Social Cognition, Vol. 41, No. 5, 2023, pp. 447–466

THE INFLUENCE OF SOCIAL STATUS ON MEMORY: NO EVIDENCE FOR EFFECTS OF SOCIAL STATUS ON EVENT ELEMENT BINDING

Marcel R. Schreiner
University of Mannheim

Mandy Hütter
Eberhard Karls University of Tübingen

Remembering events coherently requires the binding of their constituting elements in episodic memory. Considering various demonstrations of social motives influencing cognition and preliminary evidence for a facilitating effect of social status on associative memory, we investigated whether social status influences binding processes in episodic memory. Participants were presented with events consisting of a person, an object, and a location, with the status of the person being manipulated. Two experiments yielded no evidence for a facilitating effect of social status on binding processes in episodic memory. These findings suggest that effects of social status are limited to simpler associative memories, as demonstrated by previous research.

Keywords: episodic memory, binding, memory integration, social status, statistical modeling

An experienced event consists of different elements (e.g., a person, an object, and a location, Tulving, 1972, 1983) and these elements need to be bound together to enable the formation of coherent representations in episodic memory. As a consequence of such binding processes, the probability of retrieving an event element should depend on the retrieval of other elements from the same event, leading to a stochastic dependency of the retrieval of event elements (e.g., Arnold et al., 2019; Boywitt & Meiser, 2012a, 2012b; Bröder, 2009; Horner et al., 2015; Horner & Burgess, 2013, 2014; Joensen et al., 2020; Meiser & Bröder, 2002; Schreiner et al., 2023; Starns & Hicks, 2005, 2008). While these binding processes constitute a

Address correspondence to Marcel R. Schreiner, University of Würzburg, Röntgenring 11, 97070 Würzburg, Germany. E-mail: marcel.schreiner@uni-wuerzburg.de

fundamental property of our memory system, little is known about factors influencing these processes.

Previous studies identified a limited number of potential moderators influencing binding processes in episodic memory. James et al. (2020) found that written stimuli facilitate binding compared to pictorial stimuli and that multidimensional stimulus presentation (e.g., presenting stimuli both visually and auditorily) inhibits binding compared to unidimensional stimulus presentation. Awareness regarding the structure and composition of an event (e.g., the number and types of elements that can make up an event) may also facilitate binding (Kumaran & Ludwig, 2013; Morton et al., 2020; Schreiner et al., 2023). In addition, there is evidence that the presence of an animate element in an event can facilitate binding (Schreiner et al., 2023).

In the current research we focus on social status as a potential additional moderator influencing binding processes in episodic memory. There is ample evidence that social motives can exert top-down influences on cognition (e.g., Becker et al., 2005; DeWall & Maner, 2008; Fiske, 2004; Maner et al., 2008). People tend to allocate cognitive resources to the processing of persons with high personal relevance (Fiske, 2004), because such persons are able to exert power (e.g., distribute rewards and punishment) and control one's own outcomes (Fiske, 1993; Neuberg & Fiske, 1987). Thus, a person's social status may be an important cue for the allocation of cognitive resources (cf. Fiske, 1993). Indeed, increased allocation of cognitive resources to and processing advantages for persons of high status (or persons that control one's own outcomes) have been reflected in less stereotypical judgments (Fiske, 1993; Neuberg & Fiske, 1987), attentional bias (DeWall & Maner, 2008; Ratcliff et al., 2011), increased recognition memory for faces and more efficient and holistic encoding of faces (Ratcliff et al., 2011), improved emotion perception (Ratcliff et al., 2012), and improved stimulus-location binding (Ratcliff et al., 2011).

Given the importance of social status in human cognition, it is well conceivable that status also affects the binding of event elements in episodic memory. Specifically, the presence of a person of high status in an event may facilitate the formation of coherent memory representations. It may be important not only to remember persons with high personal relevance and outcome dependency, but also to remember the context such persons are encountered in or the objects such persons interact with, because this may provide insights into the person's intentions or motivational state (cf. Nairne et al., 2017) or aid the identification of persons with high personal relevance in the future. Thus, the presence of a person of high status may facilitate the integration of co-occurring event elements into a common memory representation. Preliminary evidence for this reasoning comes from findings by Ratcliff et al. (2011). In one of their studies, they had participants conduct a matching game in which participants had to report the location of matching face pairs in a set of cards lying face down (participants were initially briefly exposed to all faces). Faces belonged to persons of either high status or low status (manipulated by the displayed persons wearing uniforms implying high or low status). Ratcliff et al. (2011) found improved memory for target locations (indicated by lower error rates) for high-status compared to low-status persons, indicating improved stimulus-location binding. Further preliminary evidence may be derived from findings regarding the animacy effect, which describes the phenomenon that animate stimuli are remembered better than inanimate ones (e.g., Nairne et al., 2013; VanArsdall et al., 2015). This effect is not limited to the animate, but may also extend to inanimate objects touched by the animate (Nairne et al., 2017) and to spatial and temporal information associated with the animate (Gelin et al., 2018). In addition, there is recent evidence suggesting that the presence of an animate element in an event facilitates binding in episodic memory (Schreiner et al., 2023). Animacy effects are commonly explained from an evolutionary perspective: Selective pressure on our ancestors shaped our current memory systems (Nairne et al., 2007, 2008), whereby animacy is an important survival-related factor, as animates may be potential predators, prey, or social agents (Nairne et al., 2013, 2017). Thus, a similar reasoning may be applied to persons of high status, considering outcome dependencies and their possibility to exert power (Fiske, 1993; Neuberg & Fiske, 1987). We thus expected to find a stronger stochastic dependency of the retrieval of event elements for events that include a person of high social status than for events that include a person of low social status. The stochastic dependency of the retrieval of event elements serves as an indicator of binding effects or the degree of memory integration. This is a better indicator than retrieval accuracy for individual event elements or associations, because these are affected by variability in overall memory performance (see also Horner & Burgess, 2013). The operationalization of binding effects in terms of dependency across multiple event elements is capable of separating variations in memory integration from differences in overall memory performance.

We investigated the influence of social status on the binding of event elements in episodic memory in two experiments. Events consisted of a person of high status or low status, an object, and a location. The results from both experiments provided no evidence for an effect of social status on the binding of event elements, indicating no effect of social status on event element binding in episodic memory.

EXPERIMENT 1

In Experiment 1 we tested the hypothesis that there is a stronger stochastic dependency of the retrieval of event elements for events that include a person of high social status than for events that include a person of low social status. The experiment was preregistered at https://osf.io/svqte.

METHODS

Participants

Participants were U.S.-American nationals recruited via Prolific (https://www.prolific.co/) and received a compensation of £2.75. They were prescreened to be native English speakers and to not conduct the study on a smartphone. An a priori power analysis for detecting a medium difference between conditions (difference of 1 in event-specific trait variances according to the statistical procedure, see below and Schreiner et al., 2023; Schreiner & Meiser, 2023; cf. Glas et al., 2000; Wang et al., 2002, assumed baseline event-specific trait variance of 3.5) with 80% power using one-tailed testing yielded a desired sample size of 230 participants. We oversampled by 20%, thus collecting data from 276 participants. All participants provided online informed consent for their participation and publication of their data. One participant was excluded because they processed fewer than three calculations in the filler task. Another nine participants were excluded because they suggested their data should not be used for the analyses (e.g., due to random responding). The final sample therefore consisted of $N = 266$ participants (134 female, 131 male, 1 not wanting to disclose their gender; 45 university students) with a mean age of 38.9 years ($SD = 14.0$, range = 19–79).

Design

The experiment employed a one-factorial (status condition: high status vs. low status) within-participants design.

Material

Stimuli consisted of 72 English nouns: 24 person names, 24 common objects (e.g., *bucket*), and 24 locations (e.g., *castle*). An additional four words from each category were used as primacy buffers, which were shown at the beginning of the learning phase but were not included in the test phase to prevent primacy effects. Objects and locations were taken from James et al. (2020). Person names were randomly generated for two fictitious social groups (*Niffites* and *Luupites*, cf. Van Dessel et al., 2015) based on a corpus of German first names using a random name generator by Twidale (2015). Names were generated to consist of six letters. Half of the names belonged to the group of Niffites and were generated to end with the letter *n* and to contain two consecutive same consonants (e.g., *Emmbin*). Then, the suffix *if* was added to these names (e.g., *Emmbinif*). The other half of the names belonged to the group of Luupites and were generated to end with the letter *l* and to contain two consecutive same vowels (e.g., *Romeel*). Then, the suffix *up* was added to these names (e.g., *Romeelup*).[1] Stimuli were randomly combined to 24 triplets (and 4 primacy buffer triplets) making up the events.

Procedure

The experiment was conducted online and implemented using lab.js (Henninger et al., 2020). Data collection was managed by JATOS (Lange et al., 2015). Participants were informed about a (fictitious) country named Ulse, which was organized in a strict hierarchical societal system. They were told that two groups of people lived in this country (Niffites and Luupites, cf. Van Dessel et al., 2015) and

1. The following other settings were used for the random name generator: Order = 3, prior = 0.01, words to generate = 100, max processing time = 5,000.

that one group formed the social upper and the other group formed the social lower class. Which of the two groups formed the upper or lower class was randomly chosen for each participant. Events containing a name belonging to the upper class were assigned to the high-status condition. Events containing a name belonging to the lower class were assigned to the low-status condition. Thus, each condition contained 12 events and 2 primacy buffer events. Additionally, participants were told that only members of the group forming the upper class were allowed to practice professions such as politician, lawyer, and doctor, whereas the members of the group forming the lower class typically practiced professions such as cleaner, janitor, and miner. These professions were taken from Koch et al. (2016) and selected based on associations with high agency and socioeconomic success or low agency and socioeconomic success, respectively, in a U.S. sample (see also Carrier et al., 2014; Conway et al., 1996, for the relation between agency and status perception). Participants were then informed that the two groups followed different naming conventions and that the names of Niffites ended with *nif* and the names of Luupites ended with *lup*. Participants then conducted a test consisting of four questions regarding the assignment of groups to high status or low status and regarding the name-giving conventions. They had to reread the information and repeat the test until they answered all questions correctly. On average, participants required 1.09 (maximum = 3) trials to answer all questions correctly. Participants were then informed that they would be presented three words, one of which would be the name of a person belonging to either the group of Niffites or the group of Luupites (distinguishable by the person's name) and the other words would be objects and locations. They were then instructed to imagine these words as elements of a scene, to try to imagine the scene as vividly as possible, and to imagine the elements of the scene to interact with one another in a meaningful manner.

The main part of the experiment was based on the simultaneous encoding paradigm (Horner & Burgess, 2013) and consisted of a learning phase, a filler phase, and a test phase. In the learning phase, participants were presented the three elements (i.e., words) making up an event in a triangular array. The screen position of each element (i.e., top, left, or right) was randomized for each event. Each trial consisted of a 0.5 s fixation cross, a 6 s presentation of the event elements, and a 1.5 s blank screen (see Figure 1A). Primacy buffer events were presented at the beginning of the learning phase to prevent primacy effects, but were not used in the later test phase. After half of the learning trials (not counting primacy buffer events), participants had to click on a button to continue with the experiment to ensure they stayed attentive during the experiment. After the learning phase, participants again conducted a test consisting of two questions regarding the assignment of groups to high status or low status as a manipulation check. On average, participants scored 1.97 out of 2 points (SD = 0.24). In the subsequent filler phase, participants were to solve randomly generated arithmetic tasks for 2 minutes to prevent recency effects.

In the following test phase, participants conducted an incidental six-alternative forced-choice (6-AFC) cued recognition test. Each test trial consisted of a 0.5 s

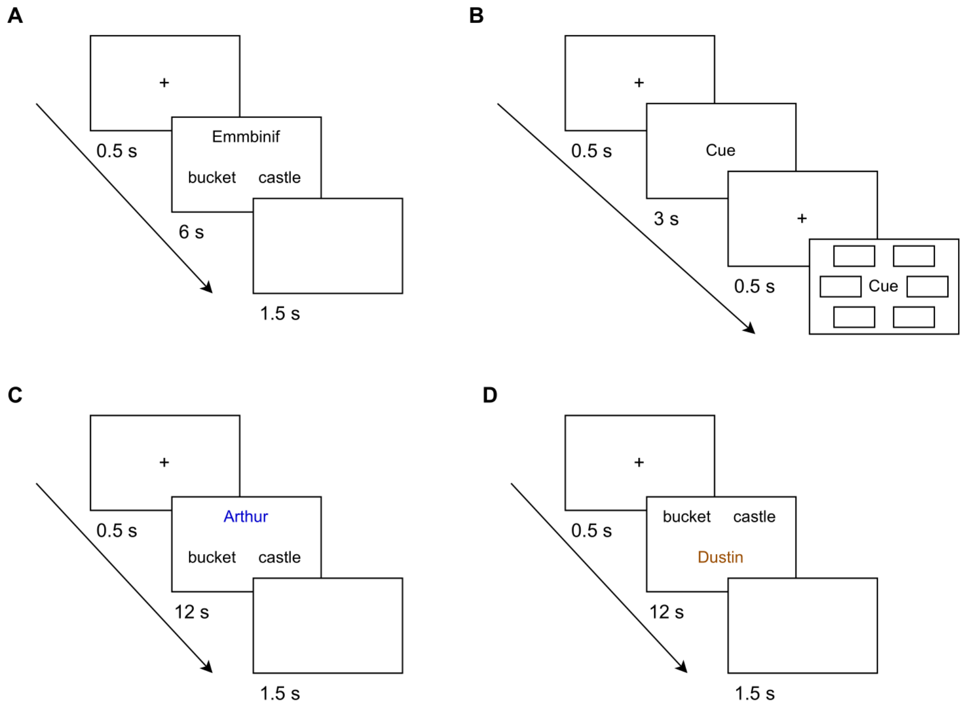

FIGURE 1. Experimental procedure. (A) Exemplary learning trial in Experiment 1, (B) Schematic depiction of a test trial, (C) Exemplary learning trial in the high-status condition of Experiment 2, (D) Exemplary learning trial in the low-status condition of Experiment 2

fixation cross, a 3 s presentation of the cue word, which was one of the words presented in the learning phase, in the screen center, and another 0.5 s fixation cross. This was followed by the actual 6-AFC cued recognition test, in which the cue word was again displayed in the screen center, being surrounded by six response alternatives in a hexagonal array (see Figure 1B). One of the response alternatives was the target word, which belonged to the same event as the cue word (i.e., was shown together with the cue word in the learning phase), and participants were instructed to select this response alternative. All of the response alternatives were of the same element type (e.g., all objects; for names stimuli response alternatives could consist of both names of Niffites and Luupites). Distractors were randomly drawn from other events. For each event, each association (i.e., person–object, person–location, or object–location) was tested, but only in one direction to avoid testing effects. Thus, for example, the cue-target pairs person–object or object–person were used for a given event, but not both. The direction tested was balanced across events within each experimental condition. This resulted in three test trials per event, with each element type serving as cue and target equally often across events. The test phase consisted of three blocks, in each of which one randomly assigned association per event was tested. Within each block, the order of test trials was randomized.

Data Analysis

All analyses were conducted in the R Programming Environment (R Core Team, 2021) and we used the R packages *papaja* (version 0.1.0.9997, Aust & Barth, 2020) and *tinylabels* (version 0.2.2, Barth, 2021) for reporting.

Exploratory Analysis of Memory Performance. For analyzing memory performance, we fit Bayesian generalized mixed linear models with a logit link function (Goldstein, 2011; Rouder & Lu, 2005) to the data. The outcomes of the 6-AFC cued recognition test (1 if the target was selected, 0 if one of the distractors was selected) served as the binary dependent variable. Thus, individual trial information, instead of aggregated information, was used as model input (see Hoffman & Rovine, 2007). We examined effects of status condition, association, and the interaction, which served as independent variables in the model. We also included random person intercepts to account for repeated measurement. We evaluated the effect of each predictor by computing Bayes factors in favor of an effect (BF_{10}). These were computed via nested model comparisons. To evaluate the main effects, we compared a model including the respective predictor (status condition or association) with a null model including only fixed and random person intercepts. To evaluate the interaction effect, we compared the full model including both main effects and the interaction with a baseline model including both main effects but no interaction. A Bayes factor > 1 provides evidence in favor of an effect, whereas a Bayes factor < 1 provides evidence in favor of the absence of an effect (Jeffreys, 1961).

Models were fit and Bayes factors were computed using the package *brms* (version 2.16.4, Bürkner, 2017, 2018) using a standard normal prior for fixed effects and a half Student-*t* prior (the package default) for random effects. As a robustness check, we additionally computed Bayes factors based on models with less informative normal priors ($SD = 4$) and more informative normal priors ($SD = 0.25$) for the fixed effects. We report Bayes factors in the form $BF_{10}^{SD=1}$ [$BF_{10}^{SD=4}$, $BF_{10}^{SD=0.25}$]. Models were fit using 4 Markov chains and 30,000 iterations per chain, the first 15,000 of which were discarded as burnin iterations. The package *emmeans* (version 1.7.2, Lenth, 2022) was used for post-hoc pairwise comparisons.

Dependency Analysis. For analyzing the stochastic dependency of the retrieval of event elements, we used the approach by Schreiner et al. (2023) and Schreiner and Meiser (2023), which is based on item response theory (IRT, Lord, 1980; Lord & Novick, 1968) and uses the Q_3 statistic (Yen, 1984) with a bias correction (Yen, 1993). Items[2] were ordered by condition, event, and association. Using a simplified three-parameter logistic (3PL) IRT model (cf. Birnbaum, 1968), the approach utilizes binding-induced violations of the local independence assumption inherent in this model, which states that item responses are independent after partialing out the latent trait (de Ayala, 2009; Lazarsfeld & Henry, 1968), which is memory performance in the current model application. We set the guessing parameter equal to

2. In the context of the current research, an item refers to the binary outcome of a test trial in the 6-AFC cued recognition test (0 = distractor selected, 1 = target selected).

the stochastic guessing probability of $\frac{1}{6}$ given six response alternatives in the cued recognition test. One-tailed p values were computed using parametric bootstrapping (cf. Schreiner et al., 2023; Schreiner & Meiser, 2023). Two bootstraps were conducted, one to test whether dependency estimates in the two groups significantly differ from zero and one to test whether dependency estimates in the two groups significantly differ from each other. For the first bootstrap, data was repeatedly sampled from a simplified 3PL IRT model. Person parameters were drawn from a normal distribution with a mean of zero and the variance estimated from the data. Item parameters were estimated from the data. For the second bootstrap, data was repeatedly sampled from a bifactor IRT model (see Gibbons & Hedeker, 1992; Wainer & Wang, 2000). Person parameters were drawn from a multivariate normal distribution with zero means and variances estimated from the data. Item parameters were estimated from the data.

We used the package *mirt* (version 1.35.1, Chalmers, 2012) and adapted functions from the package *sirt* (version 3.9-4, Robitzsch, 2020) for the dependency analysis. The package *SimDesign* (version 2.8, Chalmers & Adkins, 2020) was used for conducting the parametric bootstraps and we used 1,000 bootstrap samples for each bootstrap (cf. Davison & Hinkley, 1997). We used the conventional significance level of $\alpha = .05$ for the dependency analysis.

RESULTS

Memory Performance

The average proportion of correct responses was 0.30 ($SD = 0.46$) in the high-status condition and 0.29 ($SD = 0.46$) in the low-status condition. Figure 2 shows a raincloud plot (Allen et al., 2021) depicting the proportion of correct responses per participant. According to the Bayesian generalized mixed linear model analysis, there was evidence against a main effect of status condition ($BF_{10} = 0.06$ [0.02, 0.25]), but evidence for a main effect of association ($BF_{10} = 1.13 \times 10^{203}$ [1.22×10^{202}, 4.35×10^{200}]). The average proportion of correct responses by association was 0.23 ($SD = 0.42$) for the association person–object, 0.23 ($SD = 0.42$) for person–location, and 0.44 ($SD = 0.50$) for object–location. Post-hoc pairwise comparisons revealed that associations involving a person (person–object and person–location) were retrieved less likely than the association object–location, indicated by the 95% credible intervals not including zero (log odds ratio [log OR] = −1.07, 95% CI = [−1.15, −0.99] and log OR = −1.07, 95% CI = [−1.15, −0.99], respectively). The likelihood of retrieving the associations person–object and person–location did not differ (log OR = 0.00, 95% CI = [−0.09, 0.09]). There was evidence against an interaction of status condition and association ($BF_{10} = 0.009$ [5.45×10^{-4}, 0.16]).

Dependency. The dependency of the retrieval of event elements is depicted in Figure 3. There was a significant positive dependency in both the high-status ($D = 0.04$, $SE = 0.01$, $p < .001$) and the low-status ($D = 0.05$, $SE = 0.01$, $p < .001$) conditions. The dependency in the high-status condition was not significantly

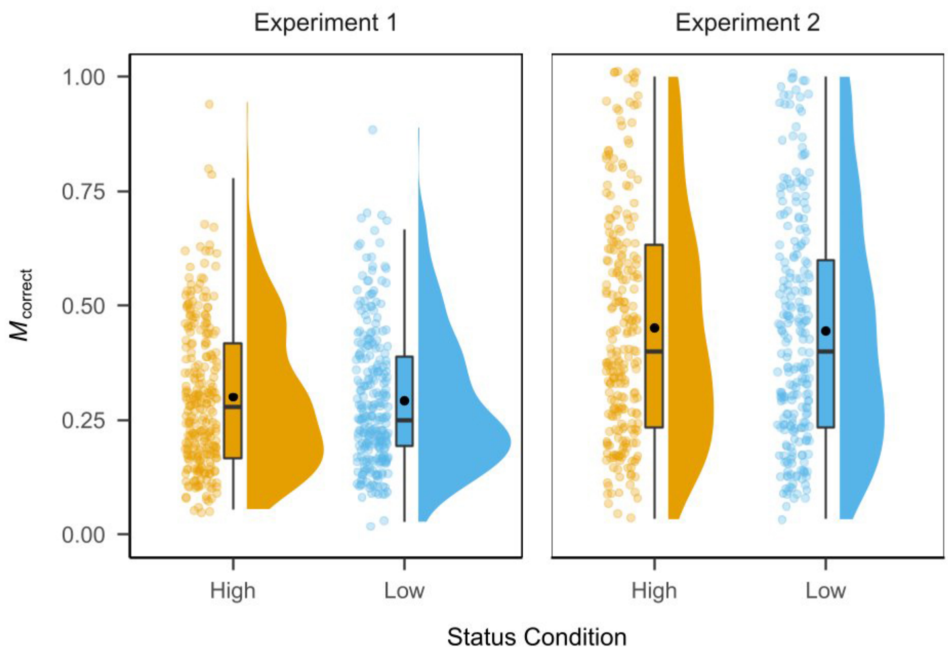

FIGURE 2. Raincloud plot depicting the proportion of correct responses per participant by status condition in Experiments 1 and 2. Black dots depict the mean across participants.

larger than the dependency in the low-status condition (D_{diff} = 0.00, *SE* = 0.02, *p* = .58).

DISCUSSION

In Experiment 1 we found evidence for successful binding in both the high-status and the low-status condition. However, the dependency in the high-status condition was not higher than the one in the low-status condition. Thus, there was no evidence supporting the hypothesis. Specifically, the results indicate no facilitating effect of social status on the binding of event elements in episodic memory. It is noteworthy that memory for associations involving a person was quite poor and considerably lower than for the object–location association. This may be caused by the quite artificial person names used and may be problematic, as our status manipulation targeted persons. The null result regarding the difference in dependency between status conditions could thus be attributed to poor performance regarding the stimuli on which the experimental manipulation was targeted. In Experiment 2 we implemented a number of changes intended to increase memory performance, particularly for associations including a person. Higher memory

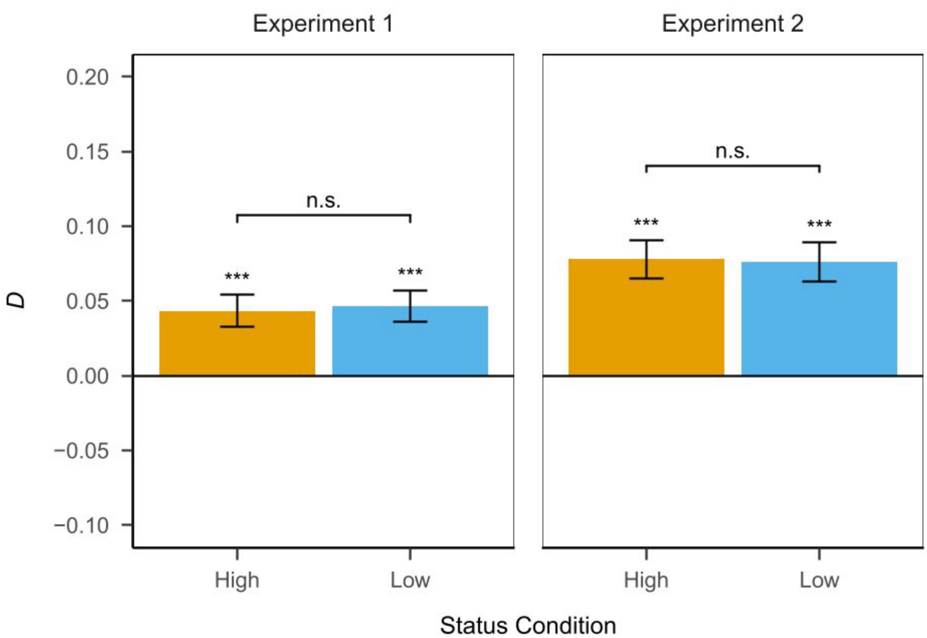

FIGURE 3. Dependency of the retrieval of event elements by status condition in Experiments 1 and 2. ***$p < .001$. n.s. = nonsignificant. Error bars represent ± *SE*.

performance is also associated with an increased power for detecting effects (see Schreiner & Meiser, 2023).

EXPERIMENT 2

In Experiment 2 we again investigated the hypothesis that there is a stronger stochastic dependency of the retrieval of event elements for events that include a person of high social status than for events that include a person of low social status, but we implemented a number of changes to increase memory performance. First, we adapted the status manipulation. Instead of using randomly generated person names belonging to different groups (cf. Van Dessel et al., 2015), we used U.S. first names and indicated social status via their vertical position (cf. Schubert, 2005) on the screen and their font color. Second, we used an intentional instead of an implicit memory test. Third, we asked participants to generate jobs they associate with high status or low status to increase imaginability in the learning phase. Fourth, we increased the presentation duration in the learning phase. Fifth, we slightly reduced the number of presented events. Finally, we reduced the duration of the filler phase. Switching from artificial groups to U.S.-American first names additionally excluded a possible alternative explanation of the null-effects obtained in Experiment 1. Namely, one may argue that the use of artificial groups renders social status of the target persons irrelevant to the self, and thus, inconsequential for binding. Experiment 2 thereby also served the evaluation of the generalizability of the findings of Experiment 1. The experiment was preregistered at https://osf.io/bsg7a.[3]

METHODS

Participants

Participants were U.S.-American nationals recruited via Prolific (https://www.prolific.co/) and received a compensation of £3.38. They were prescreened to be native English speakers, to not conduct the study on a smartphone, and to not have participated in previous experiments. An a priori power analysis for detecting a small to medium difference between conditions (difference of 0.75 in event-specific trait variances according to the statistical procedure, cf. Glas et al., 2000; Wang et al., 2002, assumed baseline event-specific trait variance of 2.5)[4] with 80% power using one-tailed testing yielded a desired sample size of 210 participants. We oversampled by 20%, thus collecting data from 252 participants. All participants provided online informed consent for their participation and publication of their data. Seven participants were excluded because they processed fewer than two calculations in the filler task. Another four participants were excluded because they suggested their data should not be used for the analyses (e.g., due to reduced memory functioning). The final sample therefore consisted of $N = 241$ participants (118 female, 120 male, 3 nonbinary; 24 university students) with a mean age of 41.5 years ($SD = 13.5$, range = 18–78).

Design

The design was identical to the one of Experiment 1. The experiment thus employed a one-factorial (status condition: high status vs. low status) within-participants design.

Material

Stimuli consisted of 60 nouns: 20 person names, 20 common objects, and 20 locations. An additional two words from each category were used as primacy buffers. Objects and locations were a subset of those used in Experiment 1. Person names were male U.S.-American first names (e.g., *Arthur*) taken from Barlow and Lahey (2018), Joubert (1994), and Lieberson and Bell (1992). The names were split into

3. The experiment reported as Experiment 2 was preregistered as Experiment 4. We conducted two additional experiments (Experiments 3 and 4, preregistered as Experiments 2 and 3), which are not reported here, in which we tested an additional hypothesis. However, these experiments yielded uninformative results. Their data, as well as information about their methods and results, are available via the OSF (https://osf.io/q5c4h).

4. We reduced the assumed baseline event-specific trait variance based on the results of Experiment 1.

two sets of equal size based on their perceived status (see Barlow & Lahey, 2018; Joubert, 1994; Lieberson & Bell, 1992). Names with perceived high status were used in the high-status condition and names with perceived low status were used in the low-status condition. Stimuli were then randomly combined to 20 triplets (and 2 primacy buffer triplets) making up the events. Thus, each condition consisted of 10 events and 1 primacy buffer event.

Procedure

The procedure was identical to Experiment 1 with the following exceptions: Instead of introducing the groups of Niffites and Luupites, participants were informed that the names of persons belonging to the social upper class would be presented at the top and were written in blue color (see Figure 1C), and that the names of persons belonging to the social lower class would be presented at the bottom and were written in brown color (see Figure 1D). Participants then conducted a test consisting of four questions regarding the position and font color of person names belonging to the upper and lower class. They had to reread the information and repeat the test until they answered all questions correctly. On average, participants required 1.05 (maximum = 3) trials to answer all questions correctly. Next, participants were given 1 minute to report jobs they associated with high social status and with low social status by entering them in either an upper text field with a blue frame (for high status) or a lower text field with a brown frame (for low status). This was intended to increase the imaginability of scenes in the learning phase. In the learning phase, the presentation duration of event elements was increased from 6 s to 12 s. Thus, each trial consisted of a 0.5 s fixation cross, a 12 s presentation of event elements, and a 1.5 s blank screen. The names of persons of high status were presented at the top and the names of persons of low status were presented at the bottom, thus being consistent with the association between vertical position and status (Schubert, 2005). In addition, the names of persons of high status were presented with blue font color and the names of persons with low status were presented with brown font color. Colors were selected based on their associations with status (see Grieve, 1991). The horizontal screen position (left or right) of the object and location were randomized. There was no test regarding group assignment at the end of the learning phase. The duration of the filler phase was reduced from 2 minutes to 1 minute. In the test phase, distractors for a given trial could consist of names of persons of both high status and low status. Names in the test phase were presented with the same font color as in the learning phase.

RESULTS

Memory Performance

The average proportion of correct responses was 0.45 (SD = 0.50) in the high-status condition and 0.44 (SD = 0.50) in the low-status condition. The proportion of correct responses per participant is depicted in Figure 1. According to the Bayesian generalized mixed linear model analysis, there was evidence against a main effect of status condition (BF_{10} = 0.05 [0.01, 0.22]), but evidence for a main effect of association ($BF_{10} = 1.13 \times 10^{114}$ [1.07×10^{113}, 2.43×10^{112}]). The average proportion of correct responses by association was 0.39 (*SD* = 0.49) for the association person–object, 0.39 (*SD* = 0.49) for person–location, and 0.57 (*SD* = 0.50) for object–location. Post-hoc pairwise comparisons revealed that associations involving a person (person–object and person–location) were retrieved less likely than the association object–location, indicated by the 95% credible intervals not including zero (log OR = −0.96, 95% CI = [−1.05, −0.86] and log OR = −0.93, 95% CI = [−1.02, −0.84], respectively). The likelihood of retrieving the associations person–object and person–location did not differ (log OR = −0.03, 95% CI = [−0.12, 0.07]). There was evidence against an interaction of status condition and association (BF_{10} = 0.01 [8.20×10^{-4}, 0.33]).

Dependency

The dependency of the retrieval of event elements is depicted in Figure 2. There was a significant positive dependency in both the high-status (D = 0.08, SE = 0.01, $p < .001$) and the low-status (D = 0.08, SE = 0.01, $p < .001$) conditions. The dependency in the high-status condition was not significantly larger than the dependency in the low-status condition (D_{diff} = 0.00, SE = 0.02, p = .49).

DISCUSSION

In Experiment 2 we replicated the findings of Experiment 1. We again found evidence for successful binding in both the high-status and the low-status condition, but not a higher dependency in the high-status than in the low-status condition. Thus, there was again no evidence supporting the hypothesis so that the results indicate no facilitating effect of social status on the binding of event elements in episodic memory. Importantly, we succeeded in increasing memory performance in Experiment 2 compared to Experiment 1, both overall and for the associations including a person. Memory performance was, for example, comparable to performances in Schreiner et al. (2023). While associations including a person were still retrieved less likely than object–location associations, memory performance for these associations was sufficiently high. Thus, the null results can likely not be attributed to poor performance regarding the stimuli on which the experimental manipulation was based.

GENERAL DISCUSSION

We investigated whether social status influences the binding of event elements in episodic memory in two experiments. The results of the current research provide evidence in favor of the absence of an effect of social status on the binding of event elements. Specifically, the presence of a person of high social status in an event did not facilitate binding compared to the presence of a person of low social status in an event. Therefore, the results of the current research suggest that social status is not a moderator of binding processes in episodic memory and does not influence the coherence of memory representations being formed.

These findings are at odds with findings by Ratcliff et al. (2011), who found improved binding of stimuli to target locations for persons of high social status compared to low social status, suggesting an effect of social status on associative memory. It seems that this advantage does not extend to more complex event-based representations, which were the focus of the current research. Thus, effects of social status may be limited to simpler associative memories or item-based representations. Item-based representations (see also the source memory literature, e.g., Johnson et al., 1993; Meiser & Bröder, 2002; Starns & Hicks, 2005, 2008) only consist of a single element with specific features, are static, and contain more specific information than more complex event-based representations (Hunt & Einstein, 1981), which can consist of multiple, possibly interacting, event elements, making these representations potentially dynamic (see also Rubin & Umanath, 2015; for a discussion of differences between item- and event-based representations see also Andermane et al., 2021; Joensen et al., 2020; Schreiner et al., 2023).

Thus, our results suggest that social status does not affect the integration of a broader event-specific context into coherent memory representations. Its influence may therefore be limited to the features associated with persons of high social status or low social status. As an explanation for the contamination effect regarding animacy (i.e., improved memory for objects touched by an animate), which may also facilitate binding in episodic memory (Schreiner et al., 2023), it has been suggested that remembering the context in which one encountered an agent and the objects an agent interacted with, is important because it can provide insights into the agents' intentions or motivational state (Nairne et al., 2017). The results of the current research suggest that this reasoning likely does not extend to social status.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

A limitation of the current research is the rather artificial manipulation of social status and the setting of the experiments in which participants were presented three words and were instructed to imagine them as part of a scene and interacting in a meaningful manner. However, this setting is very similar to the one of previous studies investigating binding effects in episodic memory (e.g., Horner & Burgess, 2013; James et al., 2020; Joensen et al., 2020; Schreiner et al., 2023) and we indeed found evidence for successful binding in both experiments. In addition, our status manipulations were informed by previous studies (for Experiment 1 see Van Dessel et al., 2015; for Experiment 2 see Barlow & Lahey, 2018; Grieve, 1991; Joubert, 1994; Lieberson & Bell, 1992; Schubert, 2005), and the results of the retention test after the learning phase in Experiment 1 suggest that participants were able to retain the relevant information for the status manipulation over the course of the learning phase. We therefore do not think that the rather artificial status manipulation and experimental setting invalidate our results. Nevertheless, it may be worthwhile to investigate effects of social status on the binding of event elements in episodic memory in a more naturalistic setting to increase ecological validity.

Ecological validity may be increased by increasing the social relevance of the person stimuli for the participants. While we attempted to address this issue in Experiment 2, in which we used natural first names instead of artificial names as in Experiment 1, social relevance of the person stimuli was arguably still likely to be low for the participants. One way to increase social relevance may be to use famous persons as stimuli, for example well-known politicians in the participants' country of residence. A possible problem with this approach could be however, that this may induce an asymmetry in familiarity between the high-status condition and the low-status condition, as person stimuli used in the low-status condition are likely to be less known in this case, which may affect the results. Ecological validity may be further increased by using different modalities of stimulus presentation that more closely approximate naturalistic settings, such as images or videos. For example, Ratcliff et al. (2011) used face images and manipulated social status using uniforms. However, James et al. (2020) found that the use of images as stimuli resulted in smaller binding effects compared to written stimuli. This may be the case, because the use of images interferes with participants' ability to engage in mental imagery. The same problem may therefore also occur with videos, although one may argue that mental imagery is less important for videos, in which elements can be shown to interact and a scene can unfold over time. Nevertheless, the use of different stimulus modalities may allow researchers to manipulate social status in a manner that is more relevant for the participants, while simultaneously providing a more naturalistic setting. Attempting to replicate the current results with different stimulus modalities and suitable associated status manipulations (e.g., uniforms or other kinds of clothing, jewelry, or royal insignia) therefore seems to be a useful endeavor for future research.

An interesting avenue for future research concerns the moderating role of the social status of the perceiver. That is, research into stereotyping has shown that people of low social status pay more attention to people of high social status, with the result that high-status persons are perceived in an individualized rather than stereotypic manner (Fiske, 1993). From these findings, the question arises whether participants of low social status would demonstrate the interaction effect proposed in the present research.

Finally, social status could have a nonlinear effect on event element binding because individuals of extremely high status may draw cognitive resources (e.g., visual attention) to such an extent that remaining resources are insufficient to properly encode other event elements. In that sense, the presence of individuals of extremely high status could have similarly disrupting effects on the binding of event elements as the presence of an element of negative emotional valence (Bisby et al., 2018). While it is unlikely that our status manipulations resulted in the extreme status perceptions that may be necessary for such disrupting effects to occur, the possibility of a nonlinear effect of social status on event element binding could be explored in future research by gradually manipulating social status, including instances of very high status.

CONCLUSION

We investigated whether social status influences binding processes in episodic memory. In two experiments, we tested whether the presence of a person of high status in an event facilitates binding compared to the presence of a person of low status in an event. The results from both experiments yielded no evidence for a moderating role of social status in the binding of event elements in episodic memory. Social status therefore does not seem to affect memory integration in event-based episodic representations.

Data availability. The designs, hypotheses, and analysis plans of all experiments were preregistered (Experiment 1: https://osf.io/svqte, Experiment 2: https://osf.io/5qbpz). All data, materials, and analysis scripts are provided via the Open Science Framework (https://osf.io/q5c4h).

Acknowledgments. The authors thank Timo Seitz for assisting in the literature search, Rabea Krone and Cosima Engel for assisting in the stimulus generation, and Alicia Gernand, Timo Seitz, Eva Pöhlmann, Bastian Schnieders, Rabea Krone, Coralie Notarbartolo Pfeifer, and Marie Mundt for assisting in testing the experiments.

Funding statement. This research was funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under grant GRK 2277 "Statistical Modeling in Psychology."

Declaration of interest. The authors have no conflicts of interest to declare.

REFERENCES

Allen, M., Poggiali, D., Whitaker, K., Marshall, T. R., Langen, J. van, & Kievit, R. A. (2021). Raincloud plots: A multi-platform tool for robust data visualization. *Wellcome Open Research*, *4*, 63. https://doi.org/10.12688/wellcomeopenres.15191.2

Andermane, N., Joensen, B. H., & Horner, A. J. (2021). Forgetting across a hierarchy of episodic representations. *Current Opinion in Neurobiology*, *67*, 50–57. https://doi.org/10.1016/j.conb.2020.08.004

Arnold, N. R., Heck, D. W., Bröder, A., Meiser, T., & Boywitt, C. D. (2019). Testing hypotheses about binding in context memory with a hierarchical multinomial modeling approach: A preregistered study. *Experimental Psychology*, *66*(3), 239–251. https://doi.org/10.1027/1618-3169/a000442

Aust, F., & Barth, M. (2020). papaja: Prepare reproducible APA journal articles with R Markdown. R package version 0.1.0.9997. https://github.com/crsh/papaja

Barlow, M. R., & Lahey, J. N. (2018). What race is Lacey? Intersecting perceptions of racial minority status and social class. *Social Science Quarterly*, *99*(5), 1680–1698. https://doi.org/10.1111/ssqu.12529

Barth, M. (2021). tinylabels: Lightweight variable labels. R package version 0.2.2. https://cran.r-project.org/package=tinylabels

Becker, D. V., Kenrick, D. T., Guerin, S., & Maner, J. K. (2005). Concentrating on beauty: Sexual selection and sociospatial memory. *Personality and Social Psychology Bulletin*, *31*(12), 1643–1652. https://doi.org/10.1177/0146167205279583

Birnbaum, A. (1968). Some latent trait models and their use in inferring an examinee's ability. In F. M. Lord & M. R. Novick (Eds.), *Statistical theories of mental test scores* (pp. 397–479). Addison-Wesley.

Bisby, J. A., Horner, A. J., Bush, D., & Burgess, N. (2018). Negative emotional content disrupts the coherence of episodic memories. *Journal of Experimental Psychology: General*, *147*(2), 243–256. https://doi.org/10.1037/xge0000356

Boywitt, C. D., & Meiser, T. (2012a). Bound context features are integrated at encoding. *Quarterly Journal of Experimental Psychology*, *65*(8), 1484–1501. https://doi.org/10.1080/17470218.2012.656668

Boywitt, C. D., & Meiser, T. (2012b). The role of attention for context-context binding of intrinsic and extrinsic features. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*(4), 1099–1107. https://doi.org/10.1037/a0026988

Bröder, A. (2009). Semantically clustered words are stored with integrated context: Validating a measurement model for source memory, storage, and retrieval in free recall. *Zeitschrift Für Psychologie/Journal of Psychology*, *217*(3), 136–148. https://doi.org/10.1027/0044-3409.217.3.136

Bürkner, P.-C. (2017). brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software*, *80*, 1–28. https://doi.org/10.18637/jss.v080.i01

Bürkner, P.-C. (2018). Advanced Bayesian multilevel modeling with the R package brms. *The R Journal*, *10*(1), 395–411. https://doi.org/10.32614/RJ-2018-017

Carrier, A., Louvet, E., Chauvin, B., & Rohmer, O. (2014). The primacy of agency over competence in status perception. *Social Psychology*, *45*(5), 347–356. https://doi.org/10.1027/1864-9335/a000176

Chalmers, R. P. (2012). mirt: A multidimensional item response theory package for the R environment. *Journal of Statistical Software*, *48*(6), 1–29. https://doi.org/10.18637/jss.v048.i06

Chalmers, R. P., & Adkins, M. C. (2020). Writing effective and reliable Monte Carlo simulations with the SimDesign package. *Quantitative Methods for Psychology*, *16*(4), 248–280. https://doi.org/10.20982/tqmp.16.4.p248

Conway, M., Pizzamiglio, M. T., & Mount, L. (1996). Status, communality, and agency: Implications for stereotypes of gender and other groups. *Journal of Personality and Social Psychology*, *71*(1), 25–38. https://doi.org/10.1037/0022-3514.71.1.25

Davison, A. C., & Hinkley, D. V. (1997). *Bootstrap methods and their application*. Cambridge University Press.

de Ayala, R. J. (2009). *The theory and practice of item response theory.* Guilford Press.

DeWall, C. N., & Maner, J. K. (2008). High status men (but not women) capture the eye of the beholder. *Evolutionary Psychology*, *6*(2), 147470490800600. https://doi.org/10.1177/147470490800600209

Fiske, S. T. (1993). Controlling other people: The impact of power on stereotyping. *American Psychologist*, *48*(6), 621–628. https://doi.org/10.1037/0003-066x.48.6.621

Fiske, S. T. (2004). Intent and ordinary bias: Unintended thought and social motivation create casual prejudice. *Social Justice Research*, *17*(2), 117–127. https://doi.org/10.1023/B:SORE.0000027405.94966.23

Gelin, M., Bonin, P., Méot, A., & Bugaiska, A. (2018). Do animacy effects persist in memory for context? *Quarterly Journal of Experimental Psychology*, *71*(4), 965–974. https://doi.org/10.1080/17470218.2017.1307866

Gibbons, R. D., & Hedeker, D. R. (1992). Full-information item bi-factor analysis. *Psychometrika*, *57*(3), 423–436. https://doi.org/10.1007/bf02295430

Glas, C. A. W., Wainer, H., & Bradlow, E. T. (2000). MML and EAP estimation in testlet-based adaptive testing. In W. J. van der Linden & C. A. W. Glas (Eds.), *Computerized adaptive testing: Theory and practice* (pp. 271–287). Kluwer.

Goldstein, H. (2011). *Multilevel statistical models* (4th ed.). Wiley.

Grieve, K. W. (1991). Traditional beliefs and colour perception. *Perceptual and Motor Skills*, *72*(3_suppl), 1319–1323. https://doi.org/10.2466/pms.1991.72.3c.1319

Henninger, F., Shevchenko, Y., Mertens, U., Kieslich, P. J., & Hilbig, B. E. (2020). lab.js: A free, open, online study builder.

https://doi.org/10.5281/zenodo.597045

Hoffman, L., & Rovine, M. J. (2007). Multilevel models for the experimental psychologist: Foundations and illustrative examples. *Behavior Research Methods*, *39*(1), 101–117. https://doi.org/10.3758/BF03192848

Horner, A. J., Bisby, J. A., Bush, D., Lin, W.-J., & Burgess, N. (2015). Evidence for holistic episodic recollection via hippocampal pattern completion. *Nature Communications*, *6*(1), 7462. https://doi.org/10.1038/ncomms8462

Horner, A. J., & Burgess, N. (2013). The associative structure of memory for multielement events. *Journal of Experimental Psychology: General*, *142*(4), 1370–1383. https://doi.org/10.1037/a0033626

Horner, A. J., & Burgess, N. (2014). Pattern completion in multielement event engrams. *Current Biology*, *24*(9), 988–992. https://doi.org/10.1016/j.cub.2014.03.012

Hunt, R. R., & Einstein, G. O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, *20*(5), 497–514. https://doi.org/10.1016/S0022-5371(81)90138-9

James, E., Ong, G., Henderson, L., & Horner, A. J. (2020). Make or break it: Boundary conditions for integrating multiple elements in episodic memory. *Royal Society Open Science*, *7*(9), 200431. https://doi.org/10.1098/rsos.200431

Jeffreys, H. (1961). *Theory of probability* (3rd ed.). Clarendon Press.

Joensen, B. H., Gaskell, M. G., & Horner, A. J. (2020). United we fall: All-or-none forgetting of complex episodic events. *Journal of Experimental Psychology: General*, *149*(2), 230–248. https://doi.org/10.1037/xge0000648

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, *114*(1), 3–28. https://doi.org/10.1037//0033-2909.114.1.3

Joubert, C. E. (1994). Relation of name frequency to the perception of social class in given names. *Perceptual and Motor Skills*, *79*(1), 623–626. https://doi.org/10.2466/pms.1994.79.1.623

Koch, A., Imhoff, R., Dotsch, R., Unkelbach, C., & Alves, H. (2016). The ABC of stereotypes about groups: Agency/socioeconomic success, conservative-progressive beliefs, and communion. *Journal of Personality and Social Psychology*, *110*(5), 675–709. https://doi.org/10.1037/pspa0000046

Kumaran, D., & Ludwig, H. (2013). Transitivity performance, relational hierarchy knowledge and awareness: Results of an instructional framing manipulation. *Hippocampus*, *23*(12), 1259–1268. https://doi.org/10.1002/hipo.22163

Lange, K., Kühn, S., & Filevich, E. (2015). "Just another tool for online studies" (JATOS): An easy solution for setup and management of web servers supporting online studies. *PLoS One*, *10*(6), e0130834. https://doi.org/10.1371/journal.pone.0130834

Lazarsfeld, P. F., & Henry, N. W. (1968). *Latent structure analysis*. Houghton Mifflin.

Lenth, R. (2022). emmeans: Estimated marginal means, aka least-squares means. R package version 1.7.2. https://cran.r-project.org/package=emmeans

Lieberson, S., & Bell, E. O. (1992). Children's first names: An empirical study of social taste. *American Journal of Sociology*, *98*(3), 511–554. https://doi.org/10.1086/230048

Lord, F. M. (1980). *Applications of item response theory to practical testing problems*. Erlbaum.

Lord, F. M., & Novick, M. R. (1968). *Statistical theories of mental test scores*. Addison-Wesley.

Maner, J. K., DeWall, C. N., & Gailliot, M. T. (2008). Selective attention to signs of success: Social dominance and early stage interpersonal perception. *Personality and Social Psychology Bulletin*, *34*(4), 488–501. https://doi.org/10.1177/0146167207311910

Meiser, T., & Bröder, A. (2002). Memory for multidimensional source information. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *28*(1), 116–137. https://doi.org/10.1037//0278-7393.28.1.116

Morton, N. W., Schlichting, M. L., & Preston, A. R. (2020). Representations of common event structure in medial temporal lobe and frontoparietal cortex support efficient inference. *Proceedings of the National Academy of Sciences*, *117*(47), 29338–29345. https://doi.org/10.1073/pnas.1912338117

Nairne, J. S., Pandeirada, J. N. S., & Thompson, S. R. (2008). Adaptive memory: The comparative value of survival processing. *Psychological Science*, *19*(2), 176–180. https://doi.org/10.1111/j.1467-9280.2008.02064.x

Nairne, J. S., Thompson, S. R., & Pandeirada, J. N. S. (2007). Adaptive memory: Survival processing enhances retention. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(2), 263–273. https://doi.org/10.1037/0278-7393.33.2.263

Nairne, J. S., VanArsdall, J. E., & Cogdill, M. (2017). Remembering the living: Episodic memory is tuned to animacy. *Current Directions in Psychological Science*, *26*(1), 22–27. https://doi.org/10.1177/0963721416667711

Nairne, J. S., VanArsdall, J. E., Pandeirada, J. N. S., Cogdill, M., & LeBreton, J. M. (2013). Adaptive memory: The mnemonic value of animacy. *Psychological Science*, *24*(10), 2099–2105. https://doi.org/10.1177/0956797613480803

Neuberg, S. L., & Fiske, S. T. (1987). Motivational influences on impression formation: Outcome dependency, accuracy-driven attention, and individuating processes. *Journal of Personality and Social Psychology*, *53*(3), 431–444. https://doi.org/10.1037/0022-3514.53.3.431

R Core Team. (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing.

Ratcliff, N. J., Franklin, R. G., Nelson, A. J., & Vescio, T. K. (2012). The scorn of status: A bias toward perceiving anger on high-status faces. *Social Cognition*, *30*(5), 631–642. https://doi.org/10.1521/soco.2012.30.5.631

Ratcliff, N. J., Hugenberg, K., Shriver, E. R., & Bernstein, M. J. (2011). The allure of status: High-status targets are privileged in face processing and memory. *Personality and Social Psychology Bulletin*, *37*(8), 1003–1015. https://doi.org/10.1177/0146167211407210

Robitzsch, A. (2020). sirt: Supplementary item response theory models. R package version 3.9-4. https://cran.r-project.org/package=sirt

Rouder, J. N., & Lu, J. (2005). An introduction to Bayesian hierarchical models with an application in the theory of signal detection. *Psychonomic Bulletin & Review*, *12*(4), 573–604. https://doi.org/10.3758/BF03196750

Rubin, D. C., & Umanath, S. (2015). Event memory: A theory of memory for laboratory, autobiographical, and fictional events. *Psychological Review*, *122*(1), 1–23. https://doi.org/10.1037/a0037907

Schreiner, M. R., & Meiser, T. (2023). Measuring binding effects in event-based episodic representations. *Behavior Research Methods*, *55*, 981–996. https://doi.org/10.3758/s13428-021-01769-1

Schreiner, M. R., Meiser, T., & Bröder, A. (2023). The binding structure of event elements in episodic memory and the role of animacy. *Quarterly Journal of Experimental Psychology*, *76*(4), 705–730. https://doi.org/10.1177/17470218221096148

Schubert, T. W. (2005). Your highness: Vertical positions as perceptual symbols of power. *Journal of Personality and Social Psychology*, *89*(1), 1–21. https://doi.org/10.1037/0022-3514.89.1.1

Starns, J. J., & Hicks, J. L. (2005). Source dimensions are retrieved independently in multidimensional monitoring tasks. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*(6), 1213–1220. https://doi.org/10.1037/0278-7393.31.6.1213

Starns, J. J., & Hicks, J. L. (2008). Context attributes in memory are bound to item information, but not to one another. *Psychonomic Bulletin & Review*, *15*(2), 309–314. https://doi.org/10.3758/PBR.15.2.309

Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 381–403). Academic Press.

Tulving, E. (1983). *Elements of episodic memory*. Oxford University Press.

Twidale, S. (2015). MarkovNameGenerator [Haxe]. https://github.com/Tw1ddle/MarkovNameGenerator

Van Dessel, P., De Houwer, J., Gast, A., & Tucker Smith, C. (2015). Instruction-based approach-avoidance effects: Changing stimulus evaluation via the mere instruction to approach or avoid stimuli. *Experimental Psychology*, *62*(3), 161–169. https://doi.org/10.1027/1618-3169/a000282

VanArsdall, J. E., Nairne, J. S., Pandeirada, J. N. S., & Cogdill, M. (2015). Adaptive memory: Animacy effects persist in paired-associate learning. *Memory*, *23*(5), 657–663. https://doi.org/10.1080/09658211.2014.916304

Wainer, H., & Wang, X. (2000). Using a new statistical model for testlets to score TOEFL. *Journal of Educational Measurement*, *37*(3), 203–220. https://doi.org/10.1111/j.1745-3984.2000.tb01083.x

Wang, X., Bradlow, E. T., & Wainer, H. (2002). A general Bayesian model for testlets: Theory and applications. *Applied Psychological Measurement*, *26*(1), 109–128. https://doi.org/10.1177/0146621602026001007

Yen, W. M. (1984). Effects of local item dependence on the fit and equating performance of the three-parameter logistic model. *Applied Psychological Measurement*, *8*(2), 125–145. https://doi.org/10.1177/014662168400800201

Yen, W. M. (1993). Scaling performance assessments: Strategies for managing local item dependence. *Journal of Educational Measurement*, *30*(3), 187–213. https://doi.org/10.1111/j.1745-3984.1993.tb00423.x