

## Article

# Effects of Perceptual and Contextual Enrichment on Visual Confrontation Naming in Adult Aging

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**Purpose:** The purpose of this study was to determine the effects of enriching line drawings with color/texture and environmental context as a facilitator of naming speed and accuracy in older adults.

**Method:** Twenty young and 23 older adults named high-frequency picture stimuli from the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 2001) under three conditions: (a) black-and-white items, (b) colorized-texturized items, and (c) scene-primed colored items (e.g., “hammock” preceded 1,000 ms by a backyard scene).

**Results:** With respect to speeded naming latencies, mixed-model analyses of variance revealed that young adults did not benefit from colorization-texturization but did show scene-priming effects.

In contrast, older adults failed to show facilitation effects from either colorized-texturized or scene-primed items. Moreover, older adults were consistently slower to initiate naming than were their younger counterparts across all conditions.

**Conclusions:** Perceptual and contextual enrichment of sparse line drawings does not appear to facilitate visual confrontation naming in older adults, whereas younger adults do tend to show benefits of scene priming. We interpret these findings as generally supportive of a processing speed account of age-related object picture-naming difficulty.

**Key Words:** aging, naming, picture, perception, response time, lexical retrieval

Older adults experience increasing word-finding difficulty with advancing age, as reflected by decreases in accuracy and increases in the amount of time needed to name items, even in the absence of pathological conditions (e.g., Au et al., 1995; Feyereisen, Demaeght, & Samson, 1998; Tsang & Lee, 2003). Given the cognitive complexity and numerous operations required for successful object picture naming, identifying a clear locus for age-related naming deficits has proven challenging. Most models of visual confrontation naming agree that naming a picture requires perceptual recognition of the object (attending to it in the

visual field and processing its physical properties), semantic activation of the concept, lexical selection from among competing alternatives, and retrieval and expression of the phonological word form (e.g., Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt et al., 1991). Although breakdowns in naming can be caused by interference in any one of these processes, in older adults, word retrieval difficulties are typically hypothesized to be a problem with lexical access (Barresi, Nicholas, Tabor Connor, Obler, & Albert, 2000; Bowles, Obler, & Poon, 1989). The multicomponent processing required for lexical retrieval is supported by higher order cognitive functions operating in a distributed neural network (Goodglass & Wingfield, 1997). In this study, we investigated whether object picture naming in typical aging may be facilitated by the addition of perceptual and contextual detail afforded by color or environmental scenes.

The clearest evidence for age-related difficulties in picture naming comes from studies of visual confrontation naming, in which participants are asked to name pictures of individual items. At a basic level, older adults are typically found to name fewer items correctly and produce more errors compared with young adults (e.g.,

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Albert, Heller, & Milberg, 1988; Au et al., 1995; Barresi et al., 2000; M. Nicholas, Obler, Albert, & Goodglass, 1985; Randolph, Lansing, Ivnik, Cullum, & Hermann, 1999; Tsang & Lee, 2003). In addition, even when naming pictures correctly, older adults take longer to respond (e.g., Feyereisen et al., 1998; Hodgson & Ellis, 1998; Thomas, Fozard, & Waugh, 1977; Tsang & Lee, 2003). Changes in accuracy and/or response latency suggest that naming is less efficient in older adults than in young adults. Although few researchers dispute the presence of changes in word finding associated with aging, the etiology of these impairments remains controversial. One interpretation of older adults' naming deficits is that these deficits are a secondary effect of generalized cognitive slowing (Feyereisen et al., 1998). The processing speed account of cognitive aging maintains that age-related cognitive declines are predominantly due to a general reduction in the speed of performing cognitive tasks (Salthouse, 1996). Under this view, picture-naming deficits result from the proportional slowing of each stage of processing, from perception to semantic activation to lexical retrieval to expression of the word form.

However, because of its dependence on visual processing, picture naming is also an inherently perceptual task, suggesting another possible locus for age-related naming impairments. Adult aging is associated with declines in sensory processing in multiple domains, and vision is no exception; decreases in visual processing with aging are well documented (Fozard & Gordon-Salant, 2001; Haegerstrom-Portnoy, Schneck, & Braybyn, 1999). Moreover, age-related changes are not limited to visual acuity but also include operations such as processing low spatial frequencies that may be important for identification of picture stimuli (Sekuler & Hutman, 1980; Sekuler, Hutman, & Owsley, 1980). Thus, in theory, challenges with accurately perceiving the to-be-named item may contribute to age-related naming difficulty. This hypothesis has received support from a recent study by Gutherie and colleagues (2010), who demonstrated significant interactions between age and spatial frequency in visual confrontation naming.

Although age-related changes in sensory processing might directly impact naming ability, they may also possibly exert an effect through their interaction with cognitive factors. Sensory processes are attributes relating to modality-specific processing of physical or ecological detail. For example, sensory processes related to vision might include detection of luminance and edge contours, whereas auditory sensory processes might include frequency discrimination and temporal sequencing. In contrast, cognitive factors are operations such as working memory, inhibitory control, or attentional vigilance that may act on primary sensory input in the service of a task. Ample evidence for a perceptual-cognitive interaction is found in studies of speech processing in older adults,

who typically show decline in hearing acuity (Morrell, Gordon-Salant, Pearson, Brant, & Fozard, 1996) and tasks such as temporal discrimination (Schneider, 1997). As a result of both perceptual and cognitive decline, older adults have difficulty processing speech that has been degraded—for example, by compressing it in time (Wingfield, Tun, Koh, & Rosen, 1999). Such difficulty is exacerbated by manipulations of linguistic complexity. Older adults respond less accurately to syntactically complex sentences presented at a moderate speech rate, but their accuracy is differentially worse at fast rates of speech (Peelle, Troiani, Wingfield, & Grossman, 2010; Wingfield, Peelle, & Grossman, 2003), indicating a relationship between perceptual (in this case, acoustic) and cognitive factors that is affected in typical aging. The same relationship is also seen in listeners with hearing impairment, in which the decline in hearing acuity similarly interacts with other factors to differentially challenge processing (Wingfield, McCoy, Peelle, Tun, & Cox, 2006). In the context of age-related declines in visual processing ability noted above, studies suggest that sensory ability might reasonably be expected to influence identification of pictured items at both perceptual and cognitive levels. If older adults' visual-perceptual processing ability contributes to their picture-naming performance, naming success should be influenced by the perceptual features of the target stimuli. The focus of the present study, then, is to determine the influence of perceptually enhanced stimuli on the picture-naming accuracy and response times of older adults.

With few exceptions, studies of picture naming use black-and-white line drawings, and these line drawings are often pictured in isolation without the added context of background scene information. However, this contrasts starkly with real-life objects, which are typically perceived in color as part of relevant environmental scenes. It is perhaps not surprising, then, that research in young adults suggests that visual recognition of pictured items is facilitated by adding color (Brodie, Wallace, & Sharrat, 1991; Price & Humphreys, 1989; Rossion & Pourtois, 2004; Tanaka & Presnell, 1999; Wurm, Legge, Isenberg, & Luebker, 1993). Rossion and Pourtois conducted what might be the most extensive psycholinguistic study of perceptual enhancement on naming to date by progressively enriching a large set of black-and-white line drawings with texture and color. Their study is notable because, unlike other studies, the same items were presented as both black-and-white line drawings and as color/texture-enriched pictures based on those drawings, providing better control than other studies for idiosyncratic stimulus characteristics. Rossion and Pourtois reported that adding color to line drawings significantly increased accuracy (as reflected in agreement scores) and reduced naming

latencies in young adults. One question is the degree to which this facilitation depends on the specific stimuli (or particular type of perceptual enrichment) used. In addition, it remains unclear whether older adults' naming accuracy and speed could—like that of the young adults—benefit from perceptual enrichment.

A second way of enhancing perceptual recognition is by priming the to-be-named item with contextually congruent scene information. In the real world, the information present in the visual environment helps set up expectations about what kinds of objects will be represented within those contexts, thus facilitating recognition of the expected objects (Bar, 2004). In a picture-naming study, the presence of a visual cue prior to the appearance of a picture of an object may aid in directing attention to the task and facilitate the perceptual processing of the object. In young adults, studies have shown that pictures of objects are identified more accurately when presented in the context of appropriate scene information (Boyce & Pollatsek, 1992; Boyce, Pollatsek, & Rayner, 1989; Davenport, 2007; Davenport & Potter, 2004; Palmer, 1975). To date, we are aware of only one study that examined the effects of scene priming on object-picture naming. Palmer (1975) presented young adults with pictures of objects paired with different kinds of contextual information: congruent scene primes (e.g., *kitchen* primes *bread*), incongruent scene primes (e.g., *kitchen* primes *mailbox*), or no scene primes. As noted above, one possibility is that preceding the target item by a scene serves to direct attention to the pictured object. However, Palmer (1975) demonstrated that accuracy was greatest for stimuli primed by congruent scenes and poorest for stimuli primed by incongruent scenes. The increased facilitation for congruent scene primes relative to incongruent scene primes suggests that it was the semantic content of the scene that affected accuracy. It is not clear how scene-priming information will affect object-picture naming in older adults. However, studies examining word-primed picture naming in aging have not reported age differences between young and older adults in the amount of semantic activation from primes (Bowles, 1994), nor have they found similar patterns of prime-induced facilitation and inhibition in both age groups (Tree & Hirsh, 2003). These findings suggest a basis for the effectiveness of a scene-priming manipulation among young and older adults.

In summary, it has been suggested that perceptually enhancing black-and-white line drawings by adding color (Rossion & Pourtois, 2004) or by priming with congruent scene information (Palmer, 1975) facilitates naming in young adults. We would like to extend the literature—first, by assessing whether previous findings transfer to a set of stimulus materials commonly used in clinical assessment, and second, by comparing the response times and accuracies of naming in young

and older adults. Additionally, because our study is based on speeded response times and because we are attempting to differentiate perceptual versus cognitive contributions to picture naming, we have included a measure of motoric speed and cognitive performance: the Trail Making Test (TMT; Reitan & Wolfson, 1985). TMT-A is considered a test of motoric speed and visual search (Crowe, 1998) that requires participants to draw lines connecting 25 consecutive numbers as quickly as possible. TMT-B is a measure of cognitive function in older adults (Oosterman et al., 2010) that has also been found to predict processing speed (Kennedy, Clement, & Curtiss, 2003). It requires participants to draw lines quickly connecting alternate numbers and letters. From these two tests, a third measure may be derived that is independent of motoric speed and visual search: TMT-B minus TMT-A, an executive function measure of set-shifting performance (Drane, Yuspeh, Huthwaite, & Klingler, 2002). The value of this comparison is that it potentially isolates information about switch cost (i.e., alternating between numbers and letters) inherent in TMT-B via a cognitive subtraction of the motor and visual search components engendered in TMT-A. Switch cost has been strongly linked to cognitive flexibility, and it is a construct that is commonly measured across many additional assessments of executive functioning such as the Wisconsin Card Sorting Test (Heaton, Chelune, Talley, & Kay, 1993).

On the basis of the existing literature and theories of perceptual and cognitive changes in older adults, we proposed two hypotheses on the effects of perceptual enrichment in aging. First, if age-related degradation of perceptual processing is interfering with older adults' naming, then we would expect an interaction of age and perceptual enrichment such that older adults would show a benefit when perceptual processing is aided either due to color enrichment or priming with a congruent scene. In contrast, if naming difficulty in aging is due to a generalized processing impairment, we would expect a main effect of age but no interaction with perceptual manipulations. In other words, older adults' response times would be similar to those of the young adults across conditions but would be proportionately slower. Finally, we predict that response time differences in the speeded naming task will reflect both a motor and additional executive resource limitation among older adults, as evidenced by TMT correlations (TMT-A, TMT-B, TMT-B minus TMT-A).

## Method

For these experiments, we examined naming accuracies and latencies for the picture stimuli of the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub,

2001) under three separate conditions: (a) black–white: unmodified line drawings of BNT picture stimuli; (b) colored: color- and texture-enriched drawings; and (c) congruent scene-primed: the same color-texturized drawings preceded 1,000 ms by an image of a congruent environmental scene. Prior to conducting our main study, we first ran a pilot study to determine what constitutes congruent or incongruent scene information. We then used the information from this pre-experiment study to develop our stimuli. Both the pilot study and the main study were approved by the University of Florida Institutional Review Board for social and behavioral research.

### Pre-Experiment Pilot Study

We first conducted a pilot study to determine which environmental contexts would be most or least typically associated with each BNT picture. Twenty-one individuals participated in an online survey, 10 young individuals (mean age = 24.30, *SD* = 4.00; mean years of education = 15.30, *SD* = 1.70) and 11 older individuals (mean age = 60.09, *SD* = 13.30). The participants were asked to rate the likelihood of finding specific items in particular contexts using a seven-point Likert scale (1 = *highly unlikely*, 2 = *very unlikely*, 3 = *somewhat unlikely*, 4 = *undecided*, 5 = *somewhat likely*, 6 = *very likely*, 7 = *highly likely*). Each of the BNT items, in word form, appeared in one of four different written contexts (two likely and two unlikely). For example, likely contexts were “accordion on a stage” and “accordion in a music store,” and unlikely contexts were “accordion in a jungle” and “accordion on a soccer field.” We obtained 240 ratings from which we took the average ratings for each ranking (1 = *highly unlikely* to 7 = *highly likely*) to derive a measure of fit for each target/context pairing. A low fit indicated that most participants found the pairing to be unlikely, and a high fit indicated that most participants found the pairing to be likely. For each BNT item, the lowest and highest fit of the four contexts was chosen, yielding 120 contexts (60 unlikely and 60 likely) for 60 BNT items.

### Pre-Experiment Stimuli Development

Stimuli included both the original and modified versions of the BNT as well as contextual scenes based on results from the pilot study. For the black–white condition, we first digitized the original 60 black-and-white BNT pictures as 250 pixel × 250 pixel bitmap images. We then edited these pictures using Adobe Photoshop by adding color, texture, and luminance contours (shadow), yielding a set of 60 color enriched picture stimuli for the colored condition. For the contextual scene condition, 120 scenes were chosen based on the ratings from the pilot study (see *Pre-Experiment Pilot Study* subsection above). We obtained scene images by querying the Google Images search engine and choosing the first image that appeared. Three members of the Cognition and Language Lab at the University of Florida then judged each image and reached a consensus on the quality and representativeness of each scene. If the first image that appeared was not of good quality and/or representative (e.g., a desert scene with a distorted sunset that could be mistaken for fire), then the second image was chosen, and so on, until all three lab members were in agreement. We modified the images to better approximate the cartoon/line-drawing aspect of the BNT stimuli using the Adobe Photoshop Palette Knife function. Half of the cartoonized scenes were congruent with the target BNT pictures (e.g., *kitchen/asparagus*) and served as the experimental scene-priming manipulation. The remaining scenes were incongruent with the targets (e.g., *aquarium/asparagus*). The incongruent scenes served as a control for the semantic effects of scene priming, thus allowing us to assess the effects of semantic content while keeping visual complexity constant. For an example of the modified scene and BNT pictures, see Appendixes A and B.

### Main Experiment Participants

Neuropsychological and demographic data for all participants are presented in Table 1. Participants

**Table 1.** Age group means and standard deviations (*SDs*) for demographic and neuropsychological data.

Variable	Older adults ( <i>n</i> = 23)		Younger adults ( <i>n</i> = 20)		<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Age	68.43	7.23	20.75	2.04	30.27	< .001
Education	15.30	3.04	15.10	2.27	.25	.81
MoCA	27.35	1.11	28.60	1.23	3.50	.001
TMT-A (sec)	30.13	9.56	21.15	5.39	3.72	.001
TMT-B (sec)	71.91	20.48	39.40	7.58	5.10	< .001
TMT-B minus TMT-A (sec)	41.78	23.52	18.25	6.64	4.59	< .001

Note. MoCA = Montreal Cognitive Assessment; TMT = Trail Making Test; sec = seconds.

included 23 healthy, community-dwelling older adults aged 54–81 years ( $M = 68.43$  years), and a comparison group of 20 young adults from the University of Florida aged 18–26 years ( $M = 20.75$  years). All participants had a minimum of 12 years of education, and older adults did not differ significantly from young adults in terms of education,  $t(41) = 0.25$ ,  $p = .81$ . Participants had normal or corrected-to-normal vision and hearing as indicated by self-report, and all passed a primary color identification screen for color blindness. Participants reported no history of neurological impairment or reading disorder and scored within normal limits (26/30 or higher) on the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), a cognitive screen. It should be noted that the older adults' MoCA scores were significantly lower than those of the young adults by 1.25 points; however, the older adults' scores were consistent with those reported in Luis, Keegan, and Mullan (2009). Older adults also differed significantly from young adults on the TMT (Reitan & Wolfson, 1985), taking a longer time to complete TMT-A and TMT-B and showing significant differences in TMT-B minus TMT-A.

## Main Experiment Design and Procedure

For all of the experimental conditions, we asked participants to name pictures as quickly and accurately as possible. Participants were seated at a desktop computer in a quiet room, where they viewed a 21" monitor. We coupled the computer to a sensitive microphone relay (Cedrus Systems) that we used to capture the onset of vocal latencies. We standardized stimulus delivery using E-Prime presentation software (Version 2.0; Psychology Software Tools). E-Prime enabled us to automate stimulus delivery and record reaction times using a voice key response box. We simultaneously recorded participant responses with a digital audio recorder for offline accuracy scoring.

Participants named four types of stimuli (black–white, colored, congruent scene-primed, and incongruent scene-primed), which were organized into two experiment blocks whose order of presentation was counter-balanced across the young and older participants. In one of the blocks, participants named 60 black-and-white BNT items randomly interspersed with the 60 colored BNT items. Stimuli appeared in one of five different locations on the monitor (centered or positioned at each of the corners) an equal number of times across items in order to prevent habituation to the target picture while ignoring the background scene. The trial structure for the black–white versus colored naming was as follows: blank screen (250 ms), fixation cross (500 ms), blank screen (250 ms), BNT picture of an object (until voice key or 8,000 ms), and wait period (1,200 ms). In another block, participants viewed 120 scene prime–target BNT picture pairs

(60 congruent scene primes interspersed randomly with 60 incongruent scene primes). Participants viewed each scene prime for 1,000 ms prior to naming one of the target 60 colored BNT items. The scene prime remained on the screen while the target BNT item appeared in one of five different locations, similar to the black–white versus colored block discussed above. The trial structure for the congruent versus incongruent prime block was as follows: blank screen (250 ms), fixation cross (500 ms), blank screen (250 ms), scene prime (until voice key or 8,000 ms), and wait period (1,200 ms; see Appendix B for an example of the scene–prime trial structure). Each of the blocks was preceded by a brief familiarization trial, during which time the participant named non-BNT stimuli and received feedback on response volume and microphone placement.

## Data Analysis

We followed the original standardized procedures for scoring the BNT, which preclude acceptance of synonyms (e.g., *dromedary* for *camel*) or related words (e.g., *squid* for *octopus*). However, participants were not penalized for using modified names for items; for example, we accepted *tennis racket* for *racket*. Prior to conducting statistical analyses, we eliminated stimuli whose item level accuracy was less than 70% across participants, corresponding to 11 of the lowest frequency BNT items: *compass*, *latch*, *tripod*, *scroll*, *tongs*, *sphinx*, *yoke*, *trellis*, *palette*, *protractor*, and *abacus*. If we had included these items and were to compute a mean reaction time (RT) for the items for the group, we would potentially introduce a bias toward the relatively small number of participants who did, in fact, name the items correctly. For the remaining 49 items, we manually coded voice onset errors (e.g., *cough*, *um*, etc.), correct responses, and incorrect responses. For the accuracy analyses, responses were considered correct even if they were preceded by a voice onset error. We obtained interrater reliability for a randomized 20% of older and younger adult samples. Point-to-point comparisons revealed an interrater reliability of 99.2%.

For the RT analyses, we eliminated RTs for incorrect responses and voice onset errors. Next, we transformed the remaining RTs into  $z$  scores based on each individual's performance and then eliminated each individual's outliers (more than 2  $SDs$  from their mean RT across conditions). We then submitted mean percentage of accuracy and mean RTs to separate mixed-model analyses of variance (ANOVAs), with perceptual enrichment as the single within-subjects factor with three levels (black–white, colored, congruent scene-primed) and age group as the between-subjects factor with two levels (young, older).

## Results

Naming accuracy and RT latencies were statistically compared across groups and experimental conditions. Table 2 summarizes the accuracy and RT results.

### Naming Accuracy

With respect to accuracy, a small but significant main effect of age was found,  $F(1, 41) = 4.81, p = .03$ , partial  $\eta^2 = .11$ , with the older adults naming BNT stimuli 2.21% more accurately than young adults (an advantage of 1.08 of 49 possible items). There was not a significant main effect of perceptual enrichment  $F(2, 82) = 0.08, p = .93$ , partial  $\eta^2 = .002$ , and likewise, the interaction between the perceptual enrichment condition and age group was not significant  $F(2, 82) = 0.55, p = .58$ , partial  $\eta^2 = .01$ .

### Naming Latency

Naming latency data are shown in Table 2. There was a significant main effect of age group,  $F(1, 41) = 16.29, p < .0001$ , partial  $\eta^2 = .28$ , such that older adults were slower than young adults across all conditions by an average of 151 ms. The main effect was qualified by an Age Group  $\times$  Perceptual Condition interaction,  $F(2, 82) = 3.25, p = .04$ , partial  $\eta^2 = .07$ . The interaction was primarily driven by performance of the young participants who demonstrated a strong facilitation effect from the scene-priming condition. Bonferroni-corrected, paired  $t$  tests supported the finding that young adults were significantly faster at naming in the congruent scene-primed condition relative to both the colored condition,  $t(19) = 2.49, p = .02$ , and the black–white condition,  $t(19) = 2.46, p = .02$ . However, no differences in

naming speed were found when young adults named black–white relative to colored items,  $t(19) = 0.19, p = .85$ . Within the older adult group, there were no differences in RTs between the black–white and colored conditions,  $t(22) = 0.25, p = .81$ ; black–white and congruent scene-primed conditions,  $t(22) = 0.61, p = .55$ ; or colored and congruent scene-primed conditions,  $t(22) = 0.74, p = .47$ . In sum, we did not replicate the previous finding reported by Rossion and Pourtois (2004) of a facilitation effect for the addition of color and surface detail to sparse line drawings. Moreover, older adults were generally slower than young adults to name items and showed no appreciable benefit from either the addition of color or scene priming.

Finally, to test whether the semantic content of the scene primes (congruent or incongruent) affected the RTs and accuracies of target picture naming, we performed additional paired-samples  $t$  tests. For  $M$ s and  $SD$ s of incongruent primes, see Table 2. The semantic content of the prime did not significantly affect naming accuracy in the young adults,  $t(19) = 0.78, p = .45$ , or in the older adults,  $t(22) = 0.36, p = .74$ , nor did it affect RTs in the young adults,  $t(19) = 0.69, p = .50$ , or older adults,  $t(22) = 1.49, p = .15$ . Additionally, to examine more closely the contributions of motor speed, processing, and task-alternating to participants' response latencies, we conducted post hoc Pearson correlations among averaged RTs and components of the TMT. We found moderate positive correlations between averaged RTs and TMT-A ( $r = .58, p < .0001$ ), TMT-B ( $r = .52, p < .0001$ ), and TMT-B minus TMT-A ( $r = .42, p = .0046$ ).

## Discussion

Previous research has demonstrated facilitative effects among young adults during visual confrontation naming tasks when enriching sparse line drawings with color (Rossion & Pourtois, 2004) and context (Palmer, 1975). A logical extension of this work was to examine whether similar facilitation effects exist for older adults. Two theories of cognitive aging predict somewhat different outcomes with respect to enriching stimuli with additional perceptual and contextual cues. A processing speed account (Salthouse, 1996) might predict a simple main effect of age on naming accuracy and response times (i.e., older adults are slower than young adults). In contrast, theories that emphasize downstream effects of age-related sensory deficits on central lexical–semantic processes (e.g., Tun, McCoy, & Wingfield, 2009; Wingfield et al., 2006) might predict an interaction between age and perceptual enrichment. That is, by enriching a picture with additional perceptual cues, performance may improve to a level that is closer to that of young participants who, at baseline, presumably do not

**Table 2.** Age group means and standard deviations ( $SD$ s) for percent accuracy (%ACC) and response time (RT) across perceptual conditions.

Perceptual condition	Older adults		Younger adults	
	$M$	$SD$	$M$	$SD$
Black–white				
%ACC	96.89	3.07	94.29	4.85
RT (ms)	951.32	151.20	825.72	135.90
Colored				
%ACC	96.36	2.88	94.80	4.80
RT (ms)	943.97	186.86	827.09	136.78
Congruent scene-primed				
%ACC	96.63	3.51	94.18	3.88
RT (ms)	970.06	134.50	760.39	93.78
Incongruent scene-primed				
%ACC	96.54	3.81	94.39	3.74
RT (ms)	1,040.83	191.41	785.49	130.68

have perceptual difficulties. Our naming latency results demonstrated that older adults failed to show facilitation effects from either perceptual enrichment (addition of color/texture to black-and-white line drawings) or scene priming (preceding a target object picture with a congruent environmental scene) when using manipulated stimuli from the BNT. However, the young adults who were tested showed scene-priming effects but did not significantly benefit from color/texture enrichment. Moreover, the response times of the older adults in this study were consistently slower than those of the young adults across all perceptual and priming conditions.

The response time findings appear to support a processing speed account of cognitive aging (Salthouse, 1996), in which naming latencies in older adults are attributed to a general decline in the speed with which information is processed and not to the specific interaction of perceptual and cognitive processing. Correlational findings of response latencies with the TMT provide some additional support. The finding that picture-naming response times were correlated with motor speed times on the TMT-A is not unusual given the fact that both tasks—confrontation naming and drawing lines between numbers—require speeded motor processing. Of interest is that tasks used to assess cognitive function, such as the TMT-B and the TMT-B minus TMT-A, were also correlated with confrontation naming response latencies. Our interpretation of this finding is cautious, however, given that correlation does not imply causation. Even so, past research also has linked TMT-B scores to processing speed (Kennedy et al., 2003) and has linked TMT-B minus TMT-A scores to set-shifting performance (Drane et al., 2002). In this study, correlations with TMT-B and TMT-B minus TMT-A (a measure independent of motoric and visual search) may suggest that processing impairment over simple motor slowing may contribute to the confrontation naming response latencies in this study. Although the present results are generally supportive of a processing speed account, participants (both older and young) demonstrated several additional trends that require greater scrutiny. We address these specific points in the sections that follow.

## **Effects of Color and Texture on Picture Naming**

For the manipulation of added color and surface detail, we observed only a significant main effect of age—that is, older adults remained slower than young adults, but neither group showed effects of facilitation or interference. Thus, using a different set of stimuli and participants, we failed to replicate the perceptual enrichment effect reported previously (Rossion & Pourtois, 2004). This discrepancy has a number of potential sources, including both item- and subject-level variables. With

respect to item-level properties, participants in the Rossion and Pourtois (2004) study named colored versions of the Snodgrass and Vanderwart (1980) picture series, whereas participants in the present study named the BNT pictures. The Snodgrass and Vanderwart pictures represent an array of common objects whose identification may be more diagnostic for color (i.e., more recognizable as a colored item than as a black-and-white item) than the BNT pictures. For example, an uncolored picture of a tomato may be confused for a peach or an orange; thus, color is a highly diagnostic feature for a tomato. The hypothesis that some of the Snodgrass and Vanderwart items are more diagnostic for color is also supported by Tanaka and Presnell's (1999) finding that young adults' naming speed was no different for items of low diagnostic color salience (e.g., *hammers*, which are highly recognizable by shape, not by color) relative to black-and-white images or anomalously colored items.

Another difference between our study and that of Rossion and Pourtois (2004) was its design. Rossion and Pourtois used a between-subjects design, leaving open the possibility that differences in naming latency were due to the particular subjects assigned to a group. By contrast, we examined naming latencies and accuracies across young and older adults (between subjects) but examined the effects of perceptual enrichment on naming latency within each person (within subjects). Although repeated naming inherent in a within-subjects design does introduce a repetition priming confound, complete randomization of the stimuli reduced the possibility of simple order effects. Moreover, a strength of the within-subjects model here is its certainty of group equivalence across conditions. Even so, the absence of facilitation for color-texture enrichment is troublesome for the assumption that color texture necessarily affords a reliable perceptual advantage (see also Tanaka & Presnell, 1999). Therefore, the question of whether perceptual enrichment effects are idiosyncratic to stimuli or moderated by subject-level variables (e.g., age) remains open.

## **Effects of Scene Priming on Picture Naming**

Young adults showed a strong facilitation effect for speeded naming when target stimuli appeared within the context of an environmental scene. In contrast, older adults failed to show a scene-priming effect. These group differences drove the interaction between age and the perceptual enrichment condition. When unpacking the interaction, however, the scene-priming effect may be misleading. An intuitive interpretation may be that young adults generated a semantic expectancy from the appearance of a scene (e.g., *kitchen*) and this expectancy, in turn, primed the target word (e.g., *asparagus*). The major challenge for such an interpretation is that young adults showed similar facilitation effects even when

target stimuli were paired with anomalous scenes. Thus, unlike Palmer (1975), who reported that young adults were more accurate when naming an item primed by a congruent context, we cannot conclude that the semantic context of the prime influenced participants' responses. Differences between our study and Palmer's may be due to differences in stimuli. In Palmer's study, more opportunity for inaccuracy was available simply due to the type of stimuli used, since items were purposely constructed that were similar in appearance (e.g., *mailbox* and *breadbox*). For example, if a contextual scene such as a kitchen countertop was displayed followed by the target item *mailbox*, similar in size and shape to a breadbox, participants would be more likely to confuse the items, resulting in poorer accuracy. Alternatively, we hypothesized that young adults in our study treated the scene prime as an attention fixation or anticipatory cue to initiate naming. Thus, for young adults at a 1,000-ms stimulus onset asynchrony, semantic content of the prime was irrelevant. Interestingly, older adults also showed no difference between congruent and incongruent primes. However, older adults also failed to show any overall facilitation effect—that is, older adults named the scene-primed conditions with similar speed as the black–white and color-texture conditions.

One possible basis for the lack of a scene-priming effect in older adults is that the 1,000-ms stimulus onset asynchrony (SOA) timeframe was not long enough for the older adults to perceive and interpret the prime information. SOA denotes the temporal distance between the prime and the target word. Effects of SOA vary significantly as functions of task (e.g., lexical decision vs. speeded naming) and item level characteristics (e.g., associative vs. lexical relationships), and such variability precludes absolute demarcations of “long” versus “short” SOAs uniformly across all priming studies (de Groot, 1984; Hagoort, 1997; McNamara, 2005). Nevertheless, there does appear to exist relative agreement that SOAs below 400 ms tap subattentional processes, whereas longer SOAs engage strategic or semantic processes (Neely, 1977; Odekar, Hallowell, Kruse, Moates, & Lee, 2009). In a recent associative semantic priming study similar to the visual paradigm employed here, the authors used a 400-ms prime–target SOA (Odekar et al., 2009). Thus, the 1,000-ms SOA in the present study conforms to a relative standard of “long” compared with other priming studies. Moreover, with such a long SOA, there is greater certainty that participants have sufficient time to process prime–target relations.

## Effects of Aging on Picture-Naming Accuracy

Older adults were reliably slower than young adults to initiate naming across all conditions but were also

consistently more accurate than the young adults. This finding is in contrast to our predictions and to studies in which older adults have poorer accuracy on tests of confrontation naming (e.g., Albert et al., 1988; Au et al., 1995; Barresi et al., 2000; M. Nicholas et al., 1985; Randolph et al., 1999; Tsang & Lee, 2003). However, studies using smaller sample sizes and fewer older participants at advanced ages have found that older adults do not have poorer accuracy than young adults (e.g., Heaton, Avitable, Grant, & Mathews, 1999; L. E. Nicholas, Brookshire, Maclennan, Schumacher, & Porrazzo, 1989; Van Gorp, Satz, Kiersch, & Henry, 1986). Similar to these studies, our sample size was small, and our older adults were on average in their late 60s and may have been too young to experience naming accuracy difficulty. For example, the healthy older adults in Zec and colleagues' studies who exhibited significantly lower BNT scores were in their 70s and 80s (Zec, Burkett, Markwell, & Larsen, 2007; Zec, Markwell, Burkett, & Larsen, 2005). Moreover, in some cases, older adults are reported to have greater accuracy than younger adults on picture naming (Guthrie et al., 2010). Despite our older adults' having greater accuracy, they had significantly slower naming latencies than our young adults, suggesting that object picture naming may become less efficient with age.

## Conclusions

The results of the present study raise several questions that should be addressed in future research on perceptual enrichment and scene-priming effects in aging. First, the SOA time should be varied from one prime to the next. This is important for two reasons: (a) variation in the SOA would likely prohibit young adults from using the prime as an anticipatory cue for an upcoming target and (b) SOAs at longer intervals might shed light on whether a lack of scene-priming effect in older adults is due to insufficient time to process the prime. Second, future studies should compare stimuli with high diagnostic feature weighting for color to those with a low feature weighting (e.g., *tomato* is more recognizable by its color than *pencil*) to determine how item level variables play a role in naming. Third, comparisons of a broader range of ages, including a separate group for adults older than 70 years, should be explored, and baseline vocabulary tests should be given to answer the question of age effects on naming accuracy. Finally, we acknowledge the issue of limited statistical power in the study, which was constrained by the smaller number of participants (fewer than 25 in each group) and our test stimuli (i.e., the BNT has only 60 items). In future studies, researchers should recruit more participants and use a larger number of stimuli.

In summary, the present study allowed us to examine the age effects of perceptually enriching the BNT



pictures with color and texture, and congruent scene priming. Unlike Rossion and Pourtois' (2004) findings, our young adults did not improve speed or accuracy when naming color-enriched stimuli; however, their response latencies were significantly reduced when target stimuli were preceded by congruent scene primes. Older adults did not benefit from either color enrichment or scene priming of stimuli. Together, our results are consistent with hypotheses linking age-related naming decline to domain-general executive resource limitations. With regard to clinical implications, unlike past studies in which researchers used colored stimuli and priming with environmental scenes, in this study we used stimuli from the BNT, a test that is widely used among researchers and clinicians in our field. The results of our study suggest that little benefit was found with perceptual enrichment of the BNT, perhaps because the BNT items do not have a high diagnostic feature weighting as do some of the other stimuli (e.g., Snodgrass & Vanderwart [1980] pictures). That is, there are few BNT pictures that need color in order for individuals to determine their content (e.g., a pencil looks like a pencil, whether it is black and white or color enhanced). What we can conclude is that, on the basis of these study results, the BNT stimuli do not need to be altered. We can also conclude that older adults may take more time to process the BNT stimuli, but their accuracy does not suffer as a result of added time.

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### **Appendix A.** Environmental context depictions.

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Barn/Farm



Desert Scene



Living Room



Soccer Field



Sky

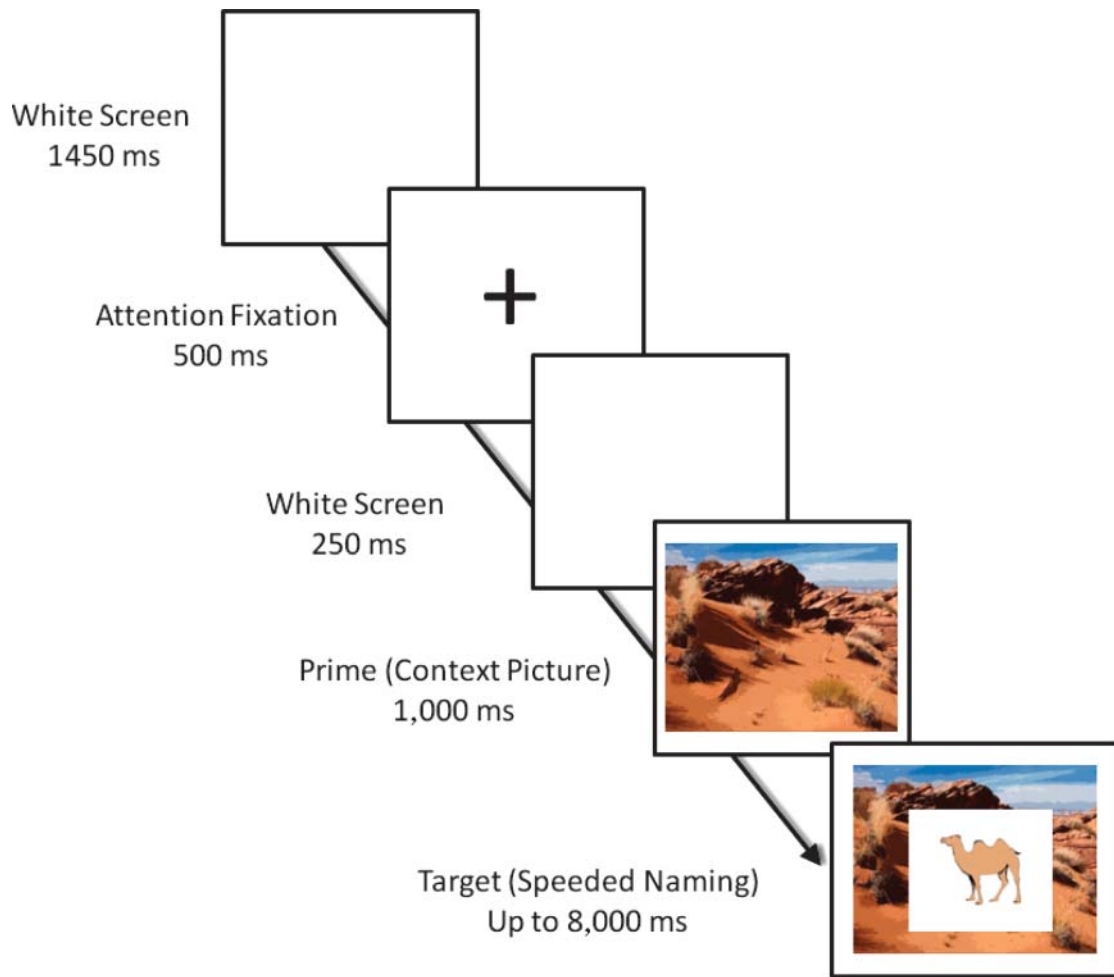


Zoo

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**Appendix B.** Trial structure.

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**Effects of Perceptual and Contextual Enrichment on Visual Confrontation  
Naming in Adult Aging**

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