Effects of Age on Detection of Emotional Information

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Author Note

This research was supported by National Science Foundation Grant BCS 0542694 awarded to Elizabeth A. Kensinger.

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Abstract

Age differences were examined in affective processing, in the context of a visual search task. Young and older adults were faster to detect high arousal images compared with low arousal and neutral items. Younger adults were faster to detect positive high arousal targets compared with other categories. In contrast, older adults exhibited an overall detection advantage for emotional images compared with neutral images. Together, these findings suggest that older adults do not display valence-based effects on affective processing at relatively automatic stages.

Keywords: aging, attention, information processing, emotion, visual search
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Calvo & Lang, 2004; Carretie et al., 2004; Juth, Lundqvist, Karlsson, & Ohman, 2005; Nummenmaa et al., 2006).

From this research, it seems clear that younger adults show detection benefits for arousing information in the environment. It is less clear whether these effects are preserved across the adult life span. The focus of the current research is on determining the extent to which aging influences the early, relatively automatic detection of emotional information.

Regions of the brain thought to be important for emotional detection remain relatively intact with aging (reviewed by Chow & Cummings, 2000). Thus, it is plausible that the detection of emotional information remains relatively stable as adults age. However, despite the preservation of emotion-processing regions with age (or perhaps because of the contrast between the preservation of these regions and age-related declines in cognitive-processing regions; Good et al., 2001; Hedden & Gabrieli, 2004; Ohnishi, Matsuda, Tabira, Asada, & Uno, 2001; Raz, 2000; West, 1996), recent behavioral research has revealed changes that occur with aging in the regulation and processing of emotion. According to the socioemotional selectivity theory (Carstensen, 1992), with aging, time is perceived as increasingly limited, and as a result, emotion regulation becomes a primary goal (Carstensen, Isaacowitz, & Charles, 1999). According to socioemotional selectivity theory, age is associated with an increased motivation to derive emotional meaning from life and a simultaneous decreasing motivation to expand one’s knowledge base. As a consequence of these motivational shifts, emotional aspects of the
To maintain positive affect in the face of negative age-related change (e.g., limited time remaining, physical and cognitive decline), older adults may adopt new cognitive strategies. One such strategy, discussed recently, is the positivity effect (Carstensen & Mikels, 2005), in which older adults spend proportionately more time processing positive emotional material and less time processing negative emotional material. Studies examining the influence of emotion on memory (Charles, Mather, & Carstensen, 2003; Kennedy, Mather, & Carstensen, 2004) have found that compared with younger adults, older adults recall proportionally more positive information and proportionally less negative information. Similar results have been found when examining eye-tracking patterns: Older adults looked at positive images longer than younger adults did, even when no age differences were observed in looking time for negative stimuli (Isaacowitz, Wadlinger, Goren, & Wilson, 2006). However, this positivity effect has not gone uncontested; some researchers have found evidence inconsistent with the positivity effect (e.g., Grühn, Smith, & Baltes, 2005; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002).

Based on this previously discussed research, three competing hypotheses exist to explain age differences in emotional processing associated with the normal aging process. First, emotional information may be processed less efficiently, leading to slower and more difficult detection of emotional information. This would be consistent with findings suggesting that older adults are disadvantaged in situations requiring rapid detection of information. For example, Mather and Knight found that like younger adults, older adults detected threatening faces more rapidly than they detected other types of emotional stimuli. Similarly, Hahn et al. (2006) also found that compared with positive and neutral faces, served as nontarget distractors in the visual search array, older adults spent proportionately more time processing positive emotional material and less time processing negative emotional material. Studies examining the influence of emotion on memory (Charles, Mather, & Carstensen, 2003; Kennedy, Mather, & Carstensen, 2004) have found that compared with younger adults, older adults recall proportionally more positive information and proportionally less negative information. Similar results have been found when examining eye-tracking patterns: Older adults looked at positive images longer than younger adults did, even when no age differences were observed in looking time for negative stimuli (Isaacowitz, Wadlinger, Goren, & Wilson, 2006). However, this positivity effect has not gone uncontested; some researchers have found evidence inconsistent with the positivity effect (e.g., Grühn, Smith, & Baltes, 2005; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002).

The primary goal in the present experiment was to adjudicate among these alternatives. Based on this previously discussed research, three competing hypotheses exist to explain age differences in emotional processing associated with the normal aging process. First, emotional information may be processed less efficiently, leading to slower and more difficult detection of emotional information. This would be consistent with findings suggesting that older adults are disadvantaged in situations requiring rapid detection of information. For example, Mather and Knight found that like younger adults, older adults detected threatening faces more rapidly than they detected other types of emotional stimuli. Similarly, Hahn et al. (2006) also found that compared with positive and neutral faces, served as nontarget distractors in the visual search array.
negative stimuli were not of equivalent arousal levels (fearful faces typically are more arousing than happy faces; Hansen & Hansen, 1988). Given that arousal is thought to be a key factor in modulating the attentional focus effect (Hansen & Hansen, 1988; Pratto & John, 1991; Reimann & McNally, 1995), to more clearly understand emotional processing in the context of aging, it is necessary to include both positive and negative emotional items with equal levels of arousal.

In the current research, therefore, we compared young and older adults’ detection of four categories of emotional information (positive high arousal, positive low arousal, negative high arousal, and negative low arousal) with their detection of neutral information. The positive and negative stimuli were carefully matched on arousal level, and the categories of high and low arousal were closely matched on valence to assure that the factors of sadness (negative), and arousal (high, low) could be investigated independently of one another. Participants were presented with a visual search task including images from these different categories (e.g., snakes, cars, teapots). For half of the multi-image arrays, all of the images were of the same item, and for the remaining half of the arrays, a single target item was included. Participants were asked to decide whether a different item was included in the array, and their reaction times were recorded for each decision. Of primary interest were differences in response times (RTs) based on the valence and arousal levels of the target items (relative to the neutral items) than shown by young adults or greater facilitation were younger adults, older adults should show either faster detection speeds for all of the stimuli for the two age groups. By contrast, if older adults were more affectively focused than information, then we would expect similar degrees of facilitation in the detection of emotional categories. We reasoned that if young and older adults were equally focused on emotional differences in response times (RTs) based on the valence and arousal levels of the target item of another type) and half did not (i.e., all 9 images of the same type). Within the 180

Materials and Procedure

The visual search task was adapted from Ohman et al. (2001). There were 10 different types of items (2 each of five Valence × Arousal categories: positive high arousal, positive low arousal, neutral, negative low arousal, negative high arousal), each containing nine individual exemplars that were used to construct 3 × 3 stimulus matrices. A total of 90 images were used, each appearing as a target and as a member of a distracting array. A total of 360 matrices were presented to each participant; half contained a target item (i.e., 8 items of one type and 1 target item of another type) and half did not (i.e., all 9 images of the same type). Within the 180
matrix. Within the 180 target trials, each of the five emotion categories (e.g., positive high arousal, neutral, etc.) was represented in 36 trials. Further, within each of the 36 trials for each emotion category, 9 trials were created for each of the combinations with the remaining four other emotion categories (e.g., 9 trials with 8 positive high arousal items and 1 neutral item). Location of the target was randomly varied such that no target within an emotion category was presented in the same location in arrays of more than one other emotion category (i.e., a negative high arousal target appeared in a different location when presented with positive high arousal array images than when presented with neutral array images).

The items within each category of grayscale images shared the same verbal label (e.g., mushroom, snake), and the items were selected from online databases and photo clipart packages. Each image depicted a photo of the actual object. Ten pilot participants were asked to write down the name corresponding to each object; any object that did not consistently generate the intended response was eliminated from the set. For the remaining images, an additional 20 pilot participants rated the emotional valence and arousal of the objects and assessed the degree of visual similarity among objects within a set (i.e., how similar the mushrooms were to one another) and between objects across sets (i.e., how similar the mushrooms were to the snakes).

**Valence and arousal ratings.** Valence and arousal were judged on 7-point scales (1 = negative valence or low arousal and 7 = positive valence or high arousal). Negative objects received mean valence ratings of 2.5 or lower, neutral objects received mean valence ratings of 3.5 to 4.5, and positive objects received mean valence ratings of 5.5 or higher. High arousal objects received mean arousal ratings greater than 5, and low arousal objects (including all neutral stimuli) received mean arousal ratings of less than 4. We selected categories for which both young and older adults agreed on the valence and arousal classifications, and stimuli were equated on within-category similarity and similarity to the rest of the objects (e.g., a set of mushrooms was as similar to the mushrooms as the cats were similar to the snakes). Overall similarity of the object categories (p > .20). For example, we selected particular mushrooms and particular cats so that the mushrooms were as similar to one another as were the cats (i.e., within-group similarity was held constant across the categories). Our object selection also assured that the categories differed from one another to a similar degree (e.g., that the mushrooms were as similar to the snakes as the cats were similar to the snakes).

**Procedure**

Each trial began with a white fixation cross presented on a black screen for 1,000 ms; the matrix was then presented, and it remained on the screen until a participant response was recorded. Participants were instructed to respond as quickly as possible with a button marked yes if there was a target present, or a button marked no if no target was present. Response latencies and accuracy for each trial were automatically recorded with E-Prime (Version 1.2) experimental...
Results

Analyses focus on participants’ RTs to the 120 trials in which a target was present and was from a different emotional category from the distractor (e.g., RTs were not included for arrays containing eight images of a cat and one image of a butterfly because cats and butterflies are both positive low arousal items). RTs were analyzed for 24 trials of each target emotion category. RTs for error trials were excluded (fewer than 5% of all responses) as were RTs that were ±3SD from each participant’s mean (approximately 1.5% of responses). Median RTs were then calculated for each of the five emotional target categories, collapsing across array type (see Table 2 for raw RT values for each of the two age groups). This allowed us to examine, for example, whether participants were faster to detect images of snakes than images of mushrooms, regardless of the type of array in which they were presented. Because our main interest was in examining the effects of valence and arousal on participants’ target detection times, we created scores for each emotional target category that controlled for the participant’s RTs to detect neutral targets (e.g., subtracting the RT to detect neutral targets from the RT to detect positive high arousal targets). These difference scores were then examined with a 2 x 2 x 2 (Age [young, older] x Valence [positive, negative] x Arousal [high, low]) analysis of variance (ANOVA). This ANOVA revealed only a significant main effect of arousal, \( F(1, 46) = 8.41, p = .006, \eta^2 = .16 \), with larger differences between neutral and high arousal images (\( M = 137 \)) than between neutral and low arousal images (\( M = 93 \)); i.e., high arousal items processed more quickly across both age groups compared with low arousal items; see Figure 1). There was no significant main effect for valence, nor was there an interaction between valence and arousal. It is critical that the analysis...
revealed only a main effect of age but no interactions with age. Thus, the arousal-mediated effects on detection time appeared stable in young and older adults.

The results described above suggested that there was no influence of age on the influences of emotion. To further test the validity of this hypothesis, we submitted the RTs to the five categories of targets to a 2 × 5 (Age [young, old] × Target Category [positive high arousal, positive low arousal, neutral, negative low arousal, negative high arousal]) repeated measures ANOVA. Both the age group, $F(1, 46) = 540.32, p < .001, \eta^2_p = .92$, and the target category, $F(4, 184) = 8.98, p < .001, \eta^2_p = .16$, main effects were significant, as well as the Age Group × Target Category interaction, $F(4, 184) = 3.59, p = .008, \eta^2_p = .07$. This interaction appeared to reflect the fact that for the younger adults, positive high arousal targets were detected faster than targets from all other categories, $t(23) < -1.90, p < .001$, with no other target categories differing significantly from one another (although there were trends for negative high arousal and negative low arousal targets to be detected more rapidly than neutral targets ($p < .12$). For older adults, all emotional categories of targets were detected more rapidly than were neutral targets, $t(23) > 2.56, p < .017$, and RTs to the different emotion categories of targets did not differ significantly from one another. Thus, these results provided some evidence that older adults may show a broader advantage for detection of any type of emotional information, whereas young adults’ benefit may be more narrowly restricted to only certain categories of emotional information.

Discussion

As outlined previously, there were three plausible alternatives for young and older adults’ performance on the visual search task: The two age groups could show a similar pattern of enhanced detection of emotional information, older adults could show a greater advantage for
emotional detection than young adults, or older adults could show a greater facilitation than young adults only for the detection of positive information. The results lent some support to the first two alternatives, but no evidence was found to support the third alternative.

In line with the first alternative, no effects of age were found when the influence of valence and arousal on target detection times was examined; both age groups showed only an arousal effect. This result is consistent with prior studies that indicated that arousing information can be detected rapidly and automatically by young adults (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Ohman & Mineka, 2001) and that older adults, like younger adults, continue to display a threat detection advantage when searching for negative facial targets in arrays of positive and neutral distractors (Hahn et al., 2006; Mather & Knight, 2006). Given the relative preservation of automatic processing with aging (Fleischman, Wilson, Gabrieli, Rosa, & Gabrieli, 2003; Ohman & Mineka, 2001) and that older adults, like younger adults, have shown an advantage for negative information (e.g., Armony & Dolan, 2002; Hansen & Hansen, 1988; Mogg, Bradley, de Bono, & Painter, 1997; Pratto & John, 1991; Reimann & McNally, 1995; Williams, Mathews, & MacLeod, 1996)—what is important to note is that the older adults detected both positive and negative stimuli at equal rates. This equivalent detection of positive and negative information provides evidence that older adults display an advantage for the detection of emotional information that is not valence-specific.

However, despite the similarity in arousal-mediated effects on detection between the two age groups, the present study did provide some evidence for age-related change (specifically, to take advantage of these automatic alerting systems for detecting high arousal information). When examining RTs for age groups, the present study did provide some evidence for age-related change (specifically, a facilitation for detecting positive information), which suggests a broader interpretation of the findings for the hypothesis that a positivity effect exists.

It is interesting to note that the positivity effect found no evidence of an age-related positivity effect. The lack of a positivity focus in the older adults is in keeping with the proposal (e.g., Mather & Knight, 2006) that the positivity effect does not arise through automatic attentional influences. Rather, when this effect is observed in older adults, it is likely due to age-related changes in emotion regulation goals that operate at later stages of processing (i.e., during consciously controlled processing), once information has been attended to and once the emotional nature of the stimulus has been discerned.

Although we cannot conclusively say that the current task relies strictly on automatic processes, there are two lines of evidence suggesting that the construct examined in the current
research examines relatively automatic processing. First, in their previous work, Ohman et al. (2001) compared RTs with both 2 × 2 and 3 × 3 arrays. No significant RT differences based on the number of images presented in the arrays were found. Second, in both Ohman et al.'s (2001) study and the present study, analyses were performed to examine the influence of target location on RT. Across both studies, and across both age groups in the current work, emotional targets were detected more quickly than were neutral targets, regardless of their location. Together, these findings suggest that task performance is dependent on relatively automatic detection processes rather than on controlled search processes.

Although further work is required to gain a more complete understanding of the age-related changes in the early processing of emotional information, our findings indicate that young and older adults exhibit similar patterns of detection error in the early processing of emotional images. Fleischman et al. (2004) found that although there is evidence for a positive focus in older adults’ controlled processing of emotional information (e.g., Carstensen & Mikels, 2005; Charles et al., 2003; Mather & Knight, 2005), the present results suggest that these findings are limited to controlled processes rather than on automatic detection. Fleischman et al. (2004; Jennings & Jacoby, 1993; Leclerc & Hess, 2005). It is critical that, of emotional images are well maintained throughout the latter portion of the life span, the current study provides further evidence that mechanisms associated with relatively automatic processing of emotional information are similar in young and older adults. The current study and the present study, analyses were performed to examine the influence of target location on RT. Across both studies, and across both age groups in the current work, emotional targets were detected more quickly than were neutral targets, regardless of their location. Together, these findings suggest that task performance is dependent on relatively automatic detection processes rather than on controlled search processes.

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3932%2882%2990100-2

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1 Analyses of covariance were conducted with these covariates, with no resulting influences of these variables on the pattern or magnitude of the results.

2 These data were also analyzed with a 2 × 5 ANOVA to examine the effect of target category when presented only in arrays containing neutral images, with the results remaining qualitatively the same. More broadly, the effects of emotion on target detection were not qualitatively impacted by the distractor category.
Table 2

<table>
<thead>
<tr>
<th>Category</th>
<th>Young group</th>
<th>Older group</th>
<th>F (1, 46)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive high arousal</td>
<td>825</td>
<td>1,580</td>
<td>18.62</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Positive low arousal</td>
<td>899</td>
<td>1,636</td>
<td>3.54</td>
<td>.066</td>
</tr>
<tr>
<td>Neutral</td>
<td>912</td>
<td>1,797</td>
<td>10.46</td>
<td>.002</td>
</tr>
<tr>
<td>Negative high arousal</td>
<td>885</td>
<td>1,578</td>
<td>1.07</td>
<td>.306</td>
</tr>
<tr>
<td>Negative low arousal</td>
<td>896</td>
<td>1,625</td>
<td>0.02</td>
<td>.963</td>
</tr>
</tbody>
</table>

Note. Values represent median response times, collapsing across array type and excluding arrays of the same category as targets (i.e., positive high arousal represents the median RT to respond to positive high arousal targets, collapsing across positive low arousal, neutral, negative high arousal, and negative low arousal array categories). The median response time values were recorded in milliseconds.
Figure 1. Mean difference values (ms) representing detection speed for each target category subtracted from the mean detection speed for neutral targets. No age differences were found in the arousal-mediated effects on detection speed. Standard errors are represented in the figure by the error bars attached to each column.
Inhibitory Influences on Asynchrony as a Cue for Auditory Segregation

Auditory grouping involves the formation of auditory objects from the sound mixture reaching the ears. The cues used to integrate or segregate these sounds and so form auditory objects have been defined by several authors (e.g., Bregman, 1990; Darwin, 1997; Darwin & Carlyon, 1995). The key acoustic cues for segregating concurrent acoustic elements are differences in onset time (e.g., Dannenbring & Bregman, 1978; Rasch, 1978) and harmonic relations (e.g., Branstrom & Roberts, 1998; Moore, Glasberg, & Peters, 1986). In an example of the importance of onset time, Darwin (1984a, 1984b) showed that increasing the level of a harmonic near the first formant (F1) frequency by adding a synchronous pure tone changes the phonetic quality of a vowel. However, when the added tone began a few hundred milliseconds before the vowel, it was essentially removed from the vowel percept. ...

General Method

Overview

In the experiments reported here, we used a paradigm developed by Darwin to assess the perceptual integration of additional energy in the F1 region of a vowel through its effect on phonetic quality (Darwin, 1984a, 1984b; Darwin & Sutherland, 1984). ...

Stimuli

Amplitude and phase values for the vowel harmonics were obtained from the vocal-tract transfer function using cascaded formant resonators (Klatt, 1980). F1 values varied in 10-Hz steps from 360–550 Hz—except in Experiment 3, which used values from 350–540 Hz—to produce a continuum of 20 tokens. ...

Listeners
Listeners were volunteers recruited from the student population of the University of Birmingham and were paid for their participation. All listeners were native speakers of British English who reported normal hearing and had successfully completed a screening procedure (described below). For each experiment, the data for 12 listeners are presented.

**Procedure**

At the start of each session, listeners took part in a warm-up block. Depending on the number of conditions in a particular experiment, the warm-up block consisted of one block of all the experimental stimuli or every second or fourth F1 step in that block. This gave between 85 and 100 randomized trials.

**Data Analysis**

The data for each listener consisted of the number of /I/ responses out of 10 repetitions for each nominal F1 value in each condition. An estimate of the F1 frequency at the phoneme boundary was obtained by fitting a probit function (Finney, 1971) to a listener’s identification data for each condition. The phoneme boundary was defined as the mean of the probit function (the 50% point).

**Experiment 1**

In this experiment, we used noise-band captors and compared their efficacy with that of a pure-tone captor. Each noise-band captor had the same energy as that of the corresponding pure-tone captor and a center frequency equal to the frequency of this tonal captor.

**Results and Discussion**

Figure 4 shows the mean phoneme boundaries for all conditions and the restoration effect for each captor type. The restoration effects are shown above the histogram bars both as a boundary shift in hertz and as a percentage of the difference in boundary position between the incremented-fourth and leading-fourth conditions.

**Experiment 2**

This experiment considers the case where the added 500-Hz tone begins at the same time as the vowel but continues after the vowel ends.
1984; Roberts & Holmes, 2006). This experiment used a gap between captor offset and vowel onset to measure the decay time of the captor effect....[section continues].

Method

There were 17 conditions: the three standard ones (vowel alone, incremented fourth, and leading fourth), five captor conditions and their controls, and four additional conditions (described separately below). A lead time of 320 ms was used for the added 500 Hz tone. The captor conditions were created by adding a 1.1 kHz pure-tone captor, of various durations, to each member of the leading-fourth continuum....[section continues].

Results

Figure 6 shows the mean phoneme boundaries for all conditions. There was a highly significant effect of condition on the phoneme boundary values, $F(16, 176) = 39.10, p < .001$. Incrementing the level of the fourth harmonic lowered the phoneme boundary relative to the vowel-alone condition (by 58 Hz, $p < .001$), which indicates that the extra energy was integrated into the vowel percept....[section continues].

Discussion

The results of this experiment show that the effect of the captor disappears somewhere between 80 and 160 ms after captor offset. This indicates that the captor effect takes quite a long time to decay away relative to the time constants typically found for cells in the CN using physiological measures (e.g., Needham & Paolini, 2003)....[section continues].

Summary and Concluding Discussion

Darwin and Sutherland (1984) first demonstrated that accompanying the leading portion of additional energy in the F1 region of a vowel with a captor tone partly reversed the effect of the onset asynchrony on perceived vowel quality. This finding was attributed to the formation of a perceptual group between the leading portion and the captor tone, on the basis of their common onset time and harmonic relationship, leaving the remainder of the extra energy to integrate into the vowel percept....[section continues].

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Persuasive messages are often accompanied by information that induces suspicions of invalidity. For instance, recipients of communications about a political candidate may discount a message coming from a representative of the opponent party because they do not perceive the source of the message as credible (e.g., Lariscy & Tinkham, 1999). Because the source of the political message serves as a discounting cue and temporarily decreases the impact of the message, recipients may not be persuaded by the advocacy immediately after they receive the communication. Over time, however, recipients of an otherwise influential message may recall the message but not the noncredible source and thus become more persuaded by the message at that time than they were immediately following the communication. The term "sleeper effect" was used to denote such a delayed increase in persuasion observed when the discounting cue (e.g., a political message serves as a discounting cue and temporarily decreases the impact of the message, recipients may not be persuaded by the advocacy immediately after they receive the communication. Over time, however, recipients of an otherwise influential message may recall the message but not the noncredible source and thus become more persuaded by the message at that time than they were immediately following the communication. The term "sleeper effect" was...

Running head: THE SLEEPER EFFECT IN PERSUASION

The Sleeper Effect in Persuasion:

A Meta-Analytic Review

We retrieved reports related to the sleeper effect that were available by March 2003 by means of multiple procedures. First, we searched computerized databases, including PsycINFO (1887–2003), Dissertation Abstracts International (1861–2003), ERIC (1967–2003), and the Social-Science-Citation-Index (1956–2003), using the keywords (1887–2003), Dissertation Abstracts International (1861–2003), ERIC (1967–2003), and the Social-Science-Citation-Index (1956–2003), using the keywords...
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was satisfactory (Orwin, 1994). We resolved disagreements by discussion and consultation with colleagues. Characteristics of the individual studies included in this review are presented in Table 1. The studies often contained several independent datasets such as different messages and different experiments. The characteristics that distinguish different datasets within a report appear on the second column of the table.

**Dependent Measures and Computation of Effect Sizes**

We calculated effect sizes for (a) persuasion and (b) recall-recognition of the message content. Calculations were based on the data described in the primary reports as well as available responses of the authors to requests of further information.… [section continues].

**Analyses of Effect Sizes**

There are two major models used in meta-analysis: fixed-effects and random-effects. To benefit from the strengths of both models, we chose to aggregate the effect sizes and to conduct analyses using random-effects models of the slee… [section continues].

To determine whether or not a delayed increase in persuasion represents an absolute sleeper effect, one needs to rule out a nonpersisting boomerang effect, which takes place when a message initially backfires but later loses this reverse effect (see panel A of Figure 1).… [section continues].

**Average sleeper effect**. Relevant statistics corresponding to average changes in persuasion from the immediate to the delayed posttest appear in Table 4, organized by the different conditions we considered (i.e., acceptance-cue, discounting-cue, no-message control, and message-only control). In Table 4, positive effect sizes indicate increases in persuasion over time, negative effect sizes indicate decay in persuasion, and zero effects denote stability in persuasion. Confidence intervals that do not include zero indicate significant changes over time. The first row of Table 4 shows that recipients of acceptance cues agreed with the message less as time went by (fixed-effects, \( d_a = -0.21 \); random-effects, \( d_a = -0.23 \)). In contrast to the decay in persuasion for recipients of acceptance cues, there was a slight increase in persuasion for recipients of discounting cues over time (\( d_d = 0.08 \)). It is important to note that change in discounting-cue conditions significantly differed from change in acceptance-cue conditions, (fixed-effects; \( B = -0.29, SE = 0.04 \); \( Q_{df}(1) = 58.15, p < .0001 \); \( Q_{df}(123) = 193.82, p < .0001 \)).… [section continues].

Summary and variability of the overall effect. The overall analyses identified a relative sleeper effect in persuasion, but no absolute sleeper effect. The latter was not surprising, because the sleeper effect was expected to emerge under specific conditions,… [section continues].
Moderator Analyses

Although overall effects have descriptive value, the variability in the change observed in discounting-cue conditions makes it unlikely that the same effect was present under all conditions. Therefore, we tested the hypotheses that the sleeper effect would be more likely (e.g., more consistent with the absolute pattern in Panel B1 of Figure 1) when...

References

References marked with an asterisk indicate studies included in the meta-analysis. The in-text citations to studies selected for meta-analysis are not preceded by asterisks.


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