

Mental Rehearsal Increases Liking for Repeatedly Exposed Stimuli

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Abstract

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Psychology

In 1968, Robert Zajonc proposed that mere repeated exposure—“a condition making the stimulus accessible to the individual's perception . . . is a sufficient condition for the enhancement of . . . attitude toward it” (p. 1). Influential reviews have concluded that minimal cognitive processing of repeated stimulus exposures, even so little as that involved in brief, visually masked (“subliminal”) presentations, produces the most reliable attitude boosts. Wide acceptance of that view may explain why relatively few studies have examined effects of variations in cognitive activity during repeated exposure. The present six experiments assessed effects of repeated exposures that were accompanied by *mental rehearsal*. The experiments uniformly revealed greater gains in liking for repeated stimuli (including letters, pronounceable non-words, and abstract images) when mental rehearsal was involved than when rehearsal was not involved. These results are not accommodated by the most widely accepted theory (perceptual fluency plus misattribution) of repeated exposure effects.

Mental Rehearsal Increases Liking for Repeatedly Exposed Stimuli

Robert Zajonc's introduction of the *mere exposure effect* (Zajonc, 1968) provided a compelling mixture of correlational and experimental studies—accompanied, remarkably, by no explanatory theory. Zajonc defined 'mere exposure' as "a condition making the stimulus accessible to the individual's perception" (1968, p. 1). Had Zajonc offered a theory, the theory might have elicited opposition from advocates of competing theories. As it was, his argument for empirical generality of the mere exposure effect encountered little opposition, and the mere exposure effect soon came to be regarded as a broadly general phenomenon. That generality continues to be proclaimed in psychology texts (e.g., Aronson, Wilson, & Akert, 2004; Baron & Byrne, 2004; Brehm, Kassin, & Fein, 2002; Franzoi, 2000; Myers, 2007; Passer & Smith, 2009).

Wide acceptance of the mere exposure effect notwithstanding, there exist empirical indications of limitations of its generality. Occasional reports of failures to obtain expected exposure effects (Fox & Burns, 1993; Greenwald, Pickrell, & Farnham, 2002; Musselman, 1985; Newell & Shanks, 2007; Yagi, Ikoma, & Kikuchi, 2009) could be the visible portion of a larger file-drawer population of null findings. Also casting doubt on the phenomenon's generality are reports of exposure effects that depend on active processing of stimuli, rather than on stimuli just being 'accessible to the individual's perception' (e.g., Fenske, Raymond, & Kunar, 2004; Greenwald et al., 2002; Stang, 1975; Yagi et al., 2009), as well as findings reported by Zajonc in his last empirical publication on the topic (Monahan, Murphy, & Zajonc, 2000). Monahan et al. reported that repeated exposure to stimuli increased liking not only for the repeatedly exposed stimuli but also for *never-before-seen* perceptually similar stimuli, and even for some perceptually dissimilar stimuli (see also Zajonc, 2001).

Processing Requirements of Repeated Exposure Procedures

In repeated exposure experiments, making stimuli ‘accessible to . . . perception’ has been operationalized in ways that vary substantially in cognitive activity demands. These procedure variations are described here in terms of the type of cognitive activity required; they are described approximately in order of their frequency of research use (most frequent first).

Attend to the repeated stimuli. Bornstein and D’Agostino (1992) and Bornstein, Leone, and Galley (1987) told subjects that their study was about visual processing, presumably prompting subjects to attend to the stimulus screen. Bornstein and D’Agostino (1994) explicitly instructed subjects to “focus their attention on the cross in the center of the stimulus field and observe the stimuli” (p. 111). Numerous other studies have similarly instructed subjects to attend to the stimuli without specifying any more explicit processing task (e.g., Harrison & Crandall, 1972; Monahan et al., 2000; Zajonc, Crandall, Robert, & Swap, 1974, Study 1; Zajonc, 1968, Experiment 2). When stimuli are presented in visually impoverished (subliminal) fashion (e.g., Bornstein & D’Agostino, 1994; Kunst-Wilson & Zajonc, 1980), the instruction to attend to the *location* of the stimuli perhaps creates an implied task of trying to detect or to identify stimuli that were visually masked or otherwise rendered marginally visible.

Studies of repeated exposure effects have sometimes instructed subjects that they were participating in studies of “verbal learning” (e.g., Stang, 1975, Study 1, p. 7) or “visual memory” (e.g., Zajonc, 1968, Experiment 3, p. 18). These instructions may encourage cognitive effort that should increase memory for the stimuli. Without explicit memorization instructions, however, subjects may or may not interpret the procedure as calling for more than just attending to the stimuli.

Remember the repeated stimuli. Stang (1975, Studies 2–3) gave subjects a sheet of paper with stimuli to study for five minutes, and Newell and Bright (2001) asked subjects to “memorize as much as possible about the items that would be presented.” Greenwald and colleagues (2002) asked subjects to spend 45 seconds memorizing the names of four members of a team.

Selective attention — attend to repeated stimuli and ignore distractors. Raymond, Fenske, and Tavassoli (2003) and Fenske, Raymond, and Kunar (2004) asked subjects to locate a designated image on a page of (mostly distracter) stimuli as quickly as possible. Similarly, Yagi et al. (2009) asked subjects to attend to polygons of a designated color and simultaneously to ignore polygons of a different color.

Attend to other stimuli (ignore the repeated stimuli). Willems, Dedonder, and Van der Linden (2010) diverted subjects’ attention from repeatedly presented stimuli by surrounding them in a rectangular frame of Os and Xs, which subjects were asked to count. In more naturalistic procedures, Stafford and Grimes (2012) repeatedly presented brand logos in the upper right corner of slides displayed during the ordinary course of lectures in an Introduction to Psychology course. Obermiller (1985) asked subjects in one of five conditions to complete math and language exercises while stimulus melodies were presented repeatedly in the background.

Generate an association to the repeated stimuli. In a “cognitive processing” condition, Obermiller (1985) asked subjects to generate appropriate titles for several melodies that were played repeatedly. In another condition, he asked subjects to generate associations with each of them.

Classify the repeated stimuli. Willems, van der Linden, & Bastin, 2007 asked subjects to classify repeatedly exposed faces according to age ranges, and Greenwald et al. (2002) asked subjects to classify repeatedly exposed names according to gender. Stone, Ladd, and Gabrieli (2000) asked subjects to classify words and non-words according to the color of their font.

Variations in Findings of Repeated Exposure Studies

Frequent findings that stimulus valences were increased by the various procedures described above have been interpreted by textbook authors as establishing the robustness of repeated exposure effects (e.g., Myers, 2007; Passer & Smith, 2009). A more theoretically based view was offered in a meta-analytic review by Bornstein (1989), who examined effects of procedural variations on magnitudes of repeated exposure effects. Bornstein focused especially on the weakening of repeated exposure effects when procedures allow strong recognition memory of the repeatedly presented stimuli (see also Bornstein & D'Agostino, 1992; Kunst-Wilson & Zajonc, 1980; Moreland & Zajonc, 1979).

Weakened exposure effects with stronger recognition memory provided a basis for the presently most widely accepted theoretical interpretation of repeated exposure findings: *perceptual fluency/misattribution* (PF/M; Bornstein & D'Agostino, 1992, 1994). PF/M holds that repeated exposure to stimuli increases their processing fluency. When the stimuli are re-encountered during liking ratings, the fluency is misattributed to liking for the stimuli (Bornstein & D'Agostino, 1994). Because this misattribution is more likely when the stimuli are not recognized from previous presentations, greater liking should be associated with poor, rather than good, memory for those previous presentations. Somewhat problematic for Bornstein's (1989) conclusions, however, are the multiple studies in which instructions to remember stimuli

resulted in increased liking (Greenwald et al., 2002; Pinter & Greenwald, 2004; Stafford & Grimes, 2012; Stang, 1975).

The Present Research

The present research grew out of an unexpected finding that had no (initial) connection to mere exposure research. That finding was that increases in both liking for and identification with a fictitious 4-person group resulted just from memorizing the first names of the group's members (Greenwald et al., 2002). The first of the present experiments (reported as the Preliminary Experiment) sought to replicate that finding with different stimuli and a different study procedure. The significance of the “rehearsal” effect that the ensuing experiments establish resides both in the challenge it poses to the presently dominant (PF/M) explanation of repeated exposure effects and the challenge it creates to describe an adequate alternative or additional theory.

Preliminary Experiment

An exploratory experiment addressed whether a set of stimuli that were actively rehearsed would later be evaluated more positively than comparable stimuli to which the task required attention without active rehearsal.

Subjects were 85 undergraduate students (mean age = 18.84, $SD = 1.15$; 67% female; 46% White, 31% Asian) from the University of Washington Psychology Department's subject pool. Subjects first completed a computerized Go/No-go task (Donders, 1868) that required remembering a set of four letters throughout the task (rehearsed exposure) and pressing the keyboard's spacebar each time one of those letters appeared on the screen. They encountered an equal number of presentations of four other letters for which there was no response requirement

(non-rehearsed exposure). Subjects next completed an Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) of either implicit liking (associations with positive versus negative valence) or implicit identification (association with self versus other), with random assignment to those two dependent measures.

The two implicit measures were scored using the IAT D measure (Greenwald, Nosek, & Banaji, 2003; theoretical range = -2 to $+2$), for which higher values indicated either greater liking of (implicit attitude) the rehearsed set relative to the non-rehearsed set or greater association of self (implicit identity) with the rehearsed than the non-rehearsed set. The rehearsed letter set was indeed more liked ($M = .40$, $SD = .37$), $t(41) = 7.01$, $p = 10^{-8}$, $d = 1.08$, and more identified with ($M = .22$, $SD = .46$), $t(42) = 3.17$, $p = .003$, $d = .48$.

Experiment 1: Replicating the Preliminary Experiment with Added Procedural Control

In the preliminary experiment, presentations of rehearsed stimulus letters differed from those of non-rehearsed letters in having the requirement of a spacebar-press response. To be sure that the observed benefit of rehearsal in the experiment was not an artifact of this response requirement, Experiment 1 included a comparison condition in which the spacebar response was required only on *non*-rehearsal trials. Experiment 1 also added self-report (explicit) measures of stimulus liking and identification to the Preliminary Experiment's use of only IAT (implicit) dependent-variable measures.

Method

Subjects. Subjects were 367 undergraduate students from the University of Washington Psychology Department subject pool (mean age = 19.25 years, $SD = 1.50$; 62% female; 47% White, 35% Asian). Fifteen of these were excluded from analyses, including three for experimenter errors that caused loss of data, six for having previously participated in the

Preliminary Experiment, and six for excessive speed while completing the IAT measure (10 percent or more of their latencies were faster than 300 ms).

Procedure

Go/No-go task. Subjects were randomly assigned to one of two conditions, which varied whether a spacebar response was associated with each stimulus in the rehearsed versus the non-rehearsed letter set. Subjects who gave spacebar responses to the rehearsed set (as in the preliminary study) read these instructions:

Whenever you see any of four specific letters — G, J, F, or C [K, L, Z, or N] — you should rapidly press the SPACEBAR. When you see any other letters, DO NOT PRESS ANY KEY — pressing a key will be scored as an error. Instead, just wait for the next letter. Please operate the spacebar with your LEFT hand for these trials. In the next set of trials we will ask you to switch to using your right hand.

Subjects who gave spacebar responses to the non-rehearsed set read this:

Whenever you see any of four specific letters — G, J, F, or C [or K, L, Z, or N] — you should CONFIRM THAT IT IS ONE OF THESE FOUR LETTERS and do nothing else. Instead, just wait for the next letter. When you see any other letters, you should rapidly DISMISS THEM FROM THE SCREEN by pressing the space bar.

The letter stimuli were counterbalanced so that subjects received either the letters G, J, F, and C or K, L, Z, and N¹ as the rehearsed set and the other as the non-rehearsed set.

The Go/No-go task had two 36-trial blocks. Half of the letters in each block were from the rehearsed set and half were from the non-rehearsed set. Each letter had nine presentations total. Subjects pressed the spacebar with their left hand in the first block and with their right hand

¹ Letters in the two sets were approximately matched in attractiveness as reported by Greenwald & Banaji (1995).

in the second block so as not to associate (in anticipation of the IAT dependent measure) either a left-hand or a right-hand response with the letter set that received spacebar responses.

Implicit liking and implicit identification. Subjects next received a measure of either implicit liking or implicit identification, using an Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). The *implicit liking* measure compared attitudes toward the two sets of four letters by comparing response times on two types of blocks when each set shared a response key with either a set of five pleasant words (i.e., *good, agree, nice, friend, truth*) or a set of five unpleasant words (i.e., *bad, vomit, ugly, horrible, wrong*). The order in which subjects completed the two types of blocks was counterbalanced in these IATs, as in all subsequent experiments.

The *implicit identification* measure used the same IAT procedure but with self words (*self, me, my, mine, I*) and other words (*other, they, them, their, theirs*) replacing pleasant and unpleasant words. Both IATs were scored using the IAT *D* measure (Greenwald, Nosek, & Banaji, 2003) so that higher values of the *D* measure indicated implicit preference for or greater implicit identification with the rehearsed letter set.

Explicit liking and explicit identification. For the self-report parallels to the IAT measures, 16 pairs of letters were presented. Subjects were asked to select either (between-subjects, randomly assigned) the one “you find more attractive” (explicit attitude) or the one “you regard as more strongly associated with you” (explicit identity). The series included all possible pairings of the four rehearsed letters with the four non-rehearsed letters, with the appearance order of these 16 pairs randomized and with rehearsed letters appearing equally often as the left or right letter in the displayed pair. These measures of explicit liking and identification

were scored so that a score of 0 indicated choosing the rehearsed and unrehearsed letters equally often. Positive values indicated more frequent selection of rehearsed letters.

Results

Figure 1 displays summary results for both implicit and explicit measures of attitude and identification. The rehearsed set was both significantly liked and identified with more than the non-rehearsed set, for implicit liking, $t(180) = 11.28$, $p = 10^{-22}$, $d = .84$, explicit liking, $t(180) = 4.57$, $p = 10^{-5}$, $d = .34$, implicit identification, $t(170) = 8.93$, $p = 10^{-15}$, $d = .68$, and explicit identification, $t(170) = 6.49$, $p = 10^{-9}$, $d = .50$. Implicit effects were larger than explicit effects, $F(1,344) = 22.35$, $p = 10^{-6}$, although this benefit for implicit measures was greater for the identification measure, $F(1,344) = 25.22$, $p = 10^{-6}$, than for the liking measure, $F(1,344) = 2.93$, $p = .09$.

The counterbalancing variable of greatest interest—providing the spacebar response for the rehearsed set versus the non-rehearsed set—did not moderate either the magnitude of preference for the rehearsed set on implicit and explicit measures, $F(1,344) = 0.98$, $p = .32$, or the comparison in magnitude of implicit versus explicit effect effects, $F(1,344) = 0.18$, $p = .68$.

Discussion

Experiment 1 confirmed the Preliminary Experiment's finding that instructions to mentally rehearse stimuli increased the effect of exposure not only on liking for the stimulus, but also on identification (association of self) with the stimulus. These findings were obtained for both implicit and explicit measures and were shown not to be artifacts of requiring a space bar press for rehearsed letters. Finding these effects more strongly with implicit than explicit measures suggests that these effects cannot be attributed to demand characteristics (Orne, 1962) that could result from subjects' knowing that they had an additional task for one subset of letters.

Experiment 2: Extension to Visual Image Stimuli

The rehearsal task for Experiment 1's letter stimuli presumably required a rehearsal process described by Baddeley (2003) as the *phonologic loop*, "an articulatory rehearsal process that is analogous to subvocal speech" (p. 830). Experiment 2 examined whether mental rehearsal would work equally with image stimuli that have no established pronounceable representations and would therefore oblige subjects to rehearse in a visual mode (such as Baddeley's *visuospatial sketchpad*). The stimuli were abstract images that had been used successfully in previous repeated exposure research (see Bornstein, 1989).

Method

Subjects. Subjects were 95 undergraduate students from the University of Washington Psychology Department subject pool (mean age = 20.89, $SD = 4.49$; 53% female; 36% White, 38% Asian). Of these, two were excluded from analyses, one for having completed a pilot study that is reported in the supplementary materials and one for excessive speed while completing the IAT measure (10 percent or more of their latencies were faster than 300 ms). Subjects completed a Go/No-go procedure (as in the Preliminary Experiment) with stimuli consisting of abstract images from the Welsh Figure Preference Test (Welsh, 1959), after which they completed the same types of measures of implicit and explicit liking or identification used in Experiment 1.

Go/No-go task. Subjects read these instructions:

For a series of "trials" you will be presented with various figures. Your instructions: Whenever you see any of three specific figures below, you should rapidly press the SPACEBAR within ONE second or it will be scored as an error. [Three figures appeared below this instruction, followed by a new paragraph:] However, when you see the three figures below, DO

NOT PRESS ANY KEY — *pressing a key will be scored as an error. Instead, just wait for the next figure.* [Three different figures appeared below this text]

The Go/No-go task had two 36-trial blocks, in which each of the six images had 12 presentations total. Subjects pressed the spacebar with their left hand in the first block and with their right hand in the second block so as not to associate either a left-hand or a right-hand response with the image set that received spacebar responses. The image stimuli were counterbalanced so that each subject received one of two sets (see supplementary materials) as the rehearsed set and the other as the non-rehearsed set.

Implicit liking and identification. Subjects next received a measure of either implicit liking or implicit identification, using an IAT. The *implicit liking* measure compared attitudes toward the two sets of three images by comparing response times on two types of blocks when each set shared a response key with either a set of five pleasant words (i.e., *good, agree, nice, friend, truth*) or a set of five unpleasant words (i.e., *bad, vomit, ugly, horrible, wrong*). The *implicit identification* measure used the same IAT procedure but with self words (*self, me, my, mine, I*) and other words (*other, they, them, their, theirs*) replacing pleasant and unpleasant words. Both IATs were scored using the IAT *D* measure so that higher values of the *D* measure indicated preference for or identification with the image set that was rehearsed.

Explicit liking and identification. For the self-report parallel to the IAT measures, 9 pairs of images were presented following the IAT. Subjects were asked to select the one “you find more attractive” (explicit attitude) or the one “you regard as more strongly associated with you” (explicit identity). The series included all possible pairings of the three rehearsed images with the three non-rehearsed images, with the appearance order of these 9 pairs randomized and with rehearsed letters appearing approximately equally often as the left or right letter in the

displayed pair. These measures were scored so that positive values indicated more frequent selection of rehearsed images.

Results and Discussion

Figure 2 summarizes results for the implicit and explicit measures of liking for and identification with the Welsh figures. Images in the rehearsed set received significantly higher scores than those in the non-rehearsed set, for both measures of liking (IAT, $t(44) = 7.17, p = 10^{-8}, d = 1.07$; and self-report, $t(44) = 6.08, p = 10^{-7}, d = .91$) and identification (IAT, $t(47) = 7.69, p = 10^{-10}, d = 1.11$; self-report, $t(47) = 5.68, p = 10^{-6}, d = .82$).

This result extended the previous experiments' findings of greater liking for and identification with repeatedly presented stimuli that were mentally rehearsed, compared to those attended without rehearsal. As can be seen by comparing Figures 1 and 2, effect magnitudes for both IAT and self-report measures were larger for Experiment 2's abstract image stimuli than for Experiment 1's letter stimuli.

Experiment 3: Separating Mental Rehearsal from Stimulus Grouping

Experiments 1 and 2 had been motivated by an earlier finding (Greenwald et al., 2002) that liking and identification with a fictitious 4-member group were increased just by having subjects spend 45 seconds rehearsing (for the purpose of remembering) the first names of the group members. That earlier finding explained why Experiments 1 and 2 used stimuli in groups—letters in Experiment 1 and abstract images in Experiment 2.

By the time the data for Experiments 1 and 2 had been analyzed, their connection to prior research relevant to the mere exposure phenomenon (Zajonc, 1968) was too apparent to ignore. It therefore became important to test whether the same effects would occur for singly presented stimuli, reproducing the characteristic one-at-a-time stimulus presentation mode of the mere

exposure tradition. Experiment 3 therefore varied whether the instructed task required rehearsing items individually (“singletons”) or in groups of three (“trios”). This was done by adapting a *memory search* task having a substantial history of use in cognitive psychology, starting with Sternberg (1966). Sternberg’s task obliged subjects to mentally rehearse singly presented or grouped stimuli for a few seconds on each trial, rather than holding them in memory for a longer series of trials. Because this procedure obliged all presented stimuli to be rehearsed, they were compared to stimuli that had never been previously presented, rather than to stimuli that had been presented without rehearsal. As was characteristic of the mere exposure tradition, this experiment used only measures of liking (not identification),.

Method

Subjects. Subjects were 198 undergraduate students from the University of Washington Psychology Department subject pool (mean age = 18.89 years, $SD = 1.27$; 57% female; 50 % White, 37 % Asian). Of these, 26 were excluded due to a programming error that caused mis-presentation of stimuli. Also, 7 were excluded because of later discovery that they had participated in one of the preceding experiments, and 9 were excluded for excessive speed while completing the IAT measure (10 percent or more of their latencies were faster than 300 ms).

Materials. Subjects were randomly assigned to see one of two types of stimuli throughout the sequence of tasks, either abstract images (Welsh figures, as used in Experiment 2) or letter strings. The letter strings consisted of five letters in a pronounceable CVCVC string (C=consonant; V=vowel; e.g., nedag, polov, tazon, cemef, lirak; also used by Stang & O’Connell, 1974). The procedure used nine different CVCVC strings and nine different Welsh figures. Counterbalanced in a Latin Square design, each stimulus was used equally often in a set of three that were always presented as a trio during rehearsal, a set of three that were always

presented as singletons during rehearsal, and a set of three that were never presented prior to their use in dependent measures (i.e., they were novel comparison stimuli).

Rehearsal (memory search) task. The rehearsal procedure was a series of 36 trials each consisting of a *rehearsal* followed by a *test* (Figure 3 gives a schematic of the procedure). Subjects first saw a focus cross for 1 second in the center of the screen. For the rehearsal, subjects saw a single stimulus (singleton) for 1.5 seconds or three stimuli together (trio) for 4.5 seconds, followed by a 1 second blank screen, with the instruction to hold the singleton or trio in memory. The memorization was in anticipation of a test that presented a single stimulus for 1.5 seconds, requiring a judgment of whether it was in the preceding “rehearsal set” of one or three stimuli. When the test stimulus disappeared after 1.5 seconds, a question mark appeared until subjects pressed a right key for Yes (in rehearsal set) or a left key for No.

Stimulus and trial design. Only the three stimuli appearing as singletons and the three stimuli appearing as a trio were used throughout the task for both the 12 “yes” trials and the 24 “no” trials. During trio rehearsal trials, “no” trials were created by using any of the singletons as the test stimulus. During singleton rehearsal trials, “no” trials were created by using either a singleton other than the one rehearsed or a stimulus from the trio set.

For rehearsal portions of the 36 trials, the trio was presented on 9 trials and the three singletons each on 9 trials. The test portions of the 36 trials presented only one stimulus on each trial. For “yes”-response test trials, each of the 3 singleton stimuli was presented 3 times, and each member of the trio was presented once (total of 12 yes-response test trials). The 24 “no”-response test trials presented each singleton 3 times (9 total) and each trio stimulus 5 times (15 total). This design used only the six string or six image stimuli (three singletons and one trio) stimuli for both rehearsal and test portions of the trials. Each of the six thus appeared nine times

in rehearsal portions of trials, and six times in test portions of trials. For test portions of trials, each singleton stimulus appeared on three yes-response and three no-response trials. A necessary imbalance for the trio stimuli was that they appeared only once on yes-response trials and five times on no-response trials.

Explicit liking. Subjects completed a liking measure using the same forced-choice format as in Experiment 2. For each of 27 pairs of stimuli they were asked to select the stimulus “you find more attractive.” These included all possible pairings of the rehearsed stimuli from trios, rehearsed singletons, and novel stimuli (3 trio stimuli versus each of 3 singletons, 3 trio stimuli versus each of 3 novel stimuli, and 3 singletons versus each of 3 novel stimuli). The appearance order of these 27 pairs was randomized with rehearsed and novel letters appearing approximately equally often as the left or right letter in the displayed pair. Responses were scored so that positive values indicated more frequent selection of trio stimuli than singletons when these were paired, and more frequent selection of either trios or singletons when these were paired with novel stimuli.

Implicit liking. Subjects next received a measure of implicit liking, using a Brief IAT format (BIAT; Sriram & Greenwald, 2009). The measure compared attitudes toward trio-set set versus singleton-set stimuli by comparing response times on two types of blocks when each set shared a response key with either a set of five pleasant words (i.e., *good, agree, nice, friend, truth*) or a set of five unpleasant words (i.e., *bad, vomit, ugly, horrible, wrong*). Novel stimuli were not included in the BIAT measure. The BIAT’s *D* measure was scored so that higher values indicated preference for stimuli from trios relative to singletons².

Results

² Parallel explicit and implicit identification measures were not included in this experiment but were included in Experiments 4a and 4b.

Explicit liking of rehearsed trios and singletons versus novel stimuli. Figure 4 gives summary results for the explicit measures of attitude comparing rehearsed trios and rehearsed singletons to the novel comparison set for both the subjects who saw string stimuli ($n = 77$) and those who saw image stimuli ($n = 79$). Rehearsed stimuli were liked significantly more than novel stimuli, $F(1,154) = 22.97, p = 10^{-6}, d = .77$. This effect was stronger for trios than for singletons, $F(1,154) = 5.76, p = .02, d = .41$.

Explicit and implicit liking of rehearsed trios versus rehearsed singletons. The rehearsed trio set was significantly preferred over the rehearsed singletons on both implicit measures of liking ($M = .44, SD = 1.00$), $F(1,154) = 34.04, p < 10^{-8}, d = .94$, and explicit measures of liking ($M = .18, SD = 1.00$), $F(1,154) = 5.17, p = .02, d = .35$. This trio over singleton preference was significantly greater for the implicit measure than for the explicit measure, $F(1,154) = 7.72, p = .006, d = .46$.

Discussion

Experiment 3's finding of consistent rehearsal effects for both trios and singletons extends the rehearsal effect found in Experiments 1 and 2 from grouped stimuli to singly presented stimuli. Although the exposures of the rehearsed stimuli were not all accompanied by rehearsal, each stimulus used in trios and singletons received an equal total duration of exposure (67.5 seconds). Experiment 3's findings for singleton stimuli provide a bridge to the procedures of past mere exposure studies; the results for trios are consistent with the hypothesis that grouping increases the effect of repeated rehearsed exposure on valence.

Experiment 4a & 4b: Rehearsal Compared to No Rehearsal for both Grouped and Individual Stimuli

Experiment 3 was limited to comparing effects for mentally rehearsed stimuli (either singletons or trios) with those for novel stimuli. Experiments 4a and 4b returned to comparing presentations accompanied by mental rehearsal to non-rehearsed presentations. To include both rehearsed and non-rehearsed stimuli in a procedure similar to the memory task of Experiment 3, Experiment 4 adapted the 2-back procedure (see review of psychometric properties in Jaeggi, Buschkuhl, Perrig, & Meier, 2010), enabling a within-subjects variation of rehearsal versus no rehearsal. Two types of stimuli were used (letter strings and Welsh images) and subjects were asked to rehearse only one of the two types. The procedure allowed presentation of both trios and singletons. Experiments 4a and 4b were identical except for the use of fixed (4a) versus ad lib (4b) stimulus exposure durations.

Method

Subjects. A total of 618 students from the University of Washington Psychology Department subject pool received course credit for participation in Experiment 4a. The first 150 of these were lost due to a programming error that was discovered in an initial version of the experiment only after data collection was complete. That error compromised control over exposure frequencies, rendering a portion of its data useless. The portion of data that could be analyzed appears in the supplementary materials and is included in this report as part of the meta-analytic summary that precedes the General Discussion. Of the remaining 468 subjects in Experiment 4a (mean age = 19.16, $SD = 1.59$; 62% female; 51% White, 29% Asian), data for 13 were lost due to researcher entry of incorrect subject ID numbers, which prevented linking their experiment data to separately obtained demographic data). Data for another 42 were lost due to more “natural” causes, including 31 for excessive speed in responding to the BIAT (more than 10 percent of BIAT response latencies faster than 300 ms), 6 for having participated in one of the

preceding experiments, and 5 for slow responding in the BIAT (more than 5 percent of latencies slower than 5 seconds). These losses reduced Experiment 4a's sample to $N = 413$.

Experiment 4b's subjects were 205 undergraduate students from the same subject pool (mean age = 18.96, SD = 1.64; 68% female; 45% White, 32% Asian). Subject losses were 3 for researcher error, 1 for having completed one of the preceding experiments, and 9 for excessive speed in the BIAT measure. These losses reduced Experiment 4b's sample to $N = 195$

Subjects in both experiments experienced a counterbalanced design that varied whether the Brief IAT (BIAT: Sriram & Greenwald, 2009) or self-report dependent measures appeared first. Initial analyses made clear that this order-of-tests variation had unanticipated large effects on results. The most plausible explanation was that repeated stimulus exposures in the BIAT procedure contaminated hypothesis tests for later-administered self-report measures; it plausibly also contaminated the BIAT measure itself (see "Implicit liking" section below). The present Results section therefore presents only the self-report data, and limits presentation of those data to the subjects who completed self-report measures first—prior to the BIAT. Additional data, including BIAT measures and self-report data for the subjects who received the BIAT first, appear in the supplementary materials and are included in this report as part of the meta-analytic summary that precedes the General Discussion.

As a consequence of the various exclusions, the sample sizes for the present Results section were $N = 208$ for Experiment 4a and $N = 98$ for Experiment 4b.

Procedure. Each subject saw nine different abstract images and nine different letter strings. For each type of stimulus, three subsets of three stimuli were used in a counterbalanced (Latin Square) design such that each stimulus subset appeared equally in three stimulus roles—

trios, singletons, and novel stimuli—with these labels having the same meanings as in Experiment 3.

Rehearsal (2-back) task. In Experiment 4a's 2-back procedure subjects viewed a series of stimuli with the instruction to judge, for one of the two types of stimuli, whether the current stimulus was identical to the one presented two trials previously. The type of stimulus presented on odd-numbered trials (letter strings or images, counterbalanced) was the type to be rehearsed. Subjects therefore knew that the 2-back task (i.e., the rehearsal requirement) never applied to the other type of stimulus. (Figure 5 schematizes the stimulus sequence for Experiment 4a.)

Rehearsed and non-rehearsed stimuli could appear either as singletons (presented for 1 second) or as trios (presented for 3 seconds). For each odd-numbered trial, subjects had two instructed tasks: (a) respond to the current stimulus (press right key if the same stimulus had been presented two trials previously, left key if not) and (b) rehearse this same stimulus in anticipation of the test on the next odd-numbered trial. After the singleton or trio on each odd-numbered trial, the screen remained blank until subjects responded to indicate *same* or *different*. On even-numbered trials, the singleton (1s) or trio (3s) was presented after a brief (50 ms) blank screen. Another brief blank screen preceded the following (odd-numbered) trial.

Seventy-four trials (37 with each type of stimulus) appeared in a quasi-random order, as described in the supplementary materials. The presented stimuli, which were presented eight times each, included the three rehearsed singletons, the three non-rehearsed singletons, and each of the three stimuli in the rehearsed and non-rehearsed trios of each stimulus type. Ten other trials contained filler stimuli as described in the supplement.

For Experiment 4b, the 2-back task was modified by allowing subjects to control stimulus durations. This sacrificed experimenter's control over stimulus presentation durations, but added

a basis for generalizing to natural situations that allow voluntary control of stimulus viewing and study durations. Subjects' control over durations was limited by obliging at least a 1-s duration for each stimulus. Rehearsed stimuli required two keyboard responses, first a choice between "same" and "different" for the 2-back task, and second a spacebar response to proceed; non-rehearsed stimuli required only the spacebar to proceed.

Explicit liking and identification. Subjects completed self-report measures for all nine letter strings and all nine images (including three novel stimuli of each type that were not presented in the 74 trials of the 2-back task), with order of these 18 stimuli randomized. For each stimulus, subjects responded to three questions (order randomized): "How attractive or unattractive do you find this stimulus?"; "How much do you like or dislike this stimulus?"; "How strongly do you identify with this stimulus?" Response options ranged from 1 (Unattractive or Dislike or Do not at all identify) to 7 (Attractive or Like or Strongly identify). The ratings of attractiveness and liking were highly correlated, Experiment 4a: $r(208) = .66, p = 10^{-27}$; Experiment 4b: $r(98) = .50, p = 10^{-7}$. These two ratings were therefore averaged for each stimulus type for the explicit liking measure. As in the previous experiments, identification was examined separately. To facilitate comparison with BIAT measures, the liking and identification measures for novel stimuli were subtracted from those for trios or singletons, then divided by the pooled standard deviations of ratings for each category, separately for letter strings and images. Positive scores thus indicated greater liking for or identification with rehearsed trios or rehearsed singletons relative to novel stimuli, measured in SD units.

Familiarity. For the first time in this series of experiments, a measure of stimulus familiarity was included. After the explicit liking measures, subjects responded to "How many

times have you seen this stimulus?” for each of the 18 stimuli, in randomized order. Subjects were asked to “Type a number between 0 and 50 into the box, then click ‘Enter.’”

Implicit liking. Subjects were randomly assigned to receive a BIAT measure that compared valences associated with either (a) rehearsed singletons relative to novel stimuli or (b) non-rehearsed singletons relative to novel stimuli. (There was no BIAT measure for trios.) Higher values of the BIAT’s *D* measure indicated preference for rehearsed or non-rehearsed singletons relative to novel stimuli.

Because the BIAT used arbitrary category labels for the stimulus sets (e.g., “Set A”), it was preceded by a categorization task so that subjects could practice classifying the stimuli into Set A and Set B. They classified previously rehearsed or non-rehearsed (randomized) singletons (the stimuli that would be compared in the BIAT) as Set A or Set B (also randomized) and the novel stimuli as the other set. Because this categorization task could itself be construed as a rehearsal procedure, the BIAT was unfortunately contaminated as a test of repeated presentation effects. For this reason, the BIAT results are presented only in the supplement³.

Results

Four findings are consistently apparent in Figures 6 and 7. First, rehearsed stimuli were both more liked and more identified with than novel stimuli. Second, non-rehearsed stimuli were both more liked and more identified with than novel stimuli. Third, these effects on liking and identification were consistently stronger for rehearsed stimuli than for non-rehearsed stimuli. Finally, all of these effects were consistently larger for stimuli presented individually than for those presented as trios. All four of these findings were statistically significant for string stimuli,

³ The BIAT did not appear contaminated in its use for the contrast between rehearsed trios and rehearsed singletons in Experiment 3. Experiment 4’s BIAT differed, however, in contrasting rehearsed stimuli with novel stimuli. To prepare subjects for the novel stimuli, Experiment 4 provided pre-BIAT practice in categorizing the novel stimuli separately from the rehearsed ones. It is easy enough to see (but only in retrospect) that this practice amounted to rehearsal of the novel set, which plausibly sufficed to undermine the desired hypothesis test.

but not consistently significant for image stimuli, as can be seen with the aid of the 95% confidence interval error bars in Figures 6 and 7. Further details of statistical tests are provided in the supplementary materials in Table S1.

Stimulus familiarity. The data in Figures 8 and 9 show that each rehearsed stimulus was judged to have been presented more times (about 19, on average) than each non-rehearsed stimulus (about 16), which were in turn judged to have been presented more times than each novel stimulus (about 11). These differences between presentation conditions were statistically significant, which is evident from the 95% confidence interval error bars in Figures 6 and 7. At the time of these measures, the rehearsed and non-rehearsed stimuli had each been presented nine times in the 2-back task and three additional times to obtain explicit liking and identification measures, while the novel stimuli had been presented only three times for the explicit measures. The relatively large overestimation for novel stimuli may have stemmed from the difficulty of discriminating among the stimuli, leading subjects to guess and to err in the direction of the average number of presentations for the full set of stimuli.

Discussion

Both Experiments 4a and 4b clearly demonstrated that rehearsed stimuli were more liked and identified with than non-rehearsed stimuli, which in turn were both more liked and more identified with than novel stimuli. Although effects in standardized units were stronger for letter strings than for images (see Figures 6 and 7), it is clear that the effects were directionally present for both stimulus categories. All of these effects were remarkably similar in magnitude between the two sub-experiments, although the stimulus presentation procedure differed notably: The stimuli were presented for fixed durations in Experiment 4a, and for self-paced durations in Experiment 4b. In the fixed-duration procedure of Experiment 4a, subjects made no response

while the stimulus was on screen. In the self-paced condition of Experiment 4b, each stimulus was viewed for a minimum of 1 s, after which the subject proceeded, when ready, with a spacebar press.

An especially interesting result of Experiments 4a and 4b was that the familiarity judgment measure, which was included as a check on the level of attention to presentations, showed the same effect of rehearsal as the liking and identification measures. Greater perceived familiarity with rehearsed than non-rehearsed stimuli is consistent with previous theoretical speculations (see General Discussion) that repeated exposure effects are associated with variations in perceptual fluency (e.g., Bornstein & D'Agostino, 1992).

An additional interesting but unexpected observation was that effects were uniformly at least slightly larger for the self-report measures of identification than for those of liking. This occurred despite the use of a 2-item measure for liking and only one item for identification, which should have increased the power of tests for liking relative to identification (leading to an expectation of larger standardized effect sizes for liking, all other things being equal). This comparison between results for liking and identification will be considered further in the General Discussion.

Meta-Analysis

Table 1 presents meta-analytic summaries of the present six experiments. The larger samples of some of the present experiments were subdivided along lines of between-subject counterbalancing variations that plausibly influenced effect sizes (e.g., stimulus type and dependent variable order). This strategy avoided giving large meta-analytic weight to effect sizes that might have large variability due to the various counterbalancing procedures; it also improved the basis for estimating random-effects variability of effect sizes. The sample splitting

produced 137 effect sizes (i.e., values of Cohen's d) that were available to assess the effects of the major treatment variations on the experiments' several dependent variables.

The present experiments used a mixture of between-subjects and repeated-measures treatment variations. In recognition of this variation, effect sizes were computed using pooled within-treatment standard deviations as the unit for d values; this allows a common metric for results from the two types of designs (cf. Morris & DeShon, 2002). That is, effects from within-subjects designs were computed as if they were from between-subjects designs. As a consequence, aggregate effect size estimates will be conservatively small, given that the correlated means of repeated-measures designs often reduce error terms relative to the pooled within-treatment computation. Weighted, random effects analyses were conducted using SPSS macros described by Lipsey & Wilson (2001). Details of significance tests are given in Table 1.

Stronger Effects of Mentally Rehearsed than Non-Rehearsed Presentations

Results in Rows 1–4 of Table 1 show that mentally rehearsed stimuli were both more liked and more identified with than non-rehearsed stimuli. This occurred for both self-report and implicit measures, with averaged effect sizes (Cohen's d , boldface values) ranging from .375 to .754.⁴ All of these aggregate effect sizes were statistically significant. With one modest exception, the data in Rows 1b, 2b, 3b, and 6b confirm these findings when including the data sets that are reported in the supplementary materials. The exception was that the added data weakened the estimated benefit of rehearsal relative to non-rehearsal for implicit liking measures (Row 6b).

Effects of Mentally Rehearsed Presentations Relative to Novel Stimuli

⁴ Meta-analysis results described first in each paragraph of this section are based on the data presented in this article, which are also the data given in the boldface-printed rows of Table 1. Variations between these main findings and the data presented in this article's supplementary materials are treated in the last paragraph of the Meta-Analysis section.

On self-report measures, mentally rehearsed stimuli were liked significantly more than novel stimuli (Row 8a: $d = .542$) and were significantly more identified with than novel stimuli (Row 11a: $d = .671$). Data analyzed in the supplement for implicit liking (Row 9b: $d = .169$) also showed a weaker, but statistically significant, benefit for mentally rehearsed stimuli relative to novel stimuli.

Effects of Non-Rehearsed Presentations Relative to Novel Stimuli

On self-report measures, non-rehearsed stimuli were liked significantly more than novel stimuli (Row 14a: $d = .249$) and were significantly more identified with than novel stimuli (Row 17a: $d = .510$). Data analyzed in the supplement for implicit liking (Row 15b: $d = .232$) also showed a statistically significant benefit for mentally rehearsed relative to novel stimuli.

Comparison of Individual and Grouped Presentations

On self-report measures, individually rehearsed stimuli were more liked than grouped rehearsed stimuli (Row 19a: $d = .146$) and were more identified with than grouped rehearsed stimuli (Row 20a: $d = .206$), with the latter finding being statistically significant. Additional data in Rows 19b and 20b confirmed these findings. However, the one available test of implicit liking of grouped versus individual stimuli showed a strong reverse pattern: a significantly larger effect for grouped than individual presentations (Row 21a: $d = -.940$).

Comparison of Effects on Identification and Liking

It was initially expected that effects of repeated exposures would appear primarily on measures of liking. However, self-report measures generally showed stronger effects on identification than on liking. The meta-analytic summaries of these contrasts appear in Rows 6, 12, and 18 of Table 1. Although not large in magnitude, these effects were consistent in

direction for the self-report measures. However, tests with implicit measures did not show this pattern, instead showing a non-significantly larger effect on liking than identification (Row 7).

Comparison of Effects on Implicit and Self-Report Measures

Rows 5, 10, and 16 of Table 1 revealed inconsistent effects for differences between effects on implicit versus explicit measures. The first three experiments showed stronger effects on implicit measures for the contrast of rehearsed versus non-rehearsed stimuli (Row 5). However, Experiments 4a and 4b showed stronger effects on self-report measures for the contrast of rehearsed versus novel stimuli (Row 10), but not for the contrast of non-rehearsed versus novel stimuli.

Comparison of Effects for Visual Images and Pronounceable Letter Strings

The tests summarized in Row 13a of Table 1 revealed significantly stronger effects of rehearsal on letter strings than on visual images ($d = .257$). However, this effect became non-significant when the additional data from the supplementary materials were included (Row 13b: $d = .067$).

Summary of Meta-Analysis Findings

The rehearsal versus non-rehearsal contrast was consistently supported (Table 1, Rows 1a, 2a, 3a, and 4a). Even when including the findings that were relegated to the supplementary materials because of concerns about their methodological adequacy, the findings remained consistently supported (Rows 1b, 2b, 3b, and 4b). The next most important finding was the consistently stronger effect of non-rehearsed presentations relative to novel stimuli (Rows 14, 15, and 17). Intriguingly, effects on measures of identification were often (not always) stronger than those on measures of liking (Rows 6, 7, 12, and 18). Additionally, effects of rehearsal were stronger for letter string stimuli than for the Welsh images (Row 13). There was no consistent

evidence on relative strength of effects for implicit versus explicit measures, warranting the conclusion that the benefits of repeated presentations, both rehearsed and non-rehearsed, were apparent on both types of measures.

General Discussion

In the present research, mentally rehearsed stimuli were consistently found to be both more liked and more identified with than were non-rehearsed stimuli that had been presented the same number of times. For self-report measures, aggregate effect sizes for the advantage of mental rehearsal, relative to equal numbers of non-rehearsed presentations, were $d = .438$ for liking; $d = .375$ for identification (Table 1, Rows 1a and 3a). In turn, non-rehearsed stimuli were more liked and more identified with than were comparable novel (non-presented) stimuli; effect sizes, respectively, $d = .542$ and $d = .671$ (Rows 8a and 11a). In addition to adding measures of stimulus association with self (identification) to the self-report attitude measures of past mere exposure research, implicit (IAT) measures of both liking and identification were used in the present studies. The benefit of rehearsal relative to non-rehearsal was greater with implicit than with self-report measures, but fewer tests of this comparison were available for IAT than for self-report measures.

The present findings for liking of non-rehearsed relative to novel stimuli agree well with Zajonc's (1968) original conception of a 'mere' exposures that did not involve cognitive processing. However, the present findings of (a) larger effects for rehearsed than non-rehearsed presentations and (b) effects on measures of identification require conceptions that go beyond past explanations of "mere exposure" effects.

Insufficiency of current theoretical understanding of repeated exposure effects. The most widely accepted theory of repeated exposure effects is the perceptual fluency/misattribution theory (PF/M; Bornstein & D'Agostino, 1992, 1994), which holds that repeated presentations increase fluency (ease) of stimulus processing on subsequent re-exposures. When the same stimuli are later presented to be rated for liking, their subjective familiarity (i.e., ease of processing) may mistakenly be attributed to liking for the stimuli. A corollary of PF/M is that this misattribution should be more likely to occur when previous stimulus presentations have been forgotten than when they are remembered. This is because, when stimuli are remembered, their familiarity should be attributed instead to those remembered previous encounters. The present rehearsal effect therefore conflicts with PF/M's expectation that the added memory afforded by rehearsal should reduce effect magnitudes.

Three other past theories of repeated exposure share PF/M's expectation that familiarity can produce positive affect independently of—even in the absence of—cognitive activity accompanying repeated exposures. Berlyne (1970) proposed that, because familiar stimuli should produce less physiological arousal than unfamiliar ones and that this reduced arousal was itself a pleasurable state, familiarity itself should produce an increase in liking. Stang (1975) proposed that familiar stimuli were rated relatively positively because they did not produce anxiety or threat due to the uncertainty that ordinarily occurs in response to unfamiliar stimuli (see also Lee, 2001; Wang & Chang, 2004). Winkielman & Cacioppo (2001) proposed that increased perceptual fluency resulting from repeated presentations directly enhanced positive mood, resulting in increased liking. All of these theories were proposed to explain a repeated exposure effect that was assumed not to depend on cognitive activity. It is therefore unsurprising that none of them offers an explanation of the presently observed mental rehearsal effects.

Notwithstanding PF/M's inability to account for repeated-rehearsal findings (and some other recent findings—e.g, Fenske, Raymond, & Kunar, 2004; Lee, 1994; Lee, 2001; Stafford & Grimes, 2012; Ste. Marie, Latimer, & Brunet, 2001; Szpunar, Schellenberg, & Pliner, 2004; Wang & Chang, 2004b; Yagi, Ikoma, & Kikuchi, 2009), PF/M nevertheless remains viable as an explanation for effects of repeated exposure when they are not memorable, especially including effects associated with marginally visible or subliminal repeated presentations (e.g., Kunst-Wilson & Zajonc, 1980)⁵.

Relation to Zajonc's (1968) experimental findings. The present research does not approach the breadth of observations in Zajonc's (1968) tour-de-force monograph that introduced and established the mere exposure effect. Although Zajonc's collection of evidence was mostly correlational, it also included findings of three original experiments. In hindsight, the procedures and findings of those experiments can be seen to share much with the present studies of mental rehearsal. The exposure task in Zajonc's first experiment asked subjects to pronounce repeatedly presented 7-letter strings ("Turkish words"; Zajonc, 1968, p. 14). The pronunciation task was itself a form of mental rehearsal. In the second experiment, after being informed that "the experiment dealt with the learning of a foreign language" (p. 15), subjects were asked to view images resembling Chinese characters that were later rated for liking. The third experiment was described to subjects as dealing with "visual memory" for face photographs of seniors from a university yearbook (p. 18). The task descriptions in these experiments plausibly led subjects to expect that it would be useful to remember the repeatedly presented stimuli, and the 2-s stimulus presentation durations used in these experiments were long enough to permit active rehearsal.

⁵ At the same time, and despite a favorable conclusion about benefits of subliminal repeated exposure effects in Bornstein's (1989) meta-analytic review (but see Stafford & Grimes, 2012 for a comment on the limited number of subliminal experiments in the meta-analysis), the replicability of subliminal repeated exposure findings has also been questioned by more recent work (Fox & Burns, 1993; Newell & Shanks, 2007). Resolution of this concern must await further research.

Does mental rehearsal convert novel stimuli into valued mental possessions? The most unexpected present finding was that either rehearsed or non-rehearsed repeated exposures reliably produced effects on measures of association of the stimulus with one's self. These effects on identification were sometimes stronger than effects obtained with measures of liking. No prior theory of exposure effects predicted these findings on measures of identification, for either rehearsed or non-rehearsed presentations. The identification results suggest a link of the present findings to *implicit self-esteem* effects, which involve liking of concepts and objects that are associated with oneself (Greenwald & Banaji, 1995).

Unanswered Questions

What is the role of stimulus exposure duration in repeated exposure effects?

Previous findings have suggested that short (even subliminal) exposure durations should produce greatest effects on liking. The PF/M theory predicts repeated exposure effects to be stronger for stimuli presented under conditions that render them difficult to remember (Bornstein & D'Agostino, 1992, 1994). The present experiments did not include presentation conditions that would be optimal for exposure effects under the PF/M theory—i.e., presentations that were brief, subliminal, or peripheral to focal attention. This leaves two interesting unanswered questions: First, can optimal PF/M conditions produce exposure effects comparable in magnitude to those produced by longer exposures accompanied by mental rehearsal? Second, will those optimal PF/M conditions produce exposure effects on measures of identification in addition to effects on measures of liking? The combination of a “yes” answer to the first question and a “no” to the second question would oblige concluding that there must be two theoretically distinct types of effects of repeated stimulus exposures on liking.

Does grouping of stimuli affect magnitude of repeated exposure effects? The meta-analytic summaries of present findings were less-than-conclusive as to whether larger effects were produced by repeated presentations of single stimuli versus grouped (trio) stimuli (see Table 1: Rows 19–21). Although there were more results supporting stronger effects for singletons than for trios, the only test with an implicit measure showed a much larger effect for trios than for singletons. Across experiments, the comparison of strength effects for trios versus singletons varied considerably (see large values for weighted SD of effect sizes in Row 19 of Table 1). Some of this heterogeneity of effect sizes may have been due to the complexity of Experiment 4's 2-back procedure.

What is the relation between numbers of exposures and magnitudes of effects? In the present studies, stimulus repetitions varied in the relatively narrow range of 8 to 12 presentations. In previous research, larger numbers of repetitions have resulted in reductions of exposure effects (Bornstein, 1989), which has sometimes been credited to boredom (Bornstein, Kale, & Cornell, 1990). At the lower end of the repetition range, it remains to be determined if an effect of rehearsal can be detected for a single exposure.

Are implicit measures useful in repeated exposure experiments? IAT measures were initially used in the present experiments because of their successful uses in the implicit partisanship studies that preceded and led to this research. Because IAT measurement procedures include multiple repetitions of stimuli for which associations are being tested, they can be useful in repeated exposure experiments only if exposure effects are strong enough to persist despite the dilution that should be expected to result from added presentations contained in the IAT measure. In the present research there was no indication of problems using IAT measures until Experiment 4, in which the BIAT measures did not function comparably to parallel self-report

measures, and their administration prior to self-report measures appeared especially to undermine usefulness of the self-report measures. The BIAT did not appear contaminated in its use for the contrast between rehearsed trios and rehearsed singletons in Experiment 3. Experiment 4's BIAT differed, however, in contrasting rehearsed stimuli with novel stimuli. To prepare subjects for the novel stimuli, Experiment 4 provided pre-BIAT practice in categorizing the novel stimuli separately from the rehearsed ones. It is easy enough to see (but only in retrospect) that this practice amounted to rehearsal of the novel set, which plausibly sufficed to undermine the desired hypothesis test.

Conclusion

The present experiments developed from a serendipitous finding (an “implicit partisanship” effect) in a study inspired by the minimal group research tradition (Greenwald et al., 2002; see also Pinter & Greenwald, 2004). The present research establishes a previously unsuspected connection between the implicit partisanship finding and the mere exposure tradition initiated by Zajonc (1968). In implicit partisanship studies, groups of names were mentally rehearsed during a single 45-second exposure; that rehearsal produced both increased liking and increased identification with the rehearsed names, relative to similar non-rehearsed names. Greenwald and colleagues speculated that these effects jointly on liking and identification might be due to the several names being rehearsed as a group. Although there may indeed be benefits due to rehearsal of stimuli in groups, it now seems plausible that the implicit partisanship effect depended more on mental rehearsal than on rehearsal of stimuli in groups.

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Appendix A. Glossary

Grouped stimuli – Two or more stimuli presented in a way that shows they are a collection of distinct objects. For example, introducing subjects to the letters “G, J, F, and C” shows that the letters are separate entities meant to comprise a single group. On the other hand, the letter string “fabuv” is processed as a single unit, despite comprising multiple letters.

Individual stimulus – A stimulus presented so that it is processed as one coherent object rather than a collection of distinct objects (e.g., an image presented on a screen or the nonsense letter string “fabuv”).

Mental rehearsal – Holding stimuli in memory for varying durations. Some procedures in the present experiments required subjects to hold stimuli in mind for an extended period of time in order to respond when one of the stimuli appeared (e.g., Experiment 1). While this may be considered long-term memory, other procedures only required subjects to hold stimuli in mind for a relatively short duration (e.g., nine 1,000 millisecond trials in Experiment 3).

Mere exposure – Zajonc’s (1968, p. 1) definition: “A condition which just makes the given stimulus accessible to the individual’s perception” (e.g., “the individual’s exposure to the stimulus consists of his passively looking at it for a period of about 2 seconds” (p. 15)).

Mere exposure effect – Zajonc’s (1968, p. 1) definition: “Mere repeated exposure of the individual to a stimulus is a sufficient condition for the enhancement of his attitude toward it”.

Novel stimulus – A stimulus not previously encountered in the procedure (e.g., several stimuli are presented to subjects during a familiarity phase of the procedure, and subjects subsequently rate those stimuli as well as stimuli that they have never previously viewed, the

“novel stimuli”). Stimuli in the procedure are often counterbalanced so that some are assigned as novel stimuli and others are exposed to participants.

Repeated exposure – Two or more presentations of a stimulus in a sequence of stimulus presentations.

Subliminal exposure – Presentation of stimuli under visually impoverished conditions (e.g., extremely short durations) that prevent recognition of the stimuli at above chance levels (Kunst-Wilson & Zajonc, 1980). For example, subjects might be told to focus their attention on a cross in the center of a screen (Bornstein & D’Agostino, 1992). They might then view 1-millisecond presentations of octagons with illumination lowered by a neutral density (ND8X) and a red gelatin filter (Kunst-Wilson & Zajonc, 1980).

| Table 1. Meta-analytic comparisons among rehearsed, non-rehearsed, and novel stimuli on self-report and implicit measures of liking and identification | | | | | | | |
|---|--|--|-------------------|---------------|-----------------------------|--------------|--|
| | | Aggregate Effect Sizes and Statistical Tests | | | | | Experiments contributing data (number of samples) b |
| | | Weighted average effect sizes | | | | | |
| Row | Measure(s) | <i>k</i> ^a | Sum of <i>N</i> s | Mean <i>d</i> | <i>p</i> | Wtd SD | |
| Stronger liking and/or identification for rehearsed than for non-rehearsed presented stimuli | | | | | | | |
| 1a | Self-report liking | 6^a | 911 | .438 | 10⁻⁵ | .208* | 1(1), 2(1), 4a(2), 4b(2) |
| 1b | | +4 _a | 1,580 | .386 | 10 ⁻⁷ | .201* | 4a(2), 4b(2) |
| 2a | Implicit liking | 3 | 525 | .953 | <10⁻¹⁶ | .110 | P(1), (1)1, 2(1) |
| 2b | | +6 | 970 | .302 | .11 | .498** | 4a(4) [†] , 4b(2) [†] |
| 3a | Self-report identification | 6 | 873 | .375 | .0005 | .218* | 1(1), 2(1), 4a(2), 4b(2) |
| 3b | | +4 | 1,513 | .327 | 10 ⁻⁵ | .210* | 4a(2), 4b(2) |
| 4a | Implicit identification | 3 | 262 | .754 | 10⁻⁶ | .196* | P(1), 1(1), 2(1) |
| 5a | Averaged implicit effects minus averaged self-report effects | 4 | 446 | .305 | .001 | .153 | 1(2), 2(2) |
| 6a | Self-report identification minus self-report liking | 6 | 778 | .106 | .07 | .070 | 1(1), 2(1), 4a(2), 4b(2) |
| 6b | | +4 | 1,105 | .095 | .07 | .074 | 1(1), 2(1), 4a(4), 4b(4) |
| 7a | Implicit identification minus implicit liking | 3 | 530 | -.220 | .16 | .190 | P(1), 1(1), 2(1) |
| Stronger liking and/or identification for rehearsed stimuli than for novel stimuli | | | | | | | |
| 8a | Self-report liking | 6 | 499 | .542 | 10⁻¹³ | .163 | 3(2), 4a(2), 4b(2) |
| 8b | | +4 | 833 | .408 | 10 ⁻⁶ | .239** | 3(2), 4a(4), 4b(4) |
| 9b | Implicit liking | 6 | 352 | .169 | .05 | .190 | 4a(4) [†] , 4b(2) [†] |
| 10b | Implicit liking minus self-report liking | 6 | 352 | -.415 | 10 ⁻⁷ | .156 | 4a(4) [†] , 4b(2) [†] |
| 11a | Self-report identification | 4 | 328 | .671 | <10⁻¹⁶ | .075 | 4a(2), 4b(2) |
| 11b | | +4 | 648 | .424 | 10 ⁻⁵ | .258** | 4a(2), 4b(2) |
| 12a | Self-report identification minus self-report liking | 4 | 328 | .091 | .24 | .064 | 4a(2), 4b(2) |
| 12b | | +4 | 648 | .045 | .41 | .084 | 4a(2), 4b(2) |
| 13a | Self-report liking for strings compared to images | 3 | 499 | .257 | .004 | .123 | 3(1), 4a(1), 4b(1) |
| 13b | | 5 | 833 | .067 | .66 | .292** | 4a(1), 4b(1) |
| Stronger liking and/or identification for non-rehearsed presented stimuli than for novel stimuli | | | | | | | |
| 14a | Self-report liking | 4 | 342 | .249 | 10⁻⁶ | .069 | 4a(2), 4b(2) |
| 14b | | +4 | 677 | .089 | .23 | .188** | 4a(4) [†] , 4b(4) [†] |

| | | | | | | | |
|---|---|----------|------------|-------------|------------------------|---------------|---|
| 15b | Implicit liking | 6 | 350 | .232 | .0002 | .138 | 4a(4) [†] , 4b(2) [†] |
| 16b | Implicit liking minus self-report Liking | 6 | 350 | .073 | .36 | .179 | 4a(4) [†] , 4b(2) [†] |
| 17a | Self-report identification | 4 | 326 | .510 | 10⁻⁸ | .154 | 4a(2), 4b(2) |
| 17b | | +4 | 646 | .253 | .03 | .300 | 4a(2), 4b(2) |
| 18a | Self-report identification minus self-report liking | 4 | 326 | .202 | .009 | .074 | 4a(2), 4b(2) |
| 18b | | +4 | 646 | .129 | .02 | .092 | 4a(2), 4b(2) |
| Effects of single stimulus presentations stronger than effects of grouped presentations | | | | | | | |
| 19a | Self-report liking | 6 | 593 | .146 | .26 | .288** | 3(2), 4a(2), 4b(2) |
| 19b | | +2 | 833 | .221 | .05 | .300** | 4a(2) |
| 20a | Self-report identification | 4 | 429 | .206 | .05 | .102 | 4a(2), 4b(2) |
| 20b | | +2 | 662 | .365 | 10 ⁻⁵ | .160 | 4a(2) |
| 21a | Implicit liking | 1 | 156 | -.94 | 10⁻⁸ | — | 3(1) |

Notes: Rows with boldface data are based on the *d* effect sizes reported in this manuscript (“a” rows). Rows with data in regular font *additionally* include effect sizes from independent samples that are reported in the supplementary materials (“b” rows).

To keep the unit of effect sizes comparable across all experiments, effect sizes based on repeated measures contrasts were computed as if they had been based on between-subjects contrasts. This meant that differences between means were divided by pooled treatment standard deviations, rather than by standard deviations of difference scores.

* $p < .01$ for heterogeneity test; ** $p < .001$ for heterogeneity test.

[†] Indicates a measure for which comparison to novel stimuli was built into the measure used in analyses.

^a*k* is the number of independent samples in each aggregate. (See supplementary materials for details on defining independent samples.) Values with a “+” indicate the number of independent samples *added* to the independent samples in the row immediately above to compute the aggregate *d* value. Results for the added independent samples are reported in the supplementary materials.

^bIndependent samples are indicated by experiment number (P = Preliminary). Number of independent samples contributing to the meta-analysis aggregate from that experiment is in parentheses. In rows for which *k* is given with a “+” prefix, the number shown is the number of samples added from those reported in the supplementary materials. The total number of independent samples in the meta-analytic aggregate for that row is the sum of *k* values in that row and the immediately preceding one.

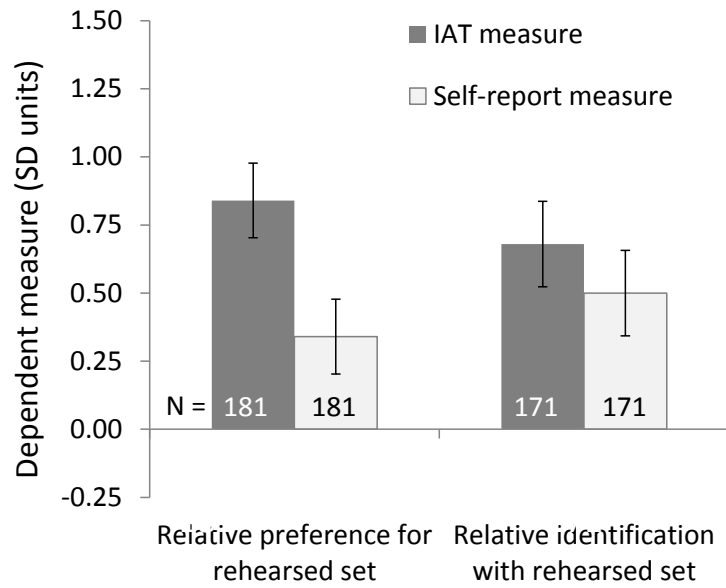


Figure 1. Experiment 1 implicit and explicit liking and identification findings, collapsed over all counterbalanced procedure variables. Measures are reported in standard deviation units to permit comparison of effect magnitudes across measures and experiments. Positive scores indicate greater liking for or identification with rehearsed than non-rehearsed stimuli. Error bars are 95% confidence intervals.

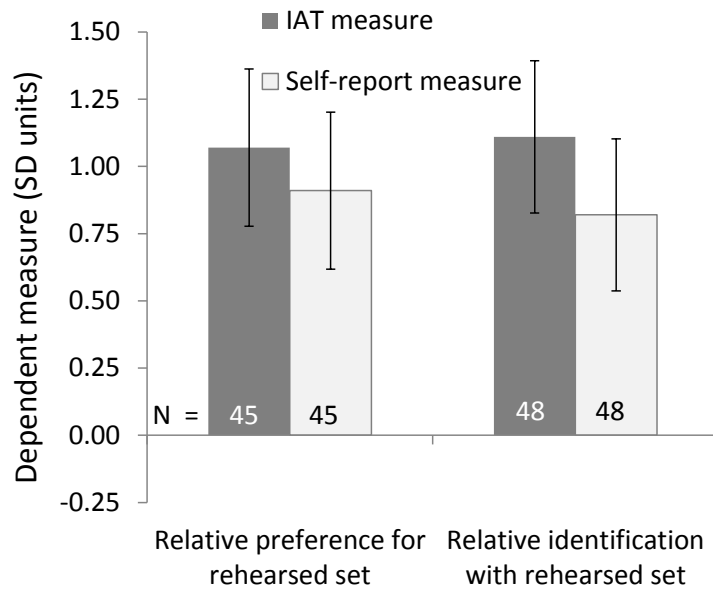


Figure 2. Experiment 2 implicit and explicit liking and identification findings, collapsed over all counterbalanced procedure variables. Measures are reported in standard deviation units. Positive scores indicate greater liking for rehearsed stimuli relative to non-rehearsed stimuli. Error bars are 95% confidence intervals.

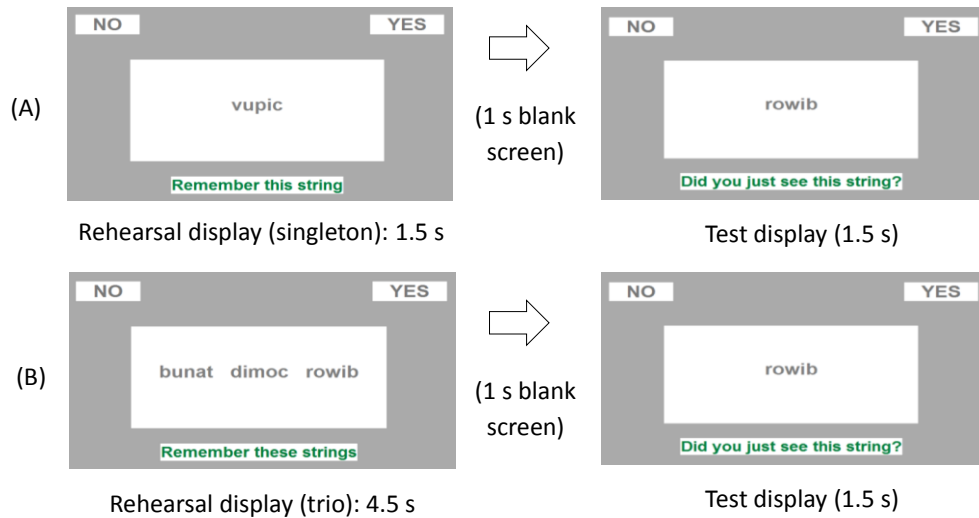


Figure 3. Example of Experiment 3 rehearsal (memory search) task trials. Row A shows the sequence for a singleton trial, and row B shows the sequence for a trio trial. For the rehearsal, subjects saw a stimulus (singleton or trio), followed by a 1 second blank screen, with the instruction to hold the singleton or trio in memory. Next, they saw a single test stimulus and pressed a right key for Yes (in rehearsal set) or a left key for No.

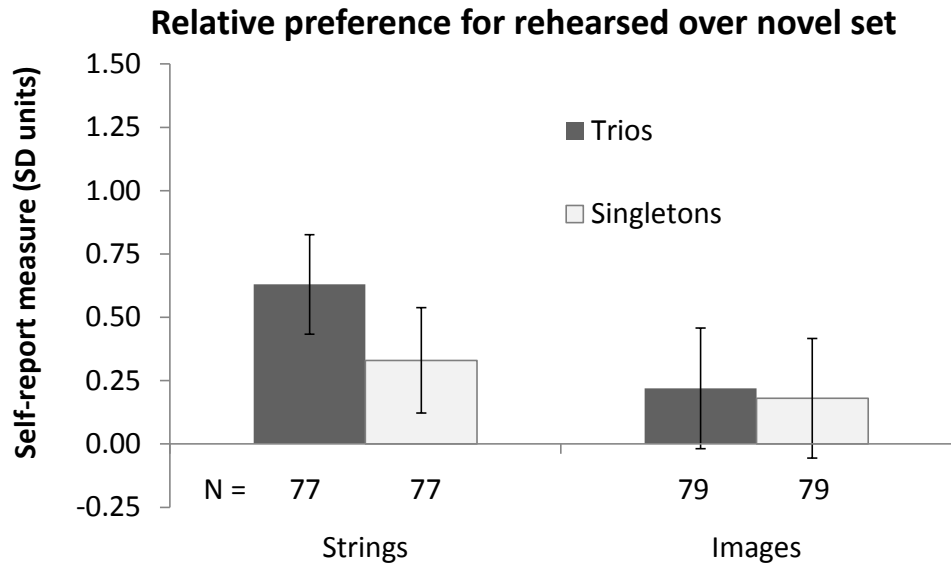


Figure 4. Experiment 3 explicit liking. All measures are reported in standard deviation units. Positive scores indicate greater liking for rehearsed trios or singletons than novel comparison items. Error bars are 95% confidence intervals.

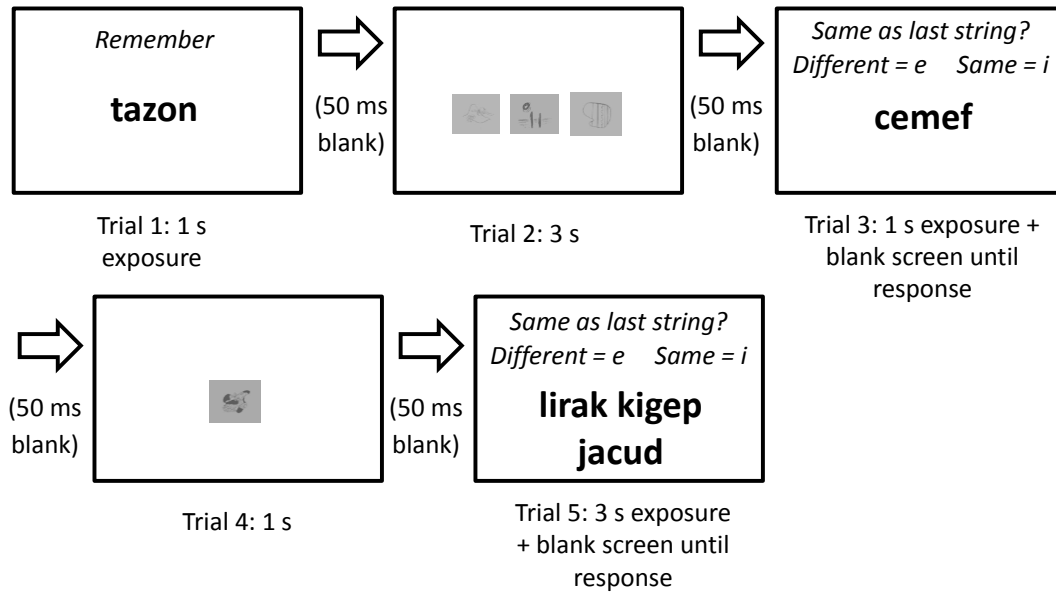


Figure 5. Example of Experiment 4a rehearsal (2-back) task trial sequence. Subjects viewed a series of stimuli with the instruction to judge, for one of the two types of stimuli, whether the current stimulus was identical to the one presented two trials previously. The type of stimulus presented on odd-numbered trials (letter strings or images, counterbalanced) was the type to be rehearsed; the type presented on even trials was passively observed without rehearsal. Experiment 4b's rehearsal task was modified by allowing subjects to control stimulus durations.

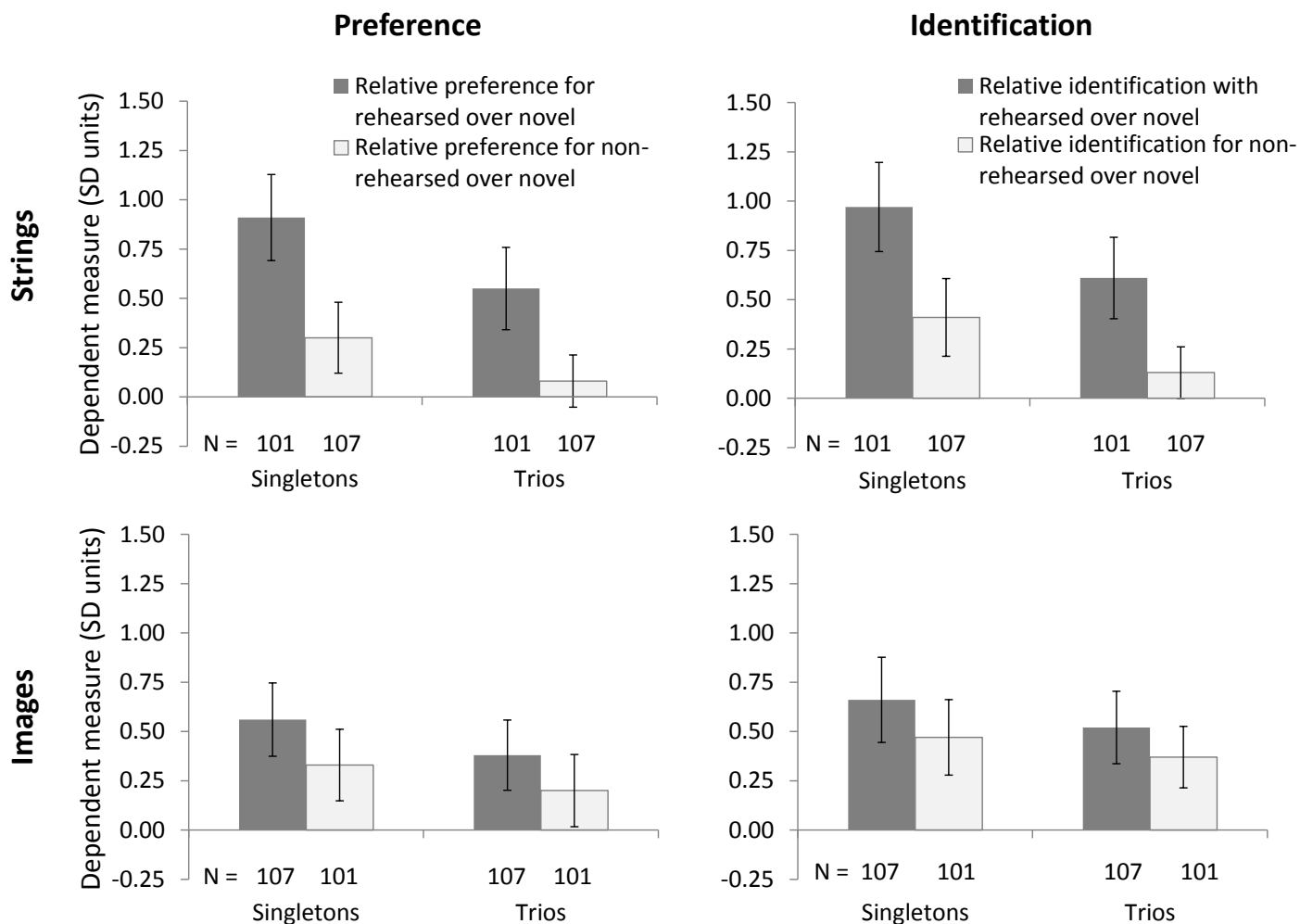


Figure 6. Experiment 4a explicit liking and identification for rehearsed and non-rehearsed letter strings and images relative to novel stimuli. Measures are reported in standard deviation units to permit comparison of effect magnitudes across measures and experiments. Positive scores indicate greater liking for rehearsed or non-rehearsed than novel stimuli. Error bars are 95% confidence intervals. Only the set of measures completed first is included here (the second set is reported in the online supplement).

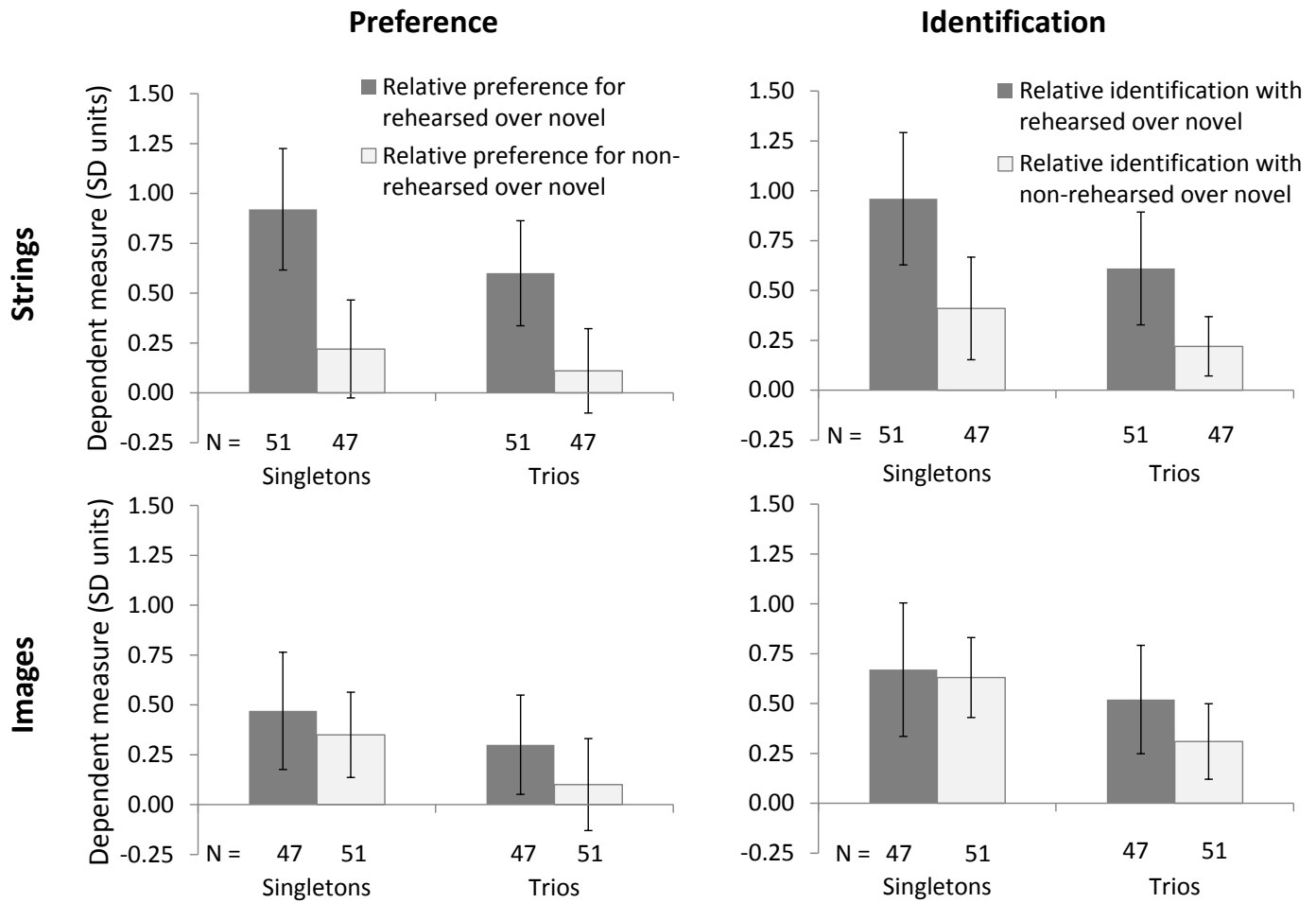


Figure 7. Experiment 4b explicit liking and identification for rehearsed and non-rehearsed letter strings and images relative to novel stimuli. Measures are reported in standard deviation units to permit comparison of effect magnitudes across measures and experiments. Positive scores indicate greater liking for rehearsed or non-rehearsed than novel stimuli. Error bars are 95% confidence intervals. Only the set of measures completed first is included here (the second set is reported in the online supplement).

Familiarity with rehearsed, non-rehearsed, and novel stimuli

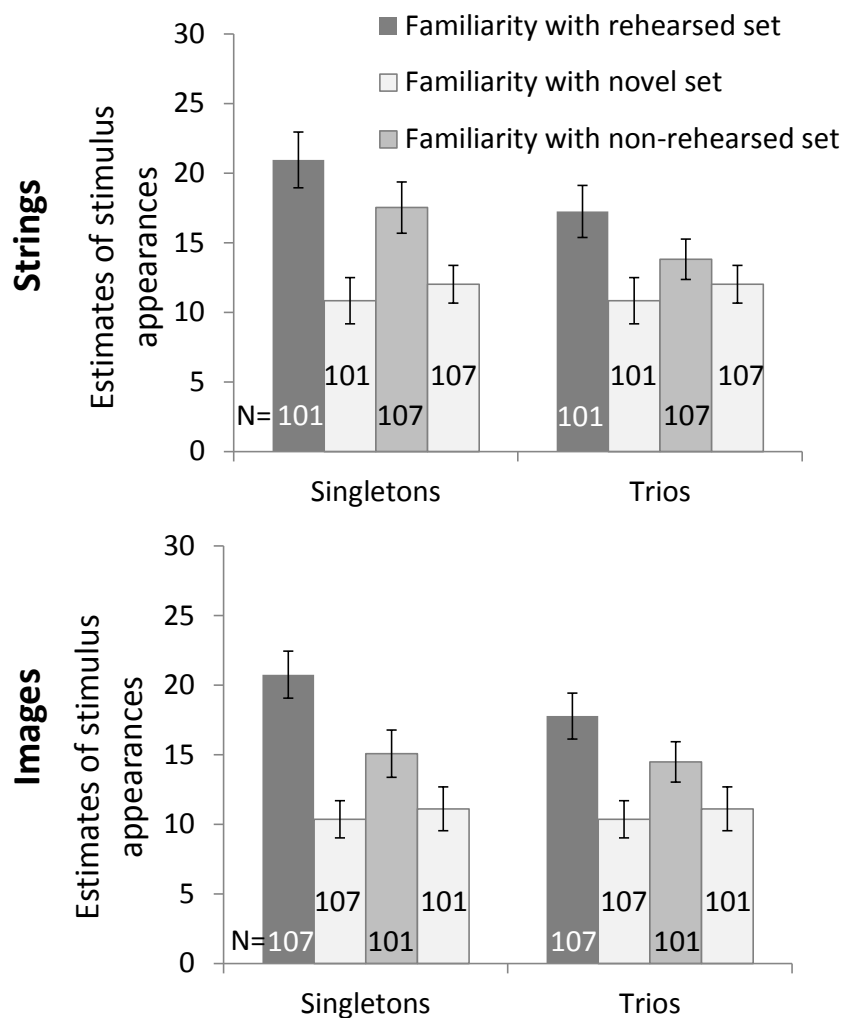


Figure 8. Experiment 4a familiarity with rehearsed, non-rehearsed, and novel letter strings and images. Bars represent the mean number of times subjects estimated seeing each stimulus. Novel stimuli were presented in dependent measures, but not during the rehearsal task; their means are duplicated as comparisons for both trios and singletons. The two bars for novel stimuli within singleton and trio graphs are split between subjects based on whether subjects rehearsed or did not rehearse the stimulus of that type (strings or images). Error bars are 95% confidence intervals. Familiarity measures are shown only for the 208 subjects who completed explicit measures first. Those for subjects who completed BIAT measures first are presented in the online supplement).

Familiarity with rehearsed, non-rehearsed, and novel stimuli

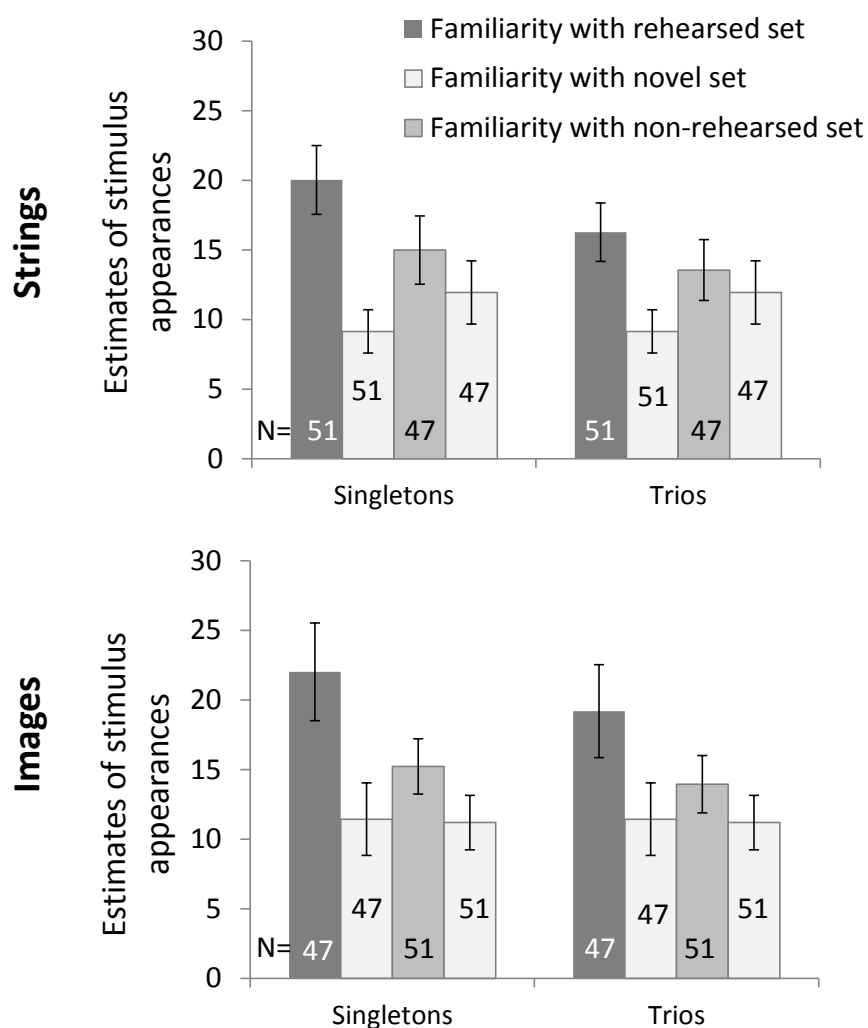


Figure 9. Experiment 4b familiarity with rehearsed, non-rehearsed, and novel letter strings and images. Bars represent the mean number of times subjects estimated seeing each stimulus. Novel stimuli were presented in dependent measures, but not during the rehearsal task; their means are duplicated as comparisons for both trios and singletons. The two bars for novel stimuli within singleton and trio graphs are split between subjects based on whether subjects rehearsed or did not rehearse the stimulus of that type (strings or images). Error bars are 95% confidence intervals. Familiarity measures are shown only for the 98 subjects who completed explicit measures first. Those for subjects who completed BIAT measures first are presented in the online supplement).