Journal of Experimental Social Psychology 73 (2017) 125–135

Contents lists available at ScienceDirect

Journal of Experimental Social Psychology

journal homepage: www.elsevier.com/locate/jesp

Mental ownership: Does mental rehearsal transform novel stimuli into mental possessions?☆

Teri A. Kirby[a,*], Anthony G. Greenwald[b]

[a] Department of Psychology, University of Exeter, United Kingdom
[b] Department of Psychology, University of Washington, United States

ARTICLE INFO

Keywords:
Mere exposure
Mere ownership
Mental rehearsal
Implicit partisanship
Self and memory

ABSTRACT

Mentally rehearsing unfamiliar first names for the purpose of categorizing them into a group produces both preference for and, more surprisingly, identification with the group of names (i.e., association of the names with self; Greenwald, Pickrell, & Farnham, 2002). The present research started as an effort to determine how these 'implicit partisanship' effects of stimulus exposures differed from the well-known mere exposure effect and whether mental rehearsal might play a role in both phenomena. Four experiments found that parallel effects on liking and association with self-occurred (a) more strongly for stimuli that were mentally rehearsed than for ones that were passively exposed, (b) equally for stimuli rehearsed individually versus categorized in groups, (c) consistently for both self-report and implicit measures, and (d) across substantial variations of stimulus types and of mental rehearsal procedures. The findings are interpreted as identifying a shared theoretical ingredient of implicit partisanship and mere exposure effects, linking these two effects more generally to phenomena of implicit self-esteem, including minimal group and mere ownership effects.

1. Introduction

Minimal group experiments have regularly shown that leading people to believe that they have similar reasoning styles, art preferences, or other similarities with a group of strangers causes them to identify with and favor the people in that group (Tajfel, Billig, Bundy, & Flament, 1971). Even more surprising, however, is that people spontaneously identify with groups without any superficial similarity (Billig & Tajfel, 1973) or even association with the group (Greenwald, Pickrell, & Farnham, 2002b). In one of the most minimal procedures demonstrating this, memorizing four first names together as a group increased both implicit identification with and preferences for the memorized group of names relative to a group with unrehearsed names (Greenwald et al., 2002b). This 'implicit partisanship' effect occurred in the absence of any instruction for subjects to consider themselves a member of the (hypothetical) group represented by the studied names. Further experiments with stimuli quite different from the first names of the initial experiments (e.g., fictitious car brands) found this same pattern of dual effects on both implicit and self-report measures of liking and identification (Pinter & Greenwald, 2004, 2011).

Because the stimuli in implicit partisanship studies were relatively unfamiliar to participants, these studies shared a procedural ingredient with the mere exposure effect (Zajonc, 1968), the finding that repeated passive exposure to unfamiliar stimuli increases liking. At the same time, the implicit partisanship procedure differs from most prior mere exposure findings in three ways: First, it involves instructed mental rehearsal of the unfamiliar stimuli rather than passive exposure; second, it uses a single sustained 45-s exposure to the stimuli rather than repeated briefer stimulus presentations; and third, stimuli were presented as a group rather than individually. The initiating, exploratory goal of this research was to evaluate and separate these three possible causes of the implicit partisanship finding.

Each of the four experiments in this report extended the generality of the original findings, while evaluating the three initially plausible causes. To anticipate the conclusion that emerged: The present findings identify a shared theoretical ingredient of implicit partisanship and mere exposure effects, linking these two effects with multiple previously identified phenomena that have been considered indicators of implicit self-esteem (Greenwald & Banaji, 1995), including minimal group and mere ownership effects. These in turn support a theory that connects attitude, identity, and self-esteem (Greenwald et al., 2002a).

☆ This research was part of the first author's M.S. thesis, and it was supported in part by a National Science Foundation graduate research fellowship awarded to the first author.
* Corresponding author.
E-mail address: t.kirby@exeter.ac.uk (T.A. Kirby).

http://dx.doi.org/10.1016/j.jesp.2017.05.004
Received 5 January 2017; Received in revised form 29 April 2017; Accepted 5 May 2017
Available online 05 July 2017

1.1. Similarities between mere exposure and implicit partisanship procedures

Although mere exposure is widely considered to involve passive (unrehearsed), repeated exposure to stimuli (see Bornstein, 1989), mere exposure procedures have often incorporated some degree of mental rehearsal. Participants in mere exposure experiments are sometimes asked to memorize the repeatedly exposed stimuli (e.g., Newell & Bright, 2001; Stang, 1975, Studies 2–3) or to attend selectively to some stimuli while ignoring others (Fenske, Raymond, & Kunar, 2004; Raymond, Fenske, & Tavassoli, 2003; Yagi, Ikoma, & Kikuchi, 2009). Even without an explicit rehearsal task, procedures such as those instructing subjects that they are in a study of "verbal learning" (e.g., Stang, 1975, Study 1, p. 7) or "visual memory" (e.g., Zajonc, 1968, Experiment 3, p. 18) may encourage subjects to mentally rehearse the repeatedly presented stimuli, rather than just observing them passively. Because both mere exposure and implicit partisanship procedures may entail mental rehearsal, there is a possible explanatory overlap that has not previously been explored.

1.2. Challenges in connecting to theories of mere exposure effects

Despite the procedural similarities to mere exposure just described, the implicit partisanship findings appear inconsistent with a theoretical proposition that has been prominent in discussions of mere exposure effects in the past 25 years. Whereas implicit partisanship studies suggest that active mental rehearsal of stimuli increases liking of those stimuli, one of the best established theories of the mere exposure effect suggests that repeated exposure effects may sometimes be weakened when procedures create good recall or recognition memory of the repeatedly presented stimuli (Bornstein, 1989; see also Bornstein & D'Agostino, 1992; Kunst-Wilson & Zajonc, 1980; Moreland & Zajonc, 1979). This *perceptual fluency/misattribution* theory holds that subsequent encounters with repeatedly presented stimuli are processed with improved ease of processing (fluency), which facilitates a liking judgment (Bornstein & D'Agostino, 1992, 1994). It has also been hypothesized that this fluency effect can be discounted when experimental procedures draw subjects' attention to the prior presentations in a way that may lead subjects to credit those prior presentations as the basis for any experienced ease of processing (Alter & Oppenheimer, 2009; cf. Reber, Winkielman, & Schwarz, 1998; Schwarz et al., 1991; Greifeneder & Unkelbach, 2013).

In addition to the empirical support for the related fluency/discounting and fluency/misattribution accounts of repeated exposure effects, there are findings that demonstrate the reverse. For example, Lee (1994) showed that mere exposure effects are not always eliminated when subjects are given an alternative explanation for perceptual fluency (Lee, 1994), and Bornstein (1989) reported that complex (less fluently processed) repeatedly exposed visual stimuli show stronger repeated exposure effects than simple stimuli (Bornstein, 1989). Multiple additional studies, including those in the implicit partisanship tradition, show that instructions to remember or attend to stimuli, which must call attention to the repeatedly presented stimuli and therefore provide a possible basis to discount processing fluency, nevertheless increase liking (Greenwald et al., 2002b; Pinter & Greenwald, 2004; Stafford & Grimes, 2012; Stang, 1975; Yagi et al., 2009).

While the fluency discounting and misattribution theories suggest that mental rehearsal has the potential to undermine repeated exposure effects, other theories used in explaining repeated exposure effects suggest that mental rehearsal might increase those effects. In addition to increasing processing fluency, rehearsed exposures should increase judged familiarity, which is presumably a more consciously perceivable effect. Berlyne (1970) and Stang (1975) both proposed that more familiar stimuli should be less threatening and anxiety-inducing than unfamiliar stimuli, which could be the source of increased liking (see also Lee, 2001; Wang & Chang, 2004). Similarly, Winkielman and Cacioppo (2001) theorized that increased fluency due to repeated presentations would enhance positive mood directly, thereby producing increased liking.

In sum, available theories from the mere exposure tradition are equivocal on expectations for effects of mental rehearsal, the most salient procedural ingredient of the implicit partisanship effect. The other two possible procedural causes of the implicit partisanship finding—grouped presentations of stimuli and sustained (rather than repeated brief) presentations—do not readily align with any of the existing mere exposure theories. An exploratory evaluation of the three suspected procedural causes is therefore likely to yield an empirical answer that cannot be anticipated from existing theory. Also of interest was to observe whether the two parallel measures in the implicit partisanship procedure (liking and identification) would remain linked.

1.3. Present research

To achieve clearer understanding of the relationships among mental rehearsal, mere exposure, and implicit partisanship, the present studies sought to determine which of the empirical components of the implicit partisanship procedure was (or were) responsible for the observed effects on liking and identification. The role of those components was tested by varying the nature of the rehearsal task and the presence or absence of stimulus groupings. To extend generality, the present experiments also varied types of stimulus materials and dependent measures, using both implicit and explicit measures of liking and identification. As was hinted in the opening paragraph (and will be elaborated in the General Discussion), the findings provided a basis for finding a common theoretical theme in implicit partisanship and mere exposure, plausibly also extending to the collection of implicit self-esteem effects described by Greenwald and Banaji (1995), including minimal group and mere ownership effects.

2. Experiment 1: rehearsal task – memory search in a set of memorized letters

Experiment 1 examined whether a set of mentally rehearsed stimuli would be evaluated more positively, on both implicit liking and identification measures (as used in implicit partisanship procedures), than comparable stimuli that were attended without rehearsal (passive exposure). To ensure rehearsal, participants completed a Go/No-go task that required them to rehearse letter sets. Because they rehearsed the same letter set continuously, this procedure corresponded more closely to past implicit partisanship procedures than to mere exposure procedures.

2.1. Method

2.1.1. Participants

Participants were 85 undergraduate students from the University of Washington Psychology Department participant pool (mean age = 18.78, *SD* = 1.01; 68% female; 47% White, 30% Asian). Data were collected until the end of the academic term because the study served as an opportunity for students to receive partial course credit for their participation. One participant was excluded from analyses for excessive speed while completing the IAT measure (10 percent or more of their latencies were faster than 300 ms). In this and subsequent studies, we have reported all exclusions, measures, and manipulations.

2.1.2. Procedure

Each participant completed a Go/No-go rehearsal task, followed by either implicit liking or identification measures.

2.1.2.1. Go/No-go rehearsal task. Participants read these instructions for the adaptation of the Go/No-go task:

> Whenever you see any of four specific letters — G, J, F, or C [or 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.

The Go/No-go task had two 36-trial blocks, and the letter stimuli were counterbalanced so that participants received either the letters G, J, F, C or K L, Z, N as the rehearsed set; the other was the non-rehearsed set. Letters in the two sets were matched in attractiveness, as reported by Greenwald and Banaji (1995). Half of the letters in each trial block were from the rehearsed set (appeared on the screen until participants pressed the spacebar), and half were from the non-rehearsed set (appeared on the screen for one second), with each letter having nine presentations in the two blocks. Participants 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 (in anticipation of the IAT dependent measure) either a left-hand or a right-hand response with the letter set that required spacebar responses.

2.1.2.2. Implicit liking and implicit identification. Participants next completed 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 four rehearsed and the four non-rehearsed letters by comparing response times on a block in which the rehearsed set shared a response key with a set of five pleasant words (i.e., *good*, *agree*, *nice*, *friend*, *truth*) to a block in which the rehearsed letter set shared a response key with a set of five unpleasant words (i.e., *bad*, *vomit*, *ugly*, *horrible*, *wrong*). As in all subsequent experiments, the order in which participants completed the two types of blocks was counterbalanced in these IATs.

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.

2.2. Results

The rehearsed letter set was indeed more liked ($M = 1.07$, $SD = 1.00$), $t(40) = 6.83$, $p = 10^{-8}$, $d = 1.07$, and more identified with ($M = 0.48$, $SD = 1.00$), $t(42) = 3.17$, $p = 0.003$, $d = 0.48$. Whether GJFC or KLZN was assigned as the rehearsed or non-rehearsed set did not affect results for implicit liking, $F(1, 39) = 0.62$, $p = 0.44$, or implicit identification, $F(1, 41) = 2.57$, $p = 0.12$.[1]

2.3. Discussion

Experiment 1 demonstrated that mental rehearsal enhances positive affect toward repeatedly exposed stimuli, which contradicts the PF/M expectation of reduced effects when presented stimuli are better remembered (Bornstein, 1989; see also Bornstein & D'Agostino, 1992; Kunst-Wilson & Zajonc, 1980; Moreland & Zajonc, 1979). This rehearsal benefit occurred on both liking and identification (association of self), making this the first study to demonstrate that repeated exposure effects may extend to identification with novel objects, although a direct test of this would require a comparison to novel stimuli not presented in the rehearsal task (addressed in Experiment 4). These findings were obtained with implicit measurement, which makes it less plausible that the effect of rehearsal was due to demand characteristics (Orne, 1962) resulting from participants' knowledge of an additional task for one subset of letters.

3. Experiment 2: rehearsal task with procedural control

In Experiment 1, presentations of rehearsed stimulus letters differed from those of non-rehearsed letters in having the requirement of a spacebar-press response. To determine whether the observed benefit of rehearsal in the experiment was an artifact of this response requirement, Experiment 2 included a comparison condition in which the spacebar response was required only on *non*-rehearsal trials. Experiment 2 also supplemented the implicit dependent measures with explicit measures of stimulus liking and identification.

3.1. Method

3.1.1. Participants

Participants were 367 undergraduate students from the University of Washington Psychology Department participant pool (mean age = 19.26 years, $SD = 1.50$; 62% female; 47% White, 35% Asian). Data were collected until the end of the academic term because the study served as an opportunity for students to receive partial course credit for their participation. Fifteen participants were excluded from analyses, including three for experimenter errors that caused loss of data, six for having previously participated in a pilot study that is reported in the Online supplement, and eight for excessive speed while completing the IAT measure (10% or more of their latencies were faster than 300 ms). These losses reduced the sample to $N = 350$.

3.1.2. Procedure

Each participant completed one of two versions of a Go/No-go rehearsal task, followed by either liking or identification measures (2×2 between-subjects design). Implicit measures always preceded parallel explicit measures in this experiment.

3.1.2.1. Go/No-go rehearsal task. Participants were randomly assigned to one of two task conditions that varied whether a spacebar response was required for the rehearsed (identical to Experiment 1) or the non-rehearsed letter set. Participants pressing the spacebar on *non*-rehearsal trials read the following instructions:

> 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 Go/No-go task was otherwise identical to that of Experiment 1.

3.1.2.2. Implicit liking and implicit identification. Participants next completed a measure of either implicit liking or implicit identification, using the same IAT procedure as in Experiment 1. Both IATs were scored using the IAT *D* measure (Greenwald et al., 2003) so that higher values of the *D* measure indicated implicit preference for or greater implicit identification with the rehearsed letter set.

3.1.2.3. Explicit liking and explicit identification. For the self-report parallels to the IAT measures, participants viewed 16 pairs of letters and selected 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 identification). 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

[1] All participants in Experiments 1–3 completed a second set of tasks with new stimuli (go/no-go task, followed by the same dependent measures) in order to lengthen the study to half an hour. To economize on presentation, we only present full details in the Online supplement. However, the second set of tasks fully replicated the rehearsal effect in Experiments 1–3, $ps < 0.04$, $ds > 0.38$.

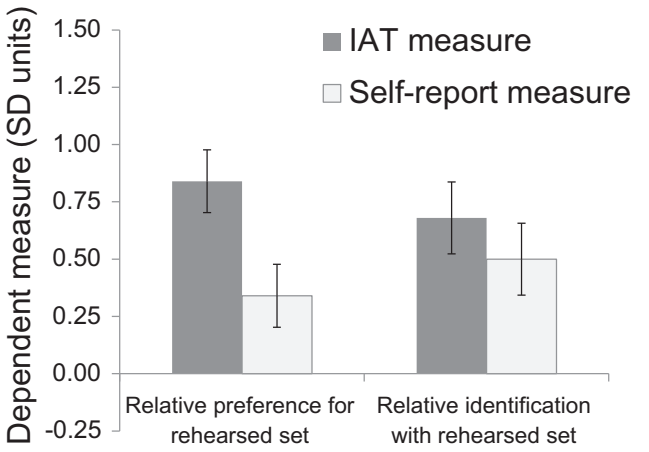

Fig. 1. Experiment 2's implicit and explicit liking and identification findings, collapsed over counterbalanced procedure variables. Measures are reported in standard deviation units to permit comparison of effect magnitudes across measures and experiments. Positive scores indicate greater liking for or greater identification with rehearsed than non-rehearsed stimuli. Error bars are 95% confidence intervals.

left or right letter in the displayed pair. Liking and identification for rehearsed over non-rehearsed letters was calculated as a percentage, then centered at 50 and divided by the standard deviation of all ratings, in order to make this measure comparable to the implicit measure. Positive scores thus indicated more frequent selection of rehearsed letters, measured in SD units.

3.2. Results

Fig. 1 displays summary results for both implicit and explicit measures of attitude and identification. The rehearsed set was significantly more liked and more identified with than the non-rehearsed set, for implicit liking, $t(180) = 11.28$, $p = 10^{-22}$, $d = 0.84$, explicit liking, $t(180) = 4.57$, $p = 10^{-5}$, $d = 0.34$, implicit identification, $t(168) = 8.89$, $p = 10^{-15}$, $d = 0.68$, and explicit identification, $t(168) = 6.50$, $p = 10^{-9}$, $d = 0.50$. The implicit and explicit measures were not significantly correlated for either liking, $r(180) = 0.07$, $p = 0.37$, or identification, $r(168) = 0.12$, $p = 0.11$.[2]

The moderator variable of interest—whether the spacebar was used to signal the rehearsed or the non-rehearsed set—mostly did not moderate magnitude of preference for the rehearsed set, $ps > 0.41$. The minor exception was that using the spacebar for the rehearsed set ($M = 0.53$, $SD = 1.00$) compared to the non-rehearsed set ($M = 0.16$, $SD = 0.98$) produced a stronger rehearsal benefit on the explicit liking measure, $F(1, 179) = 6.21$, $p = 0.01$.

3.3. Discussion

These results replicated and extended Experiment 1's findings of both greater liking for and greater identification with repeatedly presented stimuli that were mentally rehearsed as a group compared to stimuli that were attended without rehearsal. These findings were obtained for both implicit and explicit measures and could not be attributed to a procedural artifact of drawing more attention to one set of stimuli (higher goal relevance) by requiring a space bar press for them.

[2] The benefits of rehearsal were greater when GJFC appeared as the rehearsed set than when KLZN appeared as the rehearsed set on explicit, $F(1,179) = 8.33$, $p = 0.004$, and implicit liking, $F(1,179) = 5.66$, $p = 0.02$, but not on explicit, $F(1,169) = -1.02$, $p = 0.31$, and implicit identification, $F(1,167) = 2.01$, $p = 0.16$.

4. Experiment 3: rehearsal of images

The rehearsal task for Experiment 1 and 2'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 3 extended the research by examining whether mental rehearsal would have the same benefits for image stimuli that have no established pronounceable representations, therefore obliging participants to rehearse in a visual mode, corresponding to Baddeley's (2003) *visuospatial sketchpad*. The stimuli were abstract images that were used successfully in previous repeated exposure research (Bornstein, 1989).

4.1. Method

4.1.1. Participants

Ninety-five undergraduate students from the University of Washington Psychology Department participant pool (mean age = 20.42, $SD = 4.27$; 56% female; 39% White, 39% Asian) participated. Of these, two were excluded from analyses, one for having completed a pilot study (reported in the Online supplement) and one for excessive speed while completing the IAT measure (10% or more of latencies faster than 300 ms). These losses reduced the sample to $N = 93$. Data were collected until the end of an academic term because the study served as an opportunity for students to receive partial course credit for their participation.

4.1.2. Procedure

Participants completed the same Go/No-go procedure as in Experiment 2 that required them to press a spacebar for the instructed stimulus set (the *memory set*), with the exception that "go" trials only remained on the screen for 1 s and were thereafter scored as an error if participants had not responded.[3] Stimuli consisted of six abstract images (3 in the memory set and 3 non-rehearsed) from the Welsh Figure Preference Test (Welsh, 1959). Each stimulus was presented on 12 of the 72 test trials. The image stimuli were counterbalanced so that half of the participants received each of the two sets as their memory set. Participants then completed the measures of implicit and explicit liking or identification (in that order) that were used in Experiment 2, but with Experiment 3's image stimuli in place of Experiment 2's letter stimuli.

4.2. Results

Fig. 2 shows that the Welsh images in the rehearsed memory set were both more liked and more identified with than were those in the non-rehearsed set for all four dependent measures: implicit liking, $t(44) = 7.17$, $p = 10^{-8}$, $d = 1.07$; explicit liking, $t(44) = 6.08$, $p = 10^{-7}$, $d = 0.91$; implicit identification, $t(47) = 7.69$, $p = 10^{-10}$, $d = 1.11$; and explicit identification, $t(47) = 5.68$, $p = 10^{-6}$, $d = 0.82$.[4] Implicit and explicit measures were not significantly correlated in this experiment, either for liking, $r(44) = -0.10$, $p = 0.50$, or for identification, $r(47) = 0.16$, $p = 0.28$.

4.3. Discussion

These results extended the findings of greater liking for and

[3] On average, participants made relatively few errors on both "go" ($M = 0.13\%$, $SD = 0.54$) and "no-go" trials ($M = 1.45\%$, $SD = 2.40$), suggesting that the task was effective as a manipulation of rehearsal.

[4] The benefits of rehearsal were greater when image set 2 (email first author for information about image stimuli) appeared as the rehearsed set than when image set 1 appeared as the rehearsed set on explicit identification, $t(30) = 2.23$, $p = 0.03$, and implicit liking, $t(43) = 2.73$, $p = 0.01$, but not on explicit liking, $t(43) = 1.34$, $p = 0.19$, or implicit identification, $t(46) = 0.17$, $p = 0.86$.

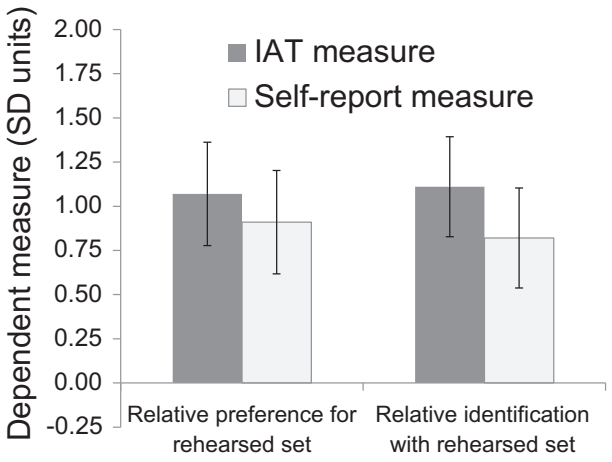

Fig. 2. Experiment 3's implicit and explicit liking and identification findings, collapsed over counterbalanced procedure variables. Positive scores indicate greater liking for or greater identification with rehearsed stimuli relative to non-rehearsed stimuli. Error bars are 95% confidence intervals.

identification with stimuli rehearsed as a group phonologically to include stimuli rehearsed in a visual mode. Rather than confirming theoretical interpretations of mere exposure predicting that recognition memory should impair stimulus liking (e.g., PF/M; Bornstein), these findings are consistent with implicit partisanship findings predicting that categorization of stimuli into groups enhances liking and identification (Greenwald et al., 2002b). However, because these findings may stem from stimulus rehearsal rather than categorization, Experiment 4 was designed to disentangle the roles of rehearsal and stimulus grouping in producing increased liking and identification with the rehearsed stimuli.

5. Experiments 4a & 4b: rehearsal task - display search for images or letter strings held in working memory

To compare effects of mental rehearsal and stimulus grouping, Experiment 4 varied whether the rehearsal task involved rehearsing items individually ("singletons") or in groups of three ("trios"). Unlike Experiments 1 - 3, the rehearsed item or item set in Experiment 4 varied from trial to trial rather than being fixed, thereby more closely resembling procedures of past mere exposure experiments. This required participants to hold stimuli in memory repeatedly for brief periods of time instead of continuously across all trials. The experiment also included a comparison to novel stimuli to directly compare the effect of rehearsal to the mere exposure effect and provide a baseline for establishing directions of changes in the varied rehearsal and grouping conditions.

5.1. Method

5.1.1. Participants

Four hundred sixty-seven students from the University of Washington Psychology Department participant pool (mean age = 19.12, *SD* = 1.60; 58% female; 54% White, 25% Asian) participated in Experiment 4a. One hundred thirty-two of these were excluded from analyses, including 82 for a programming error that sacrificed control over stimulus appearances[5], 32 for excessively fast or slow responses to the Brief IAT (> 10% of latencies faster than 300 ms or > 5% of latencies slower than 5 s; Sriram & Greenwald, 2009), 13 for experimenter errors that caused loss of data, and 5 who were discovered to have participated in one of the preceding experiments). These losses reduced Experiment 4a's sample to $N = 335$. Data were collected until the end of the academic term because the study served as an opportunity for students to earn needed partial course credit.

Experiment 4b's participants were 205 undergraduate students from the same participant pool (mean age = 19.00, *SD* = 1.73; 70% female; 46% White, 33% Asian). Participant losses were 45, including 34 for a programming error, 8 for excessive speed in responding to the BIAT, 2 for experimenter error, and 1 for having completed one of the preceding experiments. These losses reduced Experiment 4b's sample to $N = 160$. Data were again collected until the end of the academic term.

In total, Experiments 4a and 4b had 495 participants. However, both experiments varied which type of dependent measure, BIAT or self-report, appeared first in the procedure, and the extra stimulus exposures in the BIAT procedure contaminated hypothesis tests for the subsequent self-report measures (see Procedure for more information). Thus, the present Results section presents self-report data only for participants who completed those measures prior to the BIAT ($n = 251$), but presents implicit data for all participants (n = 495).

5.1.2. Procedure

All participants completed a rehearsal task, followed either by explicit measures (liking, attractiveness, and identification in a random order, followed by a stimulus familiarity measure) or by a BIAT examining implicit liking of novel stimuli as compared to rehearsed or non-rehearsed stimuli (varied between subjects). Because the BIAT only compared a subset of stimuli (either rehearsed to novel stimuli or non-rehearsed to novel stimuli), this resulted in many additional exposures to some stimuli but not to others. As a result, the subsequent explicit measures were no longer an appropriate test of the hypothesis that rehearsed versus non-rehearsed stimuli (when equally presented) would be more liked, so we do not present those analyses in the Results – we only present the results for explicit measures occurring before the BIAT. Results of explicit measures occurring after the BIAT appear in the Online supplement in Table S2, but they do not change the conclusions presented in the main text.

5.1.2.1. Stimulus design. For each participant, there were nine target images (abstract Welsh figures, as used in Experiment 3) and nine target 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). 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 the rehearsal task, a set of three that were always presented individually during the rehearsal task (singletons), and a set of three that were novel comparison stimuli, which were only used individually in dependent measures.

5.1.2.2. Rehearsal (2-back) task—Experiment 4a. To allow within-subjects variation of rehearsal versus non-rehearsal, Experiment 4 adapted a 2-back memory procedure that is often used as a memory load manipulation in cognitive research (see review in Jaeggi, Buschkuehl, Perrig, & Meier, 2010). Participants 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. Participants therefore knew that the 2-back task (i.e., the rehearsal requirement) never applied to the other type of stimulus (Fig. 3 schematizes the stimulus sequence for Experiment 4a.).

Rehearsed and non-rehearsed stimuli could appear either as singletons (presented for 1 s) or as trios (presented for 3 s). For each odd-numbered trial, participants had two instructed tasks: (a) respond to the current stimulus (press right key if the same stimulus had been

[5] Some exclusions led to imbalanced *N*'s across conditions, but results for Experiments 4a and 4b were unchanged when including all participants in analyses and when analyzing effects of counterbalancing conditions. See Online supplement for details of statistical tests.

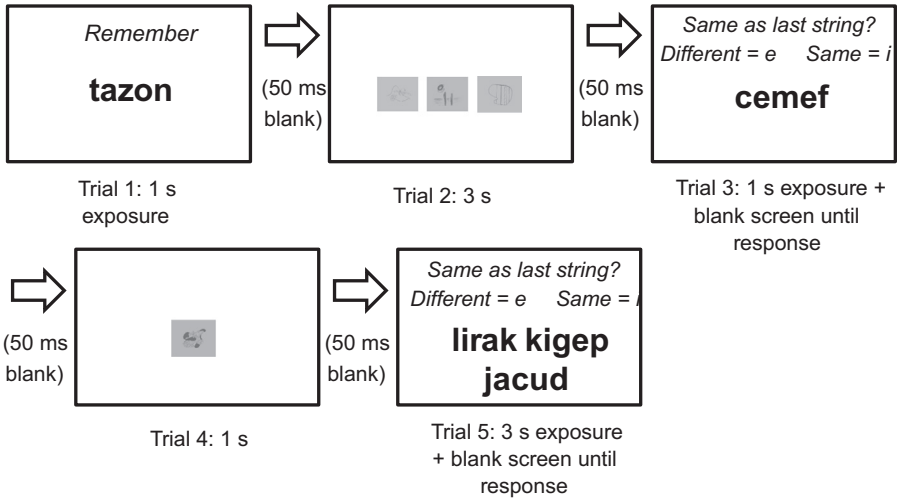

Fig. 3. Illustration of a 5-trial segment of Experiment 4a's procedure. Participants viewed a series of stimuli with the instruction to judge, for the type of stimuli presented on odd-numbered trials, whether the current stimulus was identical to the one presented two trials previously. Stimuli presented on odd-numbered trials were the type to be rehearsed; those presented on even-numbered trials were not rehearsed. Experiment 4b's rehearsal task was modified by allowing participants to control stimulus durations, rather than using the fixed durations shown in this figure.

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 participants responded to indicate *same* or *different*. For even-numbered trials, the singleton (1 s) or trio (3 s) was presented after a very brief (50 ms) blank screen following the participant's response to the preceding odd-numbered trial. After that singleton or trio presentation, another brief blank screen preceded the following (odd-numbered) trial.

The 74 trials (37 with each type of stimulus) appeared in a quasi-random order.[6] The presented stimuli, which were presented eight times each, included the three rehearsed singletons ($3 \times 8 = 24$ trials) and a set of three rehearsed trios of the same stimulus type ($1 \times 8 = 8$), as well as three non-rehearsed singletons ($3 \times 8 = 24$ trials) and three non-rehearsed trios of a different stimulus type ($1 \times 8 = 8$). Ten other trials contained filler stimuli, as described in Table 1, which shows the stimuli viewed by an example participant.

5.1.2.3. Rehearsal (2-back) task—Experiment 4b. The 2-back task was modified by allowing participants to control stimulus durations. This provides a basis for generalizing to natural situations that allow voluntary control of stimulus viewing, as has been done in some mere exposure research (e.g., Stafford & Grimes, 2012). Participants' control over durations was limited by obliging a minimum 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.

5.1.2.4. Explicit liking and identification. Participants completed self-report measures for all nine letter strings and all nine images (including the three (novel) stimuli of each type that were never presented in the 74 trials of the 2-back task). Order of these 18 stimuli was randomized. For each stimulus, participants responded to three questions that were presented in randomized order: "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 (falling between moderate and strong effect sizes), Experiment 4a: $r(167) = 0.64$, $p = 10^{-20}$; Experiment 4b: $r(82) = 0.56$, $p = 10^{-8}$. These two ratings were therefore averaged for each stimulus type for the explicit liking measure. To be consistent with previous experiments, identification was examined separately (see Table 2 for correlations between identification and the composite liking measure). In order to facilitate comparison between explicit and implicit measures, liking and identification for novel stimuli was subtracted from that for trios and 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 or non-rehearsed trios or singletons relative to novel stimuli, measured in *SD* units.

5.1.2.5. Familiarity. After the explicit liking and identification measures, participants responded to the question, "How many times have you seen this stimulus?" for each of the 18 stimuli (9 images and 9 letter strings), presented in randomized order. Participants entered responses by typing in a box in response to the request to "Type a number between 0 and 50 into the box, then click 'Enter.'"

5.1.2.6. Implicit liking. The implicit measure assessed attitudes toward either rehearsed or non-rehearsed stimuli compared to novel stimuli. Because the measure also varied whether participants responded about previously viewed letter string or image stimuli, the analysis degrees of freedom will be similar to that of explicit measures, despite the participant exclusions explained in the Participants section.

Participants completed a Brief IAT (BIAT) instead of the Standard IAT used in Experiments 1–3, but the procedure was otherwise the same with one major exception. Whereas the IATs in Experiments 1–3 showed the individual stimuli as part of the category heading in order to facilitate categorization, the BIAT in Experiment 4 did not. Instead, the BIAT was preceded by a categorization task in which participants learned which stimuli would be part of the arbitrary categories, "Set A" and "Set B," and then practiced classifying them into these sets. Only then did they complete a full BIAT where they classified words as pleasant or unpleasant and letter string or image stimuli into Set A or Set B. It is easy enough to see (but it was appreciated only in retrospect) that the practice task amounted to rehearsal of the novel set, plausibly contaminating the BIAT by repeated presentations of the novel stimuli. For this reason, the results should be interpreted cautiously.[7] The BIATs were scored using the IAT *D* measure (Greenwald et al., 2003) so that

[6] The stimulus trial order was random with two exceptions. First, the stimulus type (abstract image or letter string) alternated on each trial. Second, to sustain participants' engagement in the task, 9 trial pairs that required a "same" response were inserted at set points throughout the task, ensuring that at least 24% of the odd (rehearsal) trials required a "same" response.

[7] In addition to this problem, the extra 5–6 stimulus presentations resulted in a total of 14 presentations for previously rehearsed and non-rehearsed stimuli before the BIAT. Bornstein's (1989) meta-analysis indicates that presentation boredom effects can start at presentation frequencies as low as 10.

Table 1
Example of stimulus presentations for a participant randomly assigned to rehearse letter strings and passively view images in Experiment 4.

Stimulus	Rehearsal condition	Stimulus role	No. 2-back appearances	Self-report	Implicit
Tazon	Rehearsed	Singleton	8	x	x
Cemef	Rehearsed	Singleton	8	x	x
Polov	Rehearsed	Singleton	8	x	x
Lirak kigep jacud	Rehearsed	Trio	8	x	–
Holum sutiz nedag	Rehearsed filler stimuli	Trio	4	–	–
Vupic	1st trial filler stimulus	Singleton	1	–	–
Bunat	–	Novel stimulus	0	x	x
Rowib	–	Novel stimulus	0	x	x
Dimoc	–	Novel stimulus	0	x	x
	Non-rehearsed	Singleton	8	x	x
	Non-rehearsed	Singleton	8	x	x
	Non-rehearsed	Singleton	8	x	x
	Non-rehearsed	Trio	8	x	–
	Non-rehearsed filler stimuli	Trio	4	–	–
	2nd trial filler stimulus	Singleton	1	–	–
	–	Novel stimulus	0	x	x
	–	Novel stimulus	0	x	x
	–	Novel stimulus	0	x	x

Note. Rehearsed and non-rehearsed filler trios were included in the rehearsal task. If we had only included the single target trio throughout the task, participants might have discovered that they could respond with "same" anytime a trio appeared on adjacent odd trials, without needing to attend to the specific stimuli in the trio. Filler stimuli for the 1st and 2nd trials were also included to allow participants to acclimate to the task before using target stimuli that would ultimately appear in dependent variables.

Table 2
Correlations between explicit liking and identification measures in Experiment 4.

Stimulus type	Rehearsed	Non-rehearsed	Novel
Images	0.56[a]	0.49[b]	0.48[c]
Strings	0.57[b]	0.46[a]	0.44[c]

Note. All participants rated both novel images and strings in dependent variables. However, participants only rehearsed either images *or* strings in the procedure, so these ratings have a smaller *n*. All *ps* < 0.001.
[a] $N = 154$.
[b] $N = 97$.
[c] $N = 251$.

higher values of the *D* measure indicated implicit preference for the rehearsed or non-rehearsed stimuli over the novel stimuli.

5.2. Results

Effects of rehearsal did not differ for Experiments 4a and 4b, *ps* > 0.44, so results are collapsed across the two experiments.

5.2.1. Explicit liking and identification

Four findings were apparent for the liking and identification data (see Fig. 4). First, rehearsed stimuli (collapsed across singletons and trios) 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 stronger for rehearsed stimuli than for non-rehearsed stimuli. Finally, stimuli presented individually were more liked and identified with overall than those presented as trios.

All but two of these sixteen findings were statistically significant, the exception being liking and identification with rehearsed as compared to non-rehearsed images (collapsed across singletons and trios), *ps* $= 0.19$. However, these rehearsal effects were moderated by stimulus role (singleton or trio) for both identification, $F(1,249) = 5.43$, $p = 0.02$, and marginally for liking, $F(1,249) = 2.95$, $p = 0.09$. Rehearsed images were only more identified with, $F(1,249) = 4.12$, $p = 0.04$, $d = 0.28$, and liked, $F(1,249) = 3.73$, $p = 0.05$, $d = 0.25$, relative to non-rehearsed images when they appeared as trios. Means and details of statistical tests are provided in Fig. 4 and Table 3. Results of counterbalancing analyses can be found in the Online supplement.

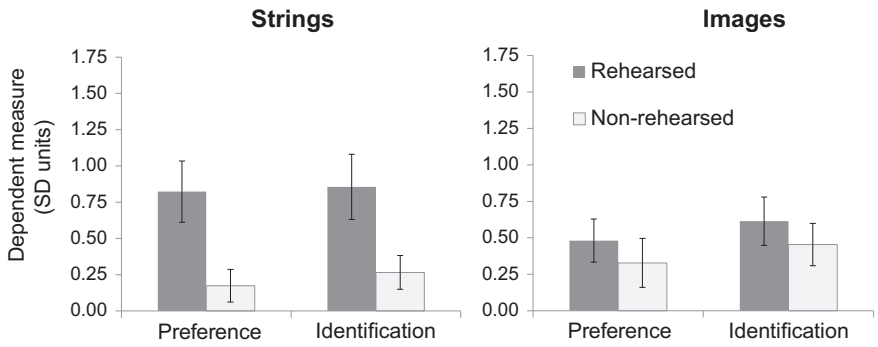

Fig. 4. Experiments 4a & 4b explicit liking and identification for rehearsed and non-rehearsed letter strings and images relative to novel stimuli. Measures are reported in standard deviation units to permit comparison of effect magnitudes across measures and experiments. Positive scores indicate greater liking for rehearsed or non-rehearsed than novel stimuli. Error bars are 95% confidence intervals. Explicit measures are shown only for the 251 participants who completed them first. Those for participants who completed BIAT measures first are presented in the Online supplement.

Table 3
Statistical analyses of comparisons between rehearsed, non-rehearsed, and novel stimuli on measures of liking, identification, and familiarity for Experiments 4a and 4b combined.

Comparison	Measure	Stimulus	*F* or *t*	*p*	*d*
Greater effect for rehearsed stimuli than novel stimuli	Self-report liking	Images	$t(153) = 6.39$	10^{-9}	0.51
		Strings	$t(96) = 7.65$	10^{-11}	0.78
	Self-report identification	Images	$t(153) = 7.26$	10^{-11}	0.58
		Strings	$t(96) = 7.46$	10^{-11}	0.76
	Stimulus familiarity	Images	$t(153) = 15.38$	10^{-32}	1.27
		Strings	$t(96) = 6.83$	10^{-21}	1.08
	Implicit liking	Images	$t(148) = 2.01$	0.05	0.16
		Strings	$t(95) = 1.39$	0.17	0.14
Greater effect for non-rehearsed stimuli than novel stimuli	Self-report liking	Images	$t(96) = 3.84$	10^{-4}	0.39
		Strings	$t(153) = 3.04$	0.003	0.24
	Self-report identification	Images	$t(96) = 6.11$	10^{-8}	0.62
		Strings	$t(153) = 4.49$	10^{-5}	0.36
	Stimulus familiarity	Images	$t(96) = 6.83$	10^{-9}	0.70
		Strings	$t(153) = 8.22$	10^{-13}	0.67
	Implicit liking	Images	$t(95) = 2.92$	0.004	0.30
		Strings	$t(153) = 2.90$	0.004	0.23
Greater effect for rehearsed than non-rehearsed stimuli	Self-report liking	Images	$F(1, 249) = 1.72$	0.19	0.17
		Strings	$F(1, 249) = 33.69$	10^{-8}	0.72
	Self-report identification	Images	$F(1, 249) = 1.74$	0.19	0.18
		Strings	$F(1, 249) = 25.17$	10^{-6}	0.62
	Stimulus familiarity	Images	$t(249) = 3.48$	0.001	0.46
		Strings	$t(249) = 3.88$	10^{-4}	0.49
	Implicit liking	Images	$t(243) = -1.11$	0.27	-0.14
		Strings	$t(248) = -0.68$	0.50	-0.09
Greater effect for single stimulus presentations than grouped presentations	Self-report liking	Images	$F(1, 249) = 21.49$	10^{-5}	0.27
		Strings	$F(1, 249) = 7.18$	0.008	0.18
	Self-report identification	Images	$F(1, 249) = 9.91$	0.002	0.17
		Strings	$F(1, 249) = 12.68$	10^{-4}	0.25

5.2.2. Stimulus familiarity

Each rehearsed stimulus was judged to have been presented more times ($M = 20$) than each non-rehearsed stimulus ($M = 15$), which were in turn judged to have been presented more times than each novel stimulus ($M = 11$). All of these differences between presentation conditions were statistically significant. 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 participants to guess and to err in the direction of the average number of presentations for the full set of stimuli. Details of statistical tests are provided in Table 3.

5.2.3. Implicit liking

The BIAT showed a preference for both rehearsed and non-rehearsed images (respectively, $M = 0.17$, $SD = 0.98$; $M = 0.31$, $SD = 1.03$) and strings (respectively, $M = 0.14$, $SD = 1.01$; $M = 0.23$, $SD = 0.99$) over novel stimuli.[8] All but one of these four findings were statistically significant, the exception being preference for rehearsed as compared to novel strings, $p = 0.17$. However, there was no significant benefit of rehearsal relative to non-rehearsed exposure. Details of statistical tests are provided in Table 3.

5.2.4. Mediation analyses

Mediation tests examined whether the superior effect of rehearsal (relative to novel stimuli) on explicit liking was mediated by the effect on explicit identification, as well as the possible reverse direction of mediation. These analyses used 10,000 bootstrap resamples of the data with the SPSS MEMORE macro of Montoya and Hayes (2016) for within-subjects mediation. All tests combined stimulus type and singleton and trio stimuli, as rehearsal effects were not moderated by presentation grouping. Although the authors are skeptical about mediation tests of these types, their results are nevertheless informative.

5.2.4.1. Mediation tests for the effect of rehearsed versus novel stimuli. Mental rehearsal increased both liking of and identification with stimuli, $b = 0.81$, $SE = 0.07$, $t(250) = 11.40$, $p < 0.0001$; $b = 1.31$, $SE = 0.11$, $t(250) = 11.70$, $p < 0.0001$. When examining both identification and mental rehearsal as predictors of liking, identification was significantly related to liking, $b = 0.37$, $SE = 0.04$, $t(248) = 10.59$, $p < 0.0001$. The effect of mental rehearsal on liking remained significant, $b = 0.32$, $SE = 0.07$, $t(248) = 4.40$, $p < 0.0001$, but was significantly reduced, $b = 0.49$, $SE = 0.06$, $CI_{95} = 0.36$ to 0.61, suggesting mediation of the effect of rehearsal on liking by identification.

In the reverse mediation pathway test with both predictors, liking was significantly related to identification, $b = 0.92$, $SE = 0.08$, $t(248) = 10.92$, $p < 0.0001$. The effect of mental rehearsal on identification remained significant, $b = 0.57$, $SE = 0.11$, $t(248) = 5.04$, $p < 0.0001$, but was significantly reduced, $b = 0.75$, $SE = 0.09$, $CI_{95} = 0.57$ to 0.93, suggesting mediation of the effect of rehearsal on identification by liking.

5.2.4.2. Mediation test for the effect of non-rehearsed versus novel stimuli. Non-rehearsed exposure increased both liking of and identification with stimuli, $b = 0.19$, $SE = 0.06$, $t(250) = 3.13$, $p = 0.002$; $b = 0.53$, $SE = 0.09$, $t(250) = 5.72$, $p < 0.0001$. When examining both identification and non-rehearsed exposure as predictors of liking, identification was significantly related to liking, $b = 0.44$, $SE = 0.03$, $t(248) = 13.13$, $p < 0.0001$. The effect of non-rehearsed

[8] These effects differed across Experiments 4a and 4b, such that preference for previously exposed stimuli (rehearsed or non-rehearsed) over novel stimuli was stronger in 4a ($M = 0.33$) than 4b ($M = -0.08$) for letter strings, $F(1, 246) = 8.18$, $p = 0.005$, but weaker in 4a ($M = 0.13$) than 4b ($M = 0.40$) for images, $F(1, 241) = 3.27$, $p = 0.07$. However, the main effect of interest (rehearsal versus non-rehearsal) did not differ across experiments, $ps > 0.44$.

exposure on liking was no longer significant, $b = -0.04$, $SE = 0.05$, $t(248) = -0.73$, $p = 0.46$, and was significantly reduced, $b = 0.23$, $SE = 0.04$, $CI_{95} = 0.15$ to 0.32, suggesting mediation by identification.

In the reverse mediation pathway, liking was significantly related to identification, $b = 1.00$, $SE = 0.08$, $t(248) = 13.20$, $p < 0.0001$. The effect of non-rehearsed exposures on identification remained significant, $b = 0.33$, $SE = 0.07$, $t(248) = 4.72$, $p < 0.0001$, but was significantly reduced, $b = 0.19$, $SE = 0.06$, $CI_{95} = 0.07$ to 0.32, suggesting mediation by liking.

5.3. Discussion

Both Experiments 4a and 4b demonstrated that rehearsed stimuli were more liked and identified with than non-rehearsed stimuli on explicit measures, which in turn were both more liked and more identified with than novel stimuli. This suggests that mental rehearsal enhances repeated exposure effects, although this finding was more robust for letter string than for image stimuli. All of these effects were similar in magnitude between the two sub-experiments, although the stimulus presentation procedures differed notably: The stimuli were presented for fixed durations in Experiment 4a, and for self-paced durations in Experiment 4b. However, these findings were not completely confirmed on implicit measures – although rehearsed and non-rehearsed stimuli were preferred over novel stimuli, rehearsed stimuli were not significantly preferred over non-rehearsed stimuli. It was possible that the extra categorization task preceding the IAT measure, by itself providing some mental rehearsal, might have weakened the test of the effect of mental rehearsal.

Importantly, Experiment 4 disentangled the roles of rehearsal and grouping in stimulus liking and identification. Indeed, the rehearsal effect found in previous experiments for grouped stimuli extended to singly presented stimuli, more clearly connecting these research procedures with procedures of past mere exposure studies. Because singly presented stimuli were more, rather than less, liked than grouped presentations, this confirms the role of mental rehearsal as an explanation of the results, rather than categorization of stimuli into groups. These findings not only contradict the PF/M expectation of reduced effects when presented stimuli are better remembered (e.g., Bornstein, 1989), but it also contradicts the previously plausible implicit partisanship interpretation that categorization of stimuli into groups might have been a substantial cause of the enhanced liking and identification findings reported by Greenwald and colleagues (2002b).

6. General discussion

Four experiments examined effects of repeated mental rehearsal of novel stimuli on liking for the stimuli and association of the stimuli with self (identification). Three types of stimuli were used: isolated consonants, pronounceable 5-letter non-word strings, and abstract drawings. Two types of mental rehearsal procedures were used: retaining stimuli continuously in memory or retaining stimuli in memory for several seconds in anticipation of judging whether a subsequent stimulus matched the rehearsed stimulus. Across the variations of stimulus types and rehearsal procedures, stronger effects on the attitude and identification measures were uniformly obtained when stimuli were mentally rehearsed than when they were seen for the same durations without rehearsal. These results did not depend on categorizing stimuli into groups.

Aggregate effect sizes for the impact of mental rehearsal, relative to non-rehearsal, were $g = 0.42$ for explicit liking, $g = 0.50$ for implicit liking, $g = 0.54$ for explicit identification, and $g = 0.58$ for implicit identification. For the impact of mental rehearsal relative to no previous exposures, aggregate effect sizes were $g = 0.63$ for explicit liking, $g = 0.15$ for implicit liking, and $g = 0.65$ for explicit identification. Finally, for the impact of non-rehearsal relative to no previous exposures, aggregate effect sizes were $g = 0.30$ for explicit liking, $g = 0.25$ for implicit liking, and $g = 0.48$ for explicit identification.[9]

Experiment 4's findings of (a) strong correlations between liking and identification and (b) mutual mediation of liking by identification and of identification by liking are more consistent with the conclusion that rehearsed or non-rehearsed exposures had *parallel effects* on liking and identification than with either directional mediation hypothesis.

6.1. A theoretical puzzle

While sharing components of procedures with previous studies of mere exposure (Zajonc, 1968) and minimal groups (Tajfel et al., 1971), this research's mental rehearsal procedures also diverged from both of those traditions. They differed from most prior mere exposure research by instructing subjects to mentally rehearse novel stimuli, and they differed from *all* prior mere exposure research by including dependent measures of association of stimuli with self. This research's procedures also differed from minimal group research by using a main *independent* variable of minimal group research—association with self—instead as one of the research's two *dependent* variables.

One approach to interpreting similar findings from mere exposure, minimal group, and mental rehearsal procedures is to consider the possibility that they share a common theoretical mechanism. This approach runs rapidly into challenges. First, the well-regarded fluency interpretation of exposure effects on valence is at best awkward (as explained in the introduction) in explaining the effect of mental rehearsal on valence. The problem: rehearsal may raise participants' awareness of presented stimuli enough to give them a basis for discounting an interpretation of experienced fluency as positive valence. Second, the minimal group effect has no plausible connection to a fluency interpretation. Third, the fluency interpretation does not account for the effect of mental rehearsal and (more weakly) mere exposure on association with self. Fourth, there remains substantial disagreement on theoretical interpretation for mere exposure effects (cf. Zajonc, 2001) and minimal group findings (cf. Hewstone, Rubin, & Willis, 2002). These challenges notwithstanding, the remainder of this article pursues the goal of seeking common theoretical ground among the three paradigms.

A starting point for theoretical synthesis is available in recent proposals of a theoretical connection between the minimal group paradigm and "mere ownership" findings (Beggan, 1992; Feys, 1991; Kahneman, Knetsch, & Thaler, 1990). In minimal group studies, participants learn that they belong to an unfamiliar group. In mere ownership procedures, they learn (approximately) the reverse—that a previously unfamiliar object belongs to them. Both procedures establish an association with self that has been described as *associative self-anchoring* (Gawronski, Bodenhausen, & Becker, 2007; Roth & Steffens, 2014) or as *implicit self-object linking* (Ye & Gawronski, 2016). Procedures such as these were previously theorized to be manifestations of implicit self-esteem (Greenwald & Banaji, 1995). The three italicized labels designate phenomena in which participants show greater liking for an entity to which an association with self has been created. Greenwald and Banaji's implicit self-esteem conception was subsequently integrated into *balanced identity theory* (Cvencek, Greenwald, & Meltzoff, 2012, 2016; Greenwald et al., 2002a), which offers theoretical accounts of both minimal group findings (Ashburn-Nardo, 2003) and mere ownership findings (Ye & Gawronski, 2016).

In this article's research, both mentally rehearsed stimulus exposures and—to a lesser extent—non-rehearsed stimulus exposures produced increased associations of the stimuli with self. Increased association with self thus emerges as a previously unknown (also

[9] A random effects meta-analysis using SPSS macros described by Lipsey and Wilson (2001) was conducted on all bias-corrected effect sizes included in the main text and online supplement (including the pilot experiment and "task set 2" for all experiments), with the exception of the explicit measures completed after implicit measures in Experiment 4. All of these effects were statistically significant, $ps < 0.02$.

untheorized and uninvestigated) consequence of mere exposure procedures. This finding poses a strong theoretical challenge: How can association with self-result from mental rehearsal of novel stimuli and (to a lesser extent) from passive exposure to novel stimuli?

6.2. Self and memory

An expectable consequence of both rehearsed and non-rehearsed stimulus exposures is establishment of some memory—even if only weak—for the presented items. Experiment 3's familiarity measures confirmed this expectation, also showing that rehearsed stimuli were remembered to have been presented more times than non-rehearsed ones, even though both had equal numbers of presentations. Might these effects on memory produce increased associations with self? Perhaps surprisingly, a *yes* answer to this question comes from the history of theory and research on the role of the self in human memory.

William James's (1890) treatment of "The Self" in Volume 1 of *Principles of Psychology* laid the foundation for subsequent theorists to describe the self as a primary organization of personal knowledge. Freud, 1917 wrote: "… an incessant stream of 'self-reference' flows through my thoughts concerning which I usually have no inkling…. It seems as if I were forced to compare with my own person all that I hear about strangers, as if my personal complexes became stirred up at every information from others. It seems impossible that this should be an individual peculiarity of my own person; it must, on the contrary, point to the way we grasp outside matters in general." (pp. 41–42) Psychiatrist Édouard Claparède (1911) interpreted the anterograde amnesia of his Korsakoff syndrome patient as a failure of the patient to connect new experiences to the patient's self. Involvement of the self as a cognitive organization central to memory was developed even more extensively in Kurt Koffka's (1935) *Principles of Gestalt Psychology* (see especially pp. 319–342, 514–528, and 591–614).

More than four decades after Koffka's book, in the mid-1970s social cognition and cognitive psychological researchers produced a substantial body of research that empirically established relationships between self and memory. These included self-generation effects, self-reference effects, and ego-involvement effects (reviewed in Greenwald, 1981). These phenomena involved demonstrations that tasks requiring encoding an event in relation to one's self benefited memory for the event more than did a wide variety of alternative memory-encoding tasks.

If, as Freud, Claparède, and Koffka supposed, one's self is a primary organization of personal knowledge (an idea developed further by Greenwald, 1980, and Greenwald & Pratkanis, 1984), then it becomes plausible that ordinary acquisition of new memories involves attaching those potentially memorable events to the self's organization of knowledge (see Cunningham & Turk, 2017 for an overview of self-processing biases). In this fashion, formation of memories through mental rehearsal may provide the common ingredient that allows four procedures—minimal groups, mere exposure, mere ownership, and mental rehearsal—to produce increased association with self (identification). With establishment of a connection to self, a link to positive valence follows directly, due to the self's well known affective positivity (for the great majority of people — see review by Greenwald & Pratkanis, 1984, pp. 151–156; also Cunningham & Turk, 2017). This description of the self's role implies that association with self might mediate the effect of mental rehearsal on valence. However, evidence for unidirectional mediation was lacking in the tests available in the present Experiment 4, for which it was more plausible that effects of mental rehearsal on association with self and association with positive valence occurred in parallel. These parallel effects have a theoretical interpretation in balanced identity theory (Greenwald et al., 2002a). However, the theoretical principles of balanced identity were hardly new in 2002, having relatively direct roots in Heider's (1946, 1958) theorization, along with less direct roots in the past work on self and memory cited in this Discussion.

6.3. Conclusion

This article's studies of mental rehearsal extend previous findings by showing that liking for and identification with novel stimuli occur with widely varied stimuli and varied rehearsal procedures. These effects consistently exceeded effects produced by stimuli encountered without rehearsal. The robustness of these findings, along with their theorized connection—via the self's organization of knowledge—to previously established minimal group, mere exposure, and mere ownership findings, suggests their potential for useful applications.

Author contributions

Both authors developed the study concept and design. T.A. Kirby oversaw data collection, statistical analysis, and interpretation of data. T.A. Kirby and A.G. Greenwald drafted and revised the manuscript. Both authors approved the final version of the manuscript for submission.

Appendix A. Supplementary Method and Analysis Details

Supplementary method and analysis details for this article can be found online at http://dx.doi.org/10.1016/j.jesp.2017.05.004.

References

Alter, A. L., & Oppenheimer, D. M. (2009). Uniting the tribes of fluency to form a metacognitive nation. *Personality and Social Psychology Review*, *13*(3), 219–235. http://dx.doi.org/10.1177/1088868309341564.

Ashburn-Nardo, L. A. (2003). Rejecting the ingroup or standing up fiercely: Implicit psychological distancing as self-protection from stigma. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, *64*(2-B), 1000 (UMI No. AAI3082683).

Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature Reviews. Neuroscience*, *4*(10), 829–839. http://dx.doi.org/10.1038/nrn1201.

Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology*, *62*, 229–237.

Berlyne, D. E. (1970). Novelty, complexity, and hedonic value. *Attention, Perception, & Psychophysics*, *8*(5), 279–286.

Billig, M., & Tajfel, H. (1973). Social categorization and similarity in intergroup behaviour. *European Journal of Social Psychology*, *3*(1), 27–52.

Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968–1987. *Psychological Bulletin*, *106*(2), 265–289. http://dx.doi.org/10.1037//0033-2909.106.2.265.

Bornstein, R. F., & D'Agostino, P. R. (1992). Stimulus recognition and the mere exposure effect. *Journal of Personality and Social Psychology*, *63*(4), 545–552.

Bornstein, R. F., & D'Agostino, P. R. (1994). The attribution and discounting of perceptual fluency: Preliminary tests of a perceptual fluency/attributional model of the mere exposure effect. *Social Cognition*, *12*(2), 103–128.

Claparède, E. (1951). Recognition and "me-ness". In D. Rapaport (Ed.), *Organization and Pathology of Thought*New York: Columbia University Press (Original French publication, 1911).

Cunningham, S. J., & Turk, D. J. (2017). Editorial: A review of self-processing biases in cognition. *Quarterly Journal of Experimental Psychology*, *70*, 987–995.

Cvencek, D., Greenwald, A. G., & Meltzoff, A. N. (2012). Balanced identity theory: Evidence for implicit consistency in social cognition. In B. Gawronski, & F. Strack (Eds.), *Cognitive consistency: A unifying concept in social psychology* (pp. 157–177). New York: Guilford Press.

Cvencek, D., Greenwald, A. G., & Meltzoff, A. N. (2016). Implicit measures for preschool children confirm self-esteem's role in maintaining a balanced identity. *Journal of Experimental Social Psychology*, *62*, 50–57.

Fenske, M. J., Raymond, J. E., & Kunar, M. A. (2004). The affective consequences of visual attention in preview search. *Psychonomic Bulletin & Review*, *11*(6), 1055–1061.

Feys, J. (1991). Briefly induced belongingness to self and preference. *European Journal of Social Psychology*, *21*, 547–552.

Freud, S. (1917) The psychopathology of everyday life. In A. A. Brill (Ed. and trans.) New York: Macmillan. (Original German publication. 1901).

Gawronski, B., Bodenhausen, G. V., & Becker, A. P. (2007). I like it, because I like myself: Associative self-anchoring and post-decisional change of implicit evaluations. *Journal of Experimental Social Psychology*, *43*(2), 221–232.

Greenwald, A. G. (1980). The totalitarian ego: Fabrication and revision of personal history. *American Psychologist*, *35*, 603–618.

Greenwald, A. G. (1981). Self and memory. In G. H. Bower (Vol. Ed.), *Psychology of learning and motivation. Vol. 15. Psychology of learning and motivation* (pp. 201–236). New York: Academic Press.

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review*, *102*(1).

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D.

S. (2002a). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review*, *109*, 3–25.
Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology*, *74*(6), 1464–1480.
Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*(2), 197–216. http://dx.doi.org/10.1037/0022-3514.85.2.197.
Greenwald, A. G., Pickrell, J. E., & Farnham, S. D. (2002b). Implicit partisanship: Taking sides for no reason. *Journal of Personality and Social Psychology*, *83*(2), 367–379.
Greenwald, A. G., & Pratkanis, A. R. (1984). The self. In R. S. Wyer, & T. K. Srull (Eds.), *Handbook of social cognition* (pp. 129–178). Hillsdale, NJ: Erlbaum.
Greifeneder, R., & Unkelbach, C. (2013). Experiencing thinking. In C. Unkelbach, & R. Greifeneder (Eds.), *The experience of thinking: How the fluency of mental processes influences cognition and behaviour* (pp. 1–7). Psychology Press.
Heider, F. (1946). Attitudes and cognitive organization. *Journal of Psychology*, *21*, 107–112.
Heider, F. (1958). *The psychology of interpersonal relations*. New York: Wiley.
Hewstone, M., Rubin, M., & Willis, H. (2002). Intergroup bias. *Annual Review of Psychology*, *53*, 575–604.
Jaeggi, S. M., Buschkuehl, M., Perrig, W. J., & Meier, B. (2010). The concurrent validity of the N-back task as a working memory measure. *Memory (Hove, England)*, *18*(4), 394–412. http://dx.doi.org/10.1080/09658211003702171.
James, W. (1890). *Principles of psychology. Vol. 1*. New York: Holt.
Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental test of the endowment effect and the coase theorem. *Journal of Political Economy*, *98*, 1325–1347.
Koffka, K. (1935). *Principles of gestalt psychology*. New York: Harcourt.
Kunst-Wilson, W., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. *Science*, *207*(4430), 557–558. http://dx.doi.org/10.1126/science.7352271.
Lee, A. Y. (1994). The mere exposure effect: Is it a mere case of misattribution? In C. T. Allen, & D. R. John (Eds.), *Advances in consumer research* (pp. 270–275). (21st ed.). Provo, UT: Association for Consumer Research.
Lee, A. Y. (2001). The mere exposure effect: An uncertainty reduction explanation revisited. *Personality and Social Psychology Bulletin*, *27*(10), 1255–1266.
Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. Thousand Oaks, CA: Sage.
Montoya, A. K., & Hayes, A. F. (2016). Two-condition within-participant statistical mediation analysis: A path-analytic framework. *Psychological Methods* (in press).
Moreland, R., & Zajonc, R. (1979). Exposure effects may not depend on stimulus recognition. *Journal of Personality and Social Psychology*, *35*(4), 191–199.
Newell, B. R., & Bright, J. E. (2001). The relationship between the structural mere exposure effect and the implicit learning process. *The Quarterly Journal of Experimental Psychology: Section A*, *54*(4), 1087–1104.
Orne, M. (1962). On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. *American Psychologist*, *17*, 776–783.
Pinter, B., & Greenwald, A. G. (2004). Understanding implicit partisanship: Enigmatic (but genuine) group identification and attraction. *Group Processes and Interpersonal Relations*, *7*, 283–296.
Pinter, B., & Greenwald, A. G. (2011). A comparison of minimal group induction procedures. *Group Processes and Interpersonal Relations*, *14*, 81–98.
Raymond, J., Fenske, M. J., & Tavassoli, N. (2003). Selective attention determines emotional responses to novel visual stimuli. *Psychological Science*, *14*(6), 537–542.
Reber, R., Winkielman, P., & Schwarz, N. (1998). Effects of perceptual fluency on affective judgments. *Social Psychology*, *9*(1), 45–48.
Roth, J., & Steffens, M. C. (2014). When I becomes we: Associative self-anchoring drives implicit intergroup bias in minimal groups. *Social Psychology*, *45*(4), 253–264.
Schwarz, N., Bless, H., Strack, F., Klumpp, G., Rittenauer-Schatka, H., & Simons, A. (1991). Ease of retrieval as information: Another look at the availability heuristic. *Journal of Personality and Social Psychology*, *61*, 195–202.
Sriram, N., & Greenwald, A. G. (2009). The Brief Implicit Association Test. *Experimental Psychology*, *56*(4), 283–294. http://dx.doi.org/10.1027/1618-3169.56.4.283.
Stafford, T., & Grimes, A. (2012). Memory enhances the mere exposure effect. *Psychology and Marketing*, 995–1003. http://dx.doi.org/10.1002/mar.
Stang, D. J. (1975). Effects of "mere exposure" on learning and affect. *Journal of Personality and Social Psychology*, *31*(1), 7–12.
Stang, D. J., & O'Connell, E. J. (1974). The computer as experimenter in social psychological research. *Behavior Research Methods & Instrumentation*, *6*(2), 223–231.
Tajfel, H., Billig, M. G., Bundy, R. F., & Flament, C. (1971). Social categorization and intergroup behaviour. *European Journal of Psychology*, *1*, 149–177.
Wang, M. Y., & Chang, H. C. (2004). The mere exposure effect and recognition memory. *Cognition & Emotion*, *18*(8), 1055–1078.
Welsh, G. S. (1959). *Welsh figure preference test: Preliminary manual*. Palo Alto, CA: Consulting Psychologists Press.
Winkielman, P., & Cacioppo, J. T. (2001). Mind at ease puts a smile on the face: psychophysiological evidence that processing facilitation elicits positive affect. *Journal of personality and social psychology*, *81*(6), 989.
Yagi, Y., Ikoma, S., & Kikuchi, T. (2009). Attentional modulation of the mere exposure effect. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *35*(6), 1403–1410. http://dx.doi.org/10.1037/a0017396.
Ye, Y., & Gawronski, B. (2016). When possessions become part of the self: Ownership and implicit self-object linking. *Journal of Experimental Social Psychology*, *64*, 72–87.
Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, *9*(2), 1–27.
Zajonc, R. B. (2001). Mere exposure: A gateway to the subliminal. *Current Directions in Psychological Science*, *10*, 224–228.