is ultimately able to successfully retrieve the memory of where the object is. Through aging, this binding process degrades and can be detrimental to overall life quality. It is important to note that the memory for item location is one example of several associations that can be made on a daily basis, whether the association be between an item and its context as just described, or simply two items, two contexts, or even two general mental codes (Naveh-Benjamin, 2000). This decline in item binding across different age groups was first explored by Chalfonte and Johnson (1996). An age related deficit in remembering items of information alone, such as objects or colors, was not found. However when participants were explicitly asked to recall the color and object as two associated items, or an associative pair, older adults were worse at remembering the associations than young (Chalfonte & Johnsons, 1996).

More recently, literature has explored the associative deficit across a wide range of paradigms and domains. In a study exploring the effects of reduced processing resources, older adults experienced a deficit for associated non-related word pairs over items alone under full attention during encoding (as opposed to divided attention) in comparison to younger adults (Castel & Craik, 2003). In line with this inter-item stimulus deficit, repetitive presentation of
pairs of unrelated words elicited an associative deficit in older adults when compared to younger adults. Though familiarity and recollection for the pairs tended to increase across both age groups, the rate of correct recall in older adults was impaired in comparison to younger adults (Light et al. 2004). ADH has further been extended to intra-item stimuli such as words presented in a specific font or color (Naveh-Benjamin, 2000). Participants were prompted to encode words in differing fonts (a word-font association). An age related deficit was noted for these associations for older adults compared to younger adults, though deficits were not observed in memory for words or fonts alone. Such results are compelling, however, the low ecological validity of the study manipulations raise concern for the representation of more commonly occurring associations. Because initial work lacked ecological validity, Naveh-Benjamin explored this gap as a manipulation of the semantic relation between word pairs. The study results suggested that when word pairs had high semantic relation, older adults were able to more easily remember the associated pairs (Naveh-Benjamin et al., 2003).

In pursuit of research with higher ecological validity, ADH has recently been studied under manipulations that may better approximate real world occurrences. For example, it is possible that ADH would not extend to face-name stimuli because these associations are commonly encountered. However, recent research has suggested otherwise. When participants were instructed to remember face-name pairs, recall of faces or names alone was not affected by age. When prompted to recognize the face-name associated pairs, however, older adults exhibited an associative deficit, in comparison to younger adults (Naveh-Benjamin et al., 2003). Consistent with these findings, older adults were also impaired in their memory for actor-action associated pairs (Old & Naveh-Benjamin, 2008b).

Given this extensive evidence for ADH, recent research has explored the effects of
manipulating behavioral content at encoding on associative memory. For example, Naveh-Benjamin investigated emotional arousal as a function of the associative deficit. His work suggests that on an item basis only, older and younger adults had better memory for emotionally arousing words over neutral words. Additionally, memory accuracy for associations of both positive and negative valence was higher than for neutral associations (Naveh-Benjamin et al. 2012). The current evidence supporting ADH does not address whether the associative deficit extends to all types of information, including that which is socially meaningful. For example, it is possible that the personal meaningfulness of a name randomly assigned to a face is low, even when considering the high ecological value of presenting a participant with a face-name association. While associative deficits have been reported for face-name pairs, we explored whether information about others that is personally meaningful affects memory for such associations.

There is evidence that older adults are more sensitive to social information in memory tasks compared to younger adults. Through aging, the experience gained in social situations results in exceptional sensitivity to social characteristics. An example of such a social characteristic includes an individual’s traits. Given this sensitivity, older adults may focus on the trait-diagnostic information more than the valence of the trait for a target (Hess and Kotter-Gruhn, 2011). Therefore, it is possible that trait information may be more memorable than non-social information in an associative memory paradigm due to the intrinsic social motivations of older adults. This idea is consistent with other research demonstrating that memory for some types of social information can be preserved with age. In a study of younger and older adults, a recognition task showed enhanced memory for impressions in older adults when presented in a socially meaningful way compared to a self-referencing method. That is, when older adults were
able to create a meaningful representation of a presented stimulus by creating behavior based impressions, memory was enhanced for the impression they formed. This would suggest that presenting socially meaningful information, such as a trait, or simulating an interpersonally meaningful interaction with the target stimulus may ameliorate age-related deficits in memory (Cassidy & Gutchess, 2012).

We investigated whether the deficit experienced by older adults in associative memory is reduced when encoded information is personally meaningful. Namely, we hypothesized that presenting socially meaningful information would ameliorate the age related deficit in associative memory. This research explored novel cognitive systems that have yet to be addressed in light of associative memory across aging populations. The implications of this research could be profound for older adults; the investigation of strategies that enhance memory formation may reduce detrimental consequences of age related memory loss.

We propose that presenting an item, such as a face, with a socially meaningful piece of information, such as a behavioral trait, will reduce age-related deficits in episodic memory. We compare age-related associative deficits in memory for three types of information including socially meaningful traits, names, and non-social information. To do so, associated pairs were presented as face-trait, face-name, and face-descriptive word pairs. We compared all three pieces of information to each other, however, the non-social condition served as a control. Conceptually, a name provides social information, but it lacks potentially meaningful connections to the individual. In contrast, a trait conveys meaningful information that is well motivated and thought to benefit older adults as described in previous research. We chose descriptive words related to food (e.g., seedless, citrus, etc) as our control stimuli because they represent a single semantic category (as is the case for traits or names), but do not convey any
socially salient information about a person.

Consistent with prior research on ADH, we predicted that we would replicate the finding of associative deficits for older adults in comparison to younger adults for face-name and face-descriptive word pairs. (Naveh-Benjamin et al. 2004). In contrast, we predicted that older adults would perform more similarly to younger adults for the face-trait word pairs.
Method

Participants

A total of forty-eight participants were recruited for this study. Twenty-four young adults (14 F, 10 M) were recruited from Brandeis University and were compensated with course credits for their participation ($M_{age}=19$, $SD=1.03$). Twenty-four older adults (11 F, 13 M) were recruited from the greater Boston area and received monetary compensation for their time and travel expenses ($M_{age}=75$, $SD=7.35$). English was the primary language across the sample. All participants provided written informed consent in accordance with the requirements and regulations of the Brandeis University Internal Review Board.

Stimuli

Facial. Facial stimuli consisted of forty-eight Caucasian faces taken from the PAL database at the University of Texas, Dallas (Minear & Park, 2004). Faces within this database were previously equated for attractiveness and distinctiveness (Gilron & Gutchess, 2012). Image characteristics included color frontal facial photographs with neutral expressions, with the photos evenly distributed across young and old female and male individuals. All facial stimuli were matched for ratings on attractiveness and distinctiveness overall and across the three study conditions.

Word. Sixteen neutral trait words that were previously normed for trait convergence (Uleman, 1988) were used in the face-trait condition. Sixteen first names were used in the face-name condition. Proper first names were drawn from the Social Security database that contained the most popular male and female names from the 1940’s and 1990’s (e.g., Michael, William,
Caroline, Elizabeth). Names were matched in popularity, number of letters, and number of syllables across young and old facial stimuli. In the final condition, words were chosen from one non-social semantic object category. Research has shown a dissociation of brain regions subserving descriptive judgments of objects in comparison to person/social judgments. Specifically, food descriptive adjectives were associated with changes in different brain regions than trait descriptive adjectives (Mitchell, Heatherton, & Macrae, 2002). We therefore chose food descriptive words as our control due to their non-social nature and their distinct neural underpinnings compared to person adjectives. All descriptive words, traits and names were matched for number of letters and syllables. For similar cognitive load, descriptive and trait words were matched for concreteness as well.

**Pairs.** The 48 facial stimuli were paired with one of three possible word conditions, such that each participant was exposed to 16 face-descriptive word pairs, 16 face-name pairs, and 16 face-trait pairs. Across each condition, an equal number of each of the four face stimuli ‘types’ were used (i.e., young and old female; young and old male). Faces were counterbalanced across the three conditions. The faces assigned to these words were counterbalanced such that they rotated evenly across all three conditions across participants.

**Additional measures**

**MMSE.** The Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) assessment was administered only to older adults. The measure is commonly used to screen for cognitive impairment.

**Shipley Vocabulary Test.** This assessment (Shipley, 1940) was administered on the computer to both younger and older adults as a measure of crystallized knowledge.

**Digit Comparison Test.** This assessment is a common measure for processing speed. It
was also administered to both younger and older adults (Hedden, et al., 2002).

**Frequency Rating Task.** Frequency ratings for trait and descriptive words were not available in the MRC Psycholinguistic Database (Coltheart, 1981). As a result, participants were asked to rate thirty-two words on how frequently they encountered the words in reading. Frequency was rated for all of the food descriptive words and trait words presented in the task. Words were rated on a 7 point scale, where “1” indicated that the participant had never seen the word while “7” indicated that the word was encountered several times a day.

**Post-Study Questionnaire.** This questionnaire was administered to all participants for feedback on potentially distinctive facial or word stimuli that may have otherwise created noise in the data. It furthermore allowed the participants to reflect on encoding and recognition strategies.

**Procedure**

**Encoding.** Participants were first presented with a practice, including task directions and four face-word pairs that were not presented during the actual task. Instructions explicitly directed participants to focus on the face and the word together as a pair, because their memory would later be tested for these pairs. Participants were then shown a series of 48 face-word pairs drawn from the three conditions (face-descriptive word, face-trait, and face-name) that were viewed on a computer monitor. Each word pair was presented for 4 seconds. Once all pairs were presented, participants were provided with encoding directions for a second time and were shown the pairs again. The second viewing showed the pairs in a randomized order that differed from the first viewing, however all pairs were exactly the same and no new or mismatched information was presented.

**Distraction.** To avoid a recency effect in memory, participants were asked to count down
from 1000 by serial 7’s and were timed for approximately 30 seconds.

**Recognition.** Participants performed a forced-choice, yes or no decision task for retrieval, determining whether or not the pairs of items had been presented together at encoding. Following completion of practice, participants were presented with 24 intact pairs (pairs originally presented at encoding) and 24 recombined pairs (faces paired with different words than were originally presented during encoding), a retrieval process modeled after Naveh-Benjamin et al. (2003, 2008). For example, during encoding, a participant may have seen an older female face paired with the name “Mary”. In the recognition task, if the female face was presented with “Mary”, it was considered an intact pair. The correct judgment would therefore be “yes, I previously saw this face with this word”. If the face was presented with the name “Susan” at encoding, it would be a recombined pair. The correct judgment was therefore “no, I did not previously see this face with this word”. The participants were asked to make these judgments for all 48 stimuli. The task was self-paced, and the pairs were presented in a random order. When recombining pairs for recognition, we recombined pairs within a specific condition (trait, name, or descriptive) only.

**Questionnaires.** Participants were then asked to complete the Shipley vocabulary test and digit comparison test. Additionally, participants completed the frequency rating task and the post study-questionnaire.

**Research Design**

The study was a mixed design where age was a between subjects variable and associative pair type (descriptive word, name, or trait) was a within subjects. The dependent variable was the participant’s memory performance for associative pairs. Memory for these associative pairs was operationalized using proportions of hits and false alarms, as well as a corrected response
measure for discrimination (d’) and criterion analysis (c), a measure of response bias. These statistics were calculated with signal detection theory formulas (Stanislaw & Todorov, 1999).

For example, a participant was asked to make the correct old (intact) / new (recombined) pair recognition response when identifying whether the target pair presented in the recognition task was exactly the same as the pair presented at encoding with a yes or no response. A participant that made an accurate (hit) judgment for an old, or intact pair, selected “yes”, while for a new, recombined pair, the correct judgment was “no”. If the participant selected yes for a recombined pair, the response would be considered a false alarm.
Results

Word Frequency Ratings. Because we were unable to obtain frequency ratings from the MRC database for two conditions (food descriptive words and traits), ratings were collected from participants. We conducted a mixed-design 2 x 2 ANOVA where the word type was a between subject factor while age group was a within subject factor. First, we found a main effect of age, F(1,30)= 23.79, p<0.001, ηp² = 0.44. Younger adults (M=4.08, SD=0.93) rated words, regardless of condition, as more frequent than older adults (M=3.74, SD=0.69). We further found a marginal main effect of word type, F(1,30) = 3.45, p=0.073, ηp² = 0.10. Descriptive words (M=3.67, SD=0.60) were rated as being encountered less frequently than trait words (M=4.16, SD=0.95). There was also an interaction of word type by age, F(1,30) = 5.08, p=0.032, ηp² = 0.15. Older adults rated descriptive (M=3.57, SD=0.55) and trait (M=3.91, SD=0.79) words more similarly than young adults (M=3.76, SD=0.65; M=4.42, SD=1.07, respectively).

Sample Characteristics. Both age groups completed two cognitive assessments, the digit comparison test and the Shipley vocabulary test. We conducted independent samples t-tests for both of these assessments, comparing performance of young adults to older adults. Processing speed was significantly different across age groups, t(46)=5.21, p<0.001. Younger adults (M=78.79, SD=14.34) had higher overall scores than older adults (M=59.25, SD=11.50), a finding that is consistent with previous research (Salthouse, 1996). The Shipley vocabulary test also revealed significantly different performance for younger and older adults, t(46)= -5.03, p<0.001. Older adults had higher vocabulary scores on average.
(M=36.83, SD=2.33) when compared to younger adults (M=32.46, SD=3.56). This is not surprising given that crystallized knowledge grows with experience and time. Finally, older adults only were asked to complete the Mini Mental State Exam. This measure of cognitive impairment revealed that our older adult sample fell within the range of 26 to 30 and had normal cognition (M= 28.88, SD 1.19).

**Hits.** The proportion of hits was calculated by dividing the participant’s hit performance for each condition by the total possible number of hits. To examine the impact of the condition and age group on recognition, we conducted a 3 x 2 repeated-measures ANOVA, with the word type condition as the within subject factor and age as the between subject factor. Analyses revealed a significant main effect of age, F(1,46) = 5.61, p =0.022, ηp² = 0.11.

On average, younger adults (M= 0.85, SE=0.02) had a higher hit rate than older adults (M=0.79, SE= 0.02). Additionally, a main effect of condition was found, F(2,92) = 3.24, p =0.044, ηp² =0.07. To investigate this effect further, we conducted paired sample t-tests across each condition. Analyses revealed no difference in hit rates for names in comparison to traits, t(47)= - 0.23, p = 0.82). However, hit rates significantly differed between the descriptive and trait conditions, t(47) =2.87, p = 0.006. On average, the proportion of hits for descriptive words (M=0.86, SD=0.12) were higher than for trait words (M= 0.80, SD=0.14). Similarly, hit rates for descriptive words and names were significantly different, t(47)= 2.14, p= 0.038. When compared to descriptive words, proportion of hits for names was lower (M=0.79, SD=0.15). These results revealed that the descriptive condition was the most memorable across age groups. Finally, there was no significant interaction of age by condition, F(2,92) = 1.35, p =0.26, ηp² = 0.03 (see figure 1).

**False Alarms.** To investigate the impact of word condition on false recognition rates, we
conducted a 3 x 2 repeated measures ANOVA, where the word condition was a within subject factor and age was a between subject factor. Analyses revealed a significant main effect of age, $F(1,46)= 14.56, p<0.001, \eta^2 =0.24$. Marginal means indicated that older adults ($M=0.34, SE=0.03$) had higher false alarm rates than younger adults ($M=0.19, SE=0.03$). In terms of the effect of condition on the false alarm rate, a marginal main effect was observed, $F(2,92) = 2.53, p= 0.086, \eta^2 = 0.05$. On average, name pairs elicited the highest false alarm rate ($M= 0.29, SE=0.03$) followed by descriptive word pairs ($M=0.27, SE=0.03$), while trait pairs elicited the lowest false alarm rates ($0.23, SE=0.02$). The age difference for performance across each condition can be seen in figure 2. A paired sample t-test further revealed significantly different false alarm rates for the name pairs in comparison to the trait pairs, $t(47)= 2.63, p = 0.012$, while comparisons for name and descriptive word false alarms ($p=0.44$) and trait and descriptive word false alarms ($p=0.20$) did not approach significance. Finally, there was no interaction of condition by age, $F(2,92)=0.11, p=0.89, \eta^2 =0.002$.

**Corrected Recognition.** We calculated $d'$, our corrected recognition response, by subtracting the $z$-score corresponding to each participant’s false alarm rate from the $z$-score corresponding to their hit rate (Stanislaw & Todorov, 1999). We conducted a 3 x 2 repeated measures ANOVA where the word condition was the within subjects factor and age was the between subjects factor. Analyses revealed a main effect of condition, $F(2,92) = 3.29, p= 0.042, \eta^2 =0.07$. Participants tended to have higher $d'$ scores for descriptive ($M= 1.89, SE = 0.12$) and trait pairs ($M= 1.82, SE = 0.11$), but showed the lowest discrimination for name pairs ($M= 1.60, SE= 0.12$). In line with these means, additional paired sample t-tests revealed a significant difference for descriptive pairs relative to names, $t(47) = 2.49, p=0.017$, a marginally significant difference between trait pairs and name pairs, $t(47) = 1.85, p = 0.070$, and no difference between trait pairs and
descriptive pairs (p=0.61).

A main effect of age was also observed, $F(1,46) = 15.21$, $p < 0.001$, $\eta^2 = 0.25$. Marginal means revealed that younger adults had higher $d'$ scores ($M=2.13$, $SE=0.13$) than older adults ($M=1.41$, $SE=0.13$. This significant trend can be noted in figure 3. However, an age by condition interaction was not observed ($F(2) = 1.38$, $p= 0.27$, $\eta^2 = 0.03$).

**Response Bias.** Finally, we were interested in measures of participant response bias, “c”.

Response bias was calculated for each participant by averaging the hit rate $Z$-score and false alarm $Z$-score, and multiplying that value by $-1$ (Stanislaw & Todorov, 1999). We conducted a 3 x 2 repeated measures ANOVA where word condition was the within subjects factor and age was the between subjects factor. A main effect of condition was not observed for response bias, $F(2) = 2.27$, $p = 0.109$, $\eta^2 = 0.05$. However, there were varying marginal means for the descriptive ($M=-0.22$, $SE=0.05$), name ($M=-0.15$, $SE=0.07$, and trait ($M=-0.05$, $SE=0.05$) conditions.

On the other hand, there was a main effect of age, $F(1,46) = 5.01$, $p = 0.030$, $\eta^2 =0.10$. Marginal means revealed that on average, younger adults ($M=-0.06$, $SE=0.05$) had a more conservative response bias in comparison to older adults ($M=-0.22$, $SE=0.05$). These results suggest that older adults adopted a more liberal approach to making decisions during the recognition task. Finally, an age by condition interaction was not found for participant response bias, $F (2,92)= 0.34$, $p = 0.71$, $\eta^2 = 0.01$ (See figure 4).
**Discussion**

People form associations on a daily basis ranging in content, contexts, and mental codes (Naveh-Benjamin, 2000). Associations are able to assist in basic memory processes through the successful binding of items of information together. Extensive literature has suggested an associative deficit in older adults; our study explored a novel domain of associative memory by investigating the effects of information at encoding on retrieval in a social context. Specifically, our study revealed the impact of socially meaningful information on retrieval for associated word-face pairs among younger and older adults.

Our study supported our hypothesis of an age difference in performance on an associative memory task. Consistent with previous research, our study revealed that older adults exhibited associative deficits in comparison to younger adults on a word-face paradigm (Naveh-Benjamin et. al, 2003), and we extend this research by identifying associative deficits across a range of conditions. Our results revealed that overall, older adults had higher false alarm rates, lower hit rates, and were less successful at discriminating old from new information for face-word stimuli in memory when compared to younger adults. Additionally, older adults had more liberal response biases than younger adults when making yes or no decisions during recognition.

We also hypothesized that the socially meaningful condition would be more memorable across both age groups in comparison to the social and non-social condition, and that associative deficits would be reduced for this type of information for older adults. Results were inconsistent with our hypothesis revealing that, based on discrimination scores, the non-social condition was more memorable than the socially meaningful condition, while overall, both age groups
remembered names more poorly than the other two conditions. Additionally, older adults exhibited a reduction in discrimination across conditions when compared to younger adults, and the magnitude of associative deficits did not vary significantly across the conditions. Participants also better discriminated old from new pairs for traits over names, however, this result was marginal. Despite face-trait pairs being better remembered across both age groups in comparison to face-name pairs, this trend is also true for face-descriptive word pairs, therefore we are unable to suggest evidence that face-trait associations are more memorable with age. Rather, the associative deficit hypothesis extends to a paradigm with socially meaningful stimuli, such as traits.

In addition to testing discrimination in memory, we were able to explore response bias within our sample by conducting criterion analyses (i.e., how liberal or conservative participants were in their decision making process). Older adults adopted a more liberal approach to decision making than younger adults over all, which is consistent with a wealth of research in healthy younger and older adults. In a facial memory recognition task, older adults exhibited both a more liberal response bias and a slight deficit in recognition in comparison to younger adults (Flicker, et al., 1990). Additionally, a study exploring recognition for a simple verbal memory task suggested a more liberal response in older adults, where response bias was positively correlated with increases in age across older adults, specifically (Huh, et al., 2005). While support for a liberal response bias exists, another study explored a facial recognition paradigm similar to our study with healthy younger and older adults that suggests otherwise. In a continuous recognition task, where yes-no decisions had to be made, a delay in stimulus presentation elicited a memory deficit in older adults. Interestingly, no bias for response criterion was noted across both age groups (Ferris, et al., 1980). This may suggest that the response criterion exhibited by our
participants may be specific to the associative aspect of our pair recognition tasks. Despite the
high variability, it is important to note that a clear trend was visible for a more conservative
decision making approach for trait pairs in both age groups. It would be valuable to investigate
this further with a larger sample size.

A possible explanation for our unsupported hypothesis may be that the trait condition did
not actually provide socially meaningful information to participants. It is unlikely that in
common social interactions, people are provided with trait information based on a single word.
Rather, individuals form impressions of others based on behavioral observation (Todorov &
Uleman, 2002). Furthermore, it has been suggested that memory for impressions is better
preserved in an aging population when it is presented in a socially meaningful way (Gutchess &
Cassidy, 2012). If humans collect information about one another based on behaviors and
interactions, the trait condition in our study is arguably not social at all. The face-trait pairs may
be presenting socially meaningful information about the target, however, the *method* of
presentation may not be consistent with real life associative encoding of a person’s trait. It is
possible then, that the trait word does not provide the participant with salient and distinctive
information at encoding to later make it more memorable.

An alternative explanation may be that the trait words presented with the faces are
incongruent with the participants’ first impression of the stimulus. Research has shown that
people spontaneously infer character traits in others based on their first impression (Todorov &
Uleman, 2003). The impact of a target’s face is shown in our impressions of people by our
overgeneralization of the target’s behaviors due to key facial features (Zebrowitz, 1997;
Zebrowitz & Montepare, 2008). In line with this evidence, it is possible that a participant’s first
trait based impression of a facial target may be incongruent with the presented trait due to
overgeneralization of key facial features. Humans, however, are flexible with inconsistent impression information and are therefore able to update their impression of a person based on new incoming information (Mende-Siedlecki, Cai, and Todorov, 2013). Therefore, it is possible that the four second stimulus presentation time in our paradigm may demand participant attentional resources for updating their incongruent impression rather than using the time for successful binding.

Another concern with our paradigm is the descriptive word condition. It is not intuitive that the descriptive word condition elicited the highest hit rates and high discrimination for younger and older adults. It is possible that rather than serving as a control, this condition was most memorable due to the type of descriptive words paired with faces. The bizarreness nature of a food descriptor paired with a face may have been more distinctive to participants than a more common face association such as a name or character trait. This bizarreness effect has been established previously. An early study explored the impact of ordinary and bizarre action phrases on recognition and cued recall. When participants were asked to passively encode a verbal task, their recognition was better for the bizarre action phrase than for the ordinary action phrase (Engelkamp, Zimmer, & Biegelmann, 1993). Furthermore, bizarre and distinctive imagery paired with words was more memorable in younger adults than common imagery (McDaniel & Einstein, 1996). It is possible that this same effect applies to our association paradigm. Perhaps participants from both age groups focused on the bizarre nature of the distinct associative pairs, which enhanced their memory for this condition. Future research may address this limitation.

In attempting to identify a more appropriate control condition for future work, our pilot work is informative. We initially included a control condition consisting of abstract, or low imageability, words that were normed for concreteness, cognitive load, and valence. However,
these items still appeared to be more distinctive and memorable paired with faces than names or traits. We attributed this trend to the fact that the words were each unique and did not share semantic relationships with each other. It is possible that because the words were unrelated to each other, they were more distinctive and memorable than name or trait words, which share inherent relationships from being drawn from the same subsets of words, potentially making them more confusable across pairs. It appears that both abstract words, that control for the abstract nature and low imagability of name and trait words, and descriptive words, depending on the bizarreness of the association with faces, pose challenges for creating a control condition.

While we did not identify an advantage for socially meaningful information in associative memory with age, improving some aspects of study design may better address our question in future research. Our study revealed that the social component of a trait descriptor is not necessarily meaningful during encoding to later enhance recognition. Social interactions are a major component of daily life. Given their immediate relevance to human nature, further investigation of associative memory in the social domain may reveal ways in which social information is remembered differently than other types of associations.
Figure 1. Mean proportion of hits across age groups for three stimuli condition types, with standard error bars.
**Figure 2.** Mean proportion of false alarms across age groups for each condition, with standard error bars.
Figure 3. Mean corrected recognition scores (d’), with standard error bars.
Figure 4. Mean response bias (c) scores, with error bars.
References


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