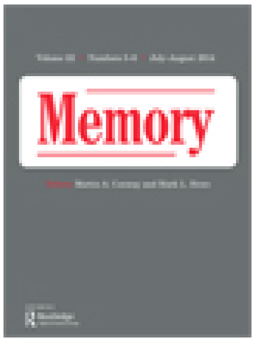

Memory

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/pmem20

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To cite this article: Dillon H. Murphy & Alan D. Castel (2021): Metamemory that matters: judgments of importance can engage responsible remembering, Memory, DOI: 10.1080/09658211.2021.1887895

To link to this article: https://doi.org/10.1080/09658211.2021.1887895

Published online: 17 Mar 2021.

MEMORY
https://doi.org/10.1080/09658211.2021.1887895

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Metamemory that matters: judgments of importance can engage responsible remembering

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ABSTRACT
Adaptive memory refers to the memory advantage for information processed in a survival and/or reproduction context while metacognition involves the awareness of what we can later remember. The notion of "responsible remembering" captures how memory functions to prioritise important information that will need to be remembered and how metacognitive processes may be more precise in situations involving consequences for forgetting. In 5 experiments, we examined whether judgments of learning and judgments of importance affect recall selectivity for information with negative consequences if forgotten. We presented participants with lists of children, each with 2 foods they like, 2 foods they dislike, and 2 foods they are allergic to. When making no metacognitive judgments or making JOLs for each food preference, participants best recalled foods the children liked, likely resulting from serial remembering (recalling information according to where it was presented). However, when judging the importance of remembering items, participants were strategic in their memory for the food preferences such that they best recalled information they rated as important to remember (allergies). These results suggest that when forced to consider the importance of remembering, participants engage in responsible remembering by deeming information with consequences for forgetting as most important and subsequently best remembering this information.

ARTICLE HISTORY
Received 9 July 2020
Accepted 4 February 2021

KEYWORDS
Metamemory; monitoring; adaptive memory; responsible remembering; selectivity

We are often presented with more information than can be remembered and humans have evolved an adaptive memory system to efficiently remember information relating to evolutionary fitness. Specifically, adaptive memory views (Nairne, 2010, 2013, 2015; Nairne & Pandeirada, 2008) posit that information processed in a survival and/or reproduction context receives a memory advantage relative to other information. For example, rating the relevance of items for a survival situation (e.g., being stranded on a deserted island) results in a memory advantage for this information (Kostic et al., 2012; Nairne et al., 2007; see also Bonin et al., 2019; Fernandes et al., 2017; Gretz & Huff, 2019; Nairne, 2015; Nairne et al., 2009; Nairne & Pandeirada, 2010). Thus, strategically remembering information pertaining to survival may be an effective method for maximising memory utility.

Metacognition involves the awareness and understanding of one's memory processes and abilities (Nelson, 1996; Nelson & Narens, 1990). To evaluate the likelihood of later remembering information, participants engage in metacognitive monitoring and these metacognitive judgments play a crucial role in the daily evaluation of memory ("Will I remember someone's name?"), in education ("Have I studied enough for the test?"), and in consequential situations ("Can I remember a child's allergies?"). First introduced by Arbuckle and Cuddy (1969), metacognitive monitoring judgments require participants to predict how likely they are to remember information by assessing their learning. Coined *judgments of learning* (JOLs; see Rhodes, 2016 for a review), predictions are generally accurate such that participants typically predict their performance better than chance.

Many metacognitive measures, such as judgments of learning, occur during the encoding phase such that judgments are made immediately after an item is studied. Thus, these monitoring assessments are often informed by the cues available during learning. Koriat (1997) proposed a cue-utilization framework in which three classes of cues inform these assessments: *intrinsic cues* (characteristics of items that influence or are believed to influence memory such as word-pair relatedness), *extrinsic cues* (the conditions of encoding or testing such as presentation rate or recall versus recognition tests), and *mnemonic cues* (the learner's past experience with items such as how easily an item comes to mind in response to a cue). Generally, Koriat's (1997) framework leads to accurate predictions when judgments and performance are primarily based on the same factor (Dunlosky & Matvey, 2001; Tiede & Leboe, 2009).

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While accurate monitoring assessments should be sensitive to the cues that affect memory performance and impervious to those that have minimal effects (Rhodes, 2016), there are some instances where the cues used to inform JOLs are unrelated to actual memory performance. For example, Rhodes and Castel (2008) found that participants rated words presented in large font as more likely to be remembered than words in a small font but font size did not affect participants' actual performance. Additionally, other studies have demonstrated instances where JOLs were based on similar erroneous beliefs about memory and ease of processing (such as word volume) resulting in a weak relationship between metamemory and performance in these instances (e.g., Besken & Mulligan, 2013; Kornell et al., 2011; Mueller & Dunlosky, 2016; Rhodes & Castel, 2009).

Accurately predicting recall is a sign of good metacognition, or awareness of what will later be remembered, but people frequently forget things they expected to remember such as items on a grocery list, birthdays, anniversaries, or where they parked. These minor instances of forgetting can be inconvenient, however, failing to consider the consequences of forgetting may be another reason JOLs are sometimes inaccurate (e.g., Serra & England, 2012). Since the most important information is often associated with the most severe outcomes if forgotten, situations with consequences for forgetting can result in improved metacognition and learning outcomes (e.g., McGillivray & Castel, 2011). How our memory functions to prioritise what information is most important and will need to be remembered as well as how metacognitive processes may be more precise in situations involving consequences for memory failure is a notion we termed *responsible remembering* (Murphy & Castel, 2020, 2021).

Responsible remembering encompasses metacognitive processes and the strategic allocation of attention toward important information to avoid undesirable outcomes and even tragic consequences. For example, McGillivray and Castel (2011) presented participants with words paired with point values and required participants to choose whether to bet on their later memory for each word. To instil rewards and consequences for remembering and forgetting, if participants "bet" on and remembered a word, they got the points associated with that word but if they forgot the word, the points associated with that word were subtracted from their score (with the goal being to maximise their score). Results revealed enhanced metacognition and learning outcomes with increased task experience suggesting that people can learn to be responsible rememberers when considering the rewards for remembering and the consequences for forgetting.

While researchers have investigated whether different methods of judging future remembering influence the accuracy of predictions (e.g., Finn, 2008; Hanczakowski et al., 2013; McCabe & Soderstrom, 2011; McGillivray & Castel, 2011; Tauber & Rhodes, 2012), few have examined the relationship between importance ratings and accuracy. Previous work has indicated that focusing attention on important information can increase the likelihood that this information will be effectively encoded and later recalled (Ariel et al., 2009; Castel et al., 2012). Thus, in contrast to more passive judgments of learning, judgments of importance (JOI) may serve as more accurate and useful metacognitive judgments and also exemplify the notion of responsible remembering. Rather than indicating the likelihood of remembering, asking participants how important it is to remember information may inform agendas and better relate to later performance.

As a result of having rated information as important to remember, the process of making judgments of importance could update the goal orientation process (e.g., Ariel et al., 2009) leading to subsequent reactivity (cf. Arbuckle & Cuddy, 1969; Double et al., 2018; Double & Birney, 2019; Soderstrom et al., 2015; Spellman & Bjork, 1992). Reactivity often occurs when participants make metacognitive assessments and sometimes demonstrate enhanced recall as a result of making these memory judgments (or negative reactivity, see Mitchum et al., 2016). Thus, responsible rememberers should be most metacognitively accurate and best remember the most important information when evaluating the importance of information.

The current study

In the current study, we examined potential consequences for misguided metacognition by setting up simulated conditions in which one was responsible for a child and needed to remember their life-threatening allergies. Specifically, we investigated how instances of forgetting influenced the way individuals determined what to-be-remembered information is important to remember and the effect of this metacognitive process on successful learning. We hoped to demonstrate that when there are consequences for forgetting, task-experience can update learning based on observations of forgetting and participants adaptively engage in responsible remembering by systematically updating their goals and shifting their attention to items of importance resulting in better recall of these items.

In three experiments, participants were presented with lists of children (each with two foods they like, two foods they dislike, and two foods they are allergic to and must avoid) and were tested to determine if participants learned to selectivity focus on remembering the most important information (allergies). We hoped to demonstrate that task-experience can update learning based on observations of forgetting (Halamish et al., 2011) and that participants adaptively engage in *responsible remembering* by showing a bias towards items of importance resulting in greater performance in the recall of these items. Thus, we expected participants to be responsible rememberers by strategically remembering the most important information (allergies) to avoid negative outcomes for forgetting.

Experiment 1a

In Experiment 1a, we examined if participants were sensitive to information importance by engaging in responsible remembering and best recalling items with consequences if forgotten. Participants studied six unique lists of four children, each with two foods they like, two foods they dislike, and two foods they are allergic to and must avoid. Following the presentation of each list, participants were cued with the children from the just-presented list and asked to recall their food items and associated preferences. We hypothesised that participants would adaptively engage in responsible remembering by best remembering the children's allergies (which may benefit from survival processing; Kostic et al., 2012; Nairne et al., 2007) and that this effect would be more pronounced with increased task experience.

Method

Participants

Participants were 30 undergraduate students (age: M = 20.50, SD = 2.27) recruited from the University of California Los Angeles Human Subjects Pool and received course credit for their participation. A sensitivity analysis indicated that for a repeated measures, within-subjects ANOVA with 3 groups (preferences) and 6 measurements (lists), with a small correlation between repeated measures, assuming alpha = .05, power = .80, the smallest effect size the design could reliably detect is $\eta^2 = .07$. Participants were tested individually or in groups of up to 8 individuals in a laboratory session lasting approximately 1 h.

Procedure and materials

Participants were told to imagine they would be meeting several children that they would be taking care of in the future and babysitting and that each child has two foods they like, two foods they dislike, and two foods that they are allergic to and must avoid. Participants' were instructed to remember this information for a later test where they would see the children again and need to recall the information associated with each kid. Participants were then shown pictures of children; each child had a name, two foods they like, two foods they dislike, and two foods they are allergic to (e.g., likes: crabs and tangerine; dislikes: watermelon and avocado; allergic to: walnuts and eggs; see Appendix for stimuli). An example of the study and test phase can be seen in Figure 1. Half of the children were male and half were female; the children were of similar apparent age (around 5 years old). Food items were used only once throughout the task and were randomly paired with children and randomly presented as either likes, dislikes, or allergies. On each trial, participants were shown four different children, and each child's picture and food preferences were presented for 20 sec.

After the study phase, participants were cued with the name and picture of each child, one at a time, in random order, and asked to recall the foods paired with each child and whether it was a like, dislike, or allergy (they could recall items in any order they wished). Participants were given 20-seconds to recall the foods associated with each child. This was repeated for a total of six study-test cycles, with new food preferences paired with different sets of children on each list (for a total of 24 kids). The task was scored such that items were only considered correct if they were correctly paired with each child while also correctly identifying the associated preference.

Results

The results from Experiment 1a are shown in Figure 2. A 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures, within-subjects ANOVA was conducted but Mauchly's test of sphericity indicated violations for list [Mauchly's $W = .41$, $p = .048$]. Huynh-Feldt corrected results did not reveal a main effect of list [$F(4.54, 131.72) = .83$, $p = .522$, $\eta^2 = .03$] such that the proportion of foods recalled on each list ($M = .16$, $SD = .10$) did not improve with task experience. However, results revealed a main effect of preference [$F(2, 58) = 8.08$, $p < .001$, $\eta^2 = .22$] such that the likes ($M = .21$, $SD = .15$) were recalled better than the dislikes ($M = .10$, $SD = .09$), [p_{adj}[1] < .001, d = 1.24], the likes were recalled better than the allergies ($M = .15$, $SD = .15$), [$p_{adj} = .006$, $d = .57$], and the allergies were recalled better than the dislikes [$p_{adj} = .016$, $d = .52$]. Finally, list did not interact with preference [$F(10, 290) = .69$, $p = .737$, $\eta^2 = .02$] suggesting no difference in selectivity with increased task experience.

Discussion

We expected participants to best recall the critical information (allergies) and that this effect would be enhanced with increased task experience. However, participants' performance was generally best for the likes, followed by the allergies, and worst for the dislikes indicating that participants did not engage in responsible remembering but exemplified serial processing of the information rather than an adaptive form of memory (e.g., Nairne, 2010, 2013, 2015; Nairne & Pandeirada, 2008).

Experiment 1b

In Experiment 1a, we expected participants to adaptively engage in responsible remembering by best recalling foods the children were allergic to and must avoid. However, participants' recall may have reflected a habitual reading bias (Ariel et al., 2011) whereby the likes were best recalled as a result of their favourable location in the study phase rather than the strategic remembering of this category. Alternatively, participants may believe that

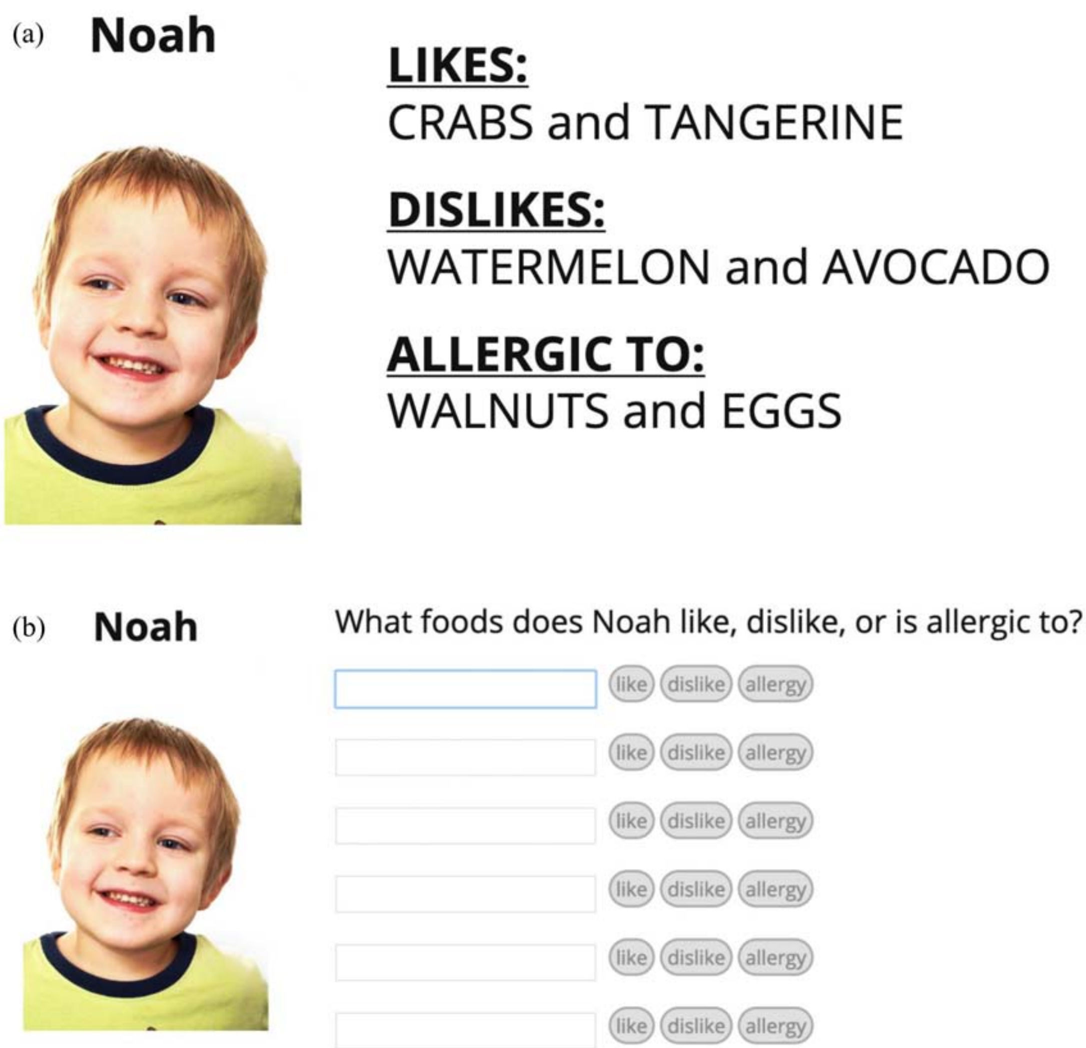

Figure 1. Study phase (a) and test phase (b) in Experiments 1a, 2a, 2b, and 3. Participants were presented with 6 lists with 4 kids on each list. The study and test phase were both 20 sec per kid.

remembering foods that children like is more important than foods they dislike or are allergic to. To examine whether participants engaged in serial remembering as opposed to responsible remembering, in Experiment 1b we presented the foods in different orders to determine if participants' recall in reflected the foods' position in the study phase (top, middle, bottom) or the prioritisation of the different preferences (likes, dislikes, allergies).

Method

Participants

After exclusions, participants were 92 undergraduate students (age: $M = 19.84$, $SD = 1.65$) recruited from the University of California Los Angeles Human Subjects Pool and received course credit for their participation. Participants were tested online. Participants were excluded from analysis if they admitted to cheating (e.g., writing down answers) in a post-task questionnaire (participants were told they would still receive credit if they cheated). This exclusion process resulted in 2 exclusions. A power analysis indicated that for a repeated measures, between-subjects ANOVA with 3 groups (food order) and 3 measurements (preferences), with a high correlation between repeated measures, assuming alpha = .05, power = .80, 90 participants would be needed to reliably detect a medium effect size ($\eta^2 = .10$).

Procedure and materials

The task in Experiment 1b was similar to the task in Experiment 1a but participants were randomly assigned to either view the foods in a likes, dislikes, allergies order ($n = 33$), dislikes, allergies, likes order ($n = 31$), or allergies, dislikes, likes order ($n = 28$) in the study phase.

Results

To investigate possible differences in recall based on food location in the study phase, a 3 (location: top, middle, bottom) x 6 (list) x 3 (condition) repeated-measures

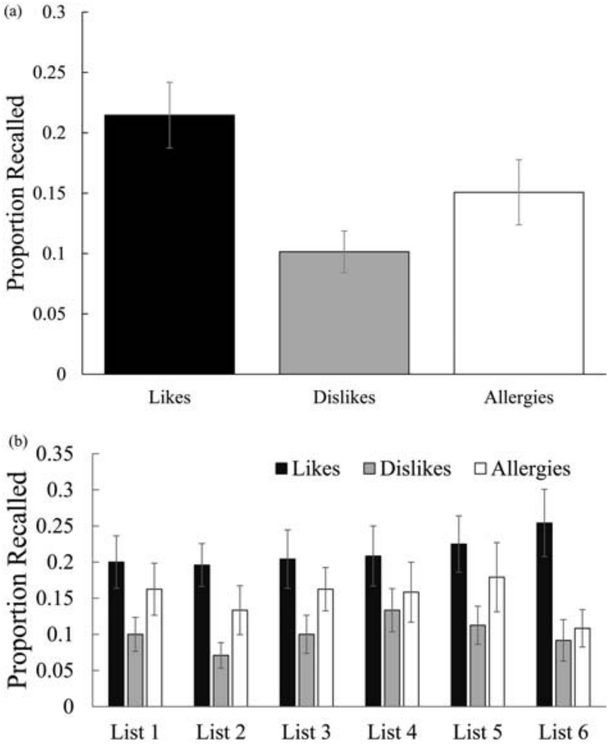

Figure 2. Recall performance across lists for each preference (a) and recall performance for each preference on each list (b) in Experiment 1a. Error bars reflect the standard error of the mean.

ANOVA revealed a main effect of location [$F(2, 178) = 7.97$, $p < .001$, $\eta^2 = .08$] such that the foods at the top ($M = .28$, $SD = .19$) were recalled better than the foods in the middle ($M = .20$, $SD = .17$), [$p_{adj} < .001$, $d = .69$] and the foods at the bottom ($M = .25$, $SD = .17$), [$p_{adj} = .037$, $d = .26$], and recall for the foods at the bottom was better than foods in the middle [$p_{adj} < .001$, $d = .39$]. Additionally, results revealed a main effect of condition [$F(2, 89) = 4.10$, $p = .020$, $\eta^2 = .08$] such that participants in the likes, dislikes, allergies order ($M = .29$, $SD = .13$) recalled more foods than participants in the allergies, dislikes, likes order ($M = .21$, $SD = .09$), [$p_{adj} = .025$, $d = .28$] but not participants in the dislikes, allergies, likes order ($M = .23$, $SD = .13$), [$p_{adj} = .113$, $d = .22$], and allergies, dislikes, likes order recalled a similar proportion of foods as participants in the dislikes, allergies, likes order [$p_{adj} > .999$, $d = .07$]. However, there was not a main effect of list [Mauchly's $W = .68$, $p = .002$; Huynh-Feldt corrected results: $F(4.58, 407.24) = 1.81$, $p = .117$, $\eta^2 = .02$]. Furthermore, location interacted with condition [$F(4, 178) = 3.87$, $p = .005$, $\eta^2 = .07$] such that location did not affect recall when viewing the foods in the dislikes, allergies, likes order. However, there was not an interaction between condition and list [$F(9.15, 407.24) = .52$, $p = .864$, $\eta^2 = .01$], between location and list [Mauchly's $W = .38$, $p = .007$; Huynh-Feldt corrected results: $F(9.40, 836.18) = .49$, $p = .889$, $\eta^2 = .01$], or a three way interaction between location, list, and condition [$F(18.79, 836.18) = .80$, $p = .706$, $\eta^2 = .02$].

Discussion

Although we did not include a full onslaught of counterbalanced viewing orders, it is evident that the viewing order of the foods impacts recall in addition to qualitative differences between the food preferences. Specifically, we demonstrated that there is an advantage for the foods presented at the top of the screen in the study phase but it also matters whether the food is a like, dislike, or allergy. Additionally, the variation in recall between the preferences may stem from how the processing of each food preference affects the processing of the others (see Janes et al., 2018). For example, in the likes, dislikes, allergies order, even if participants aim to focus on the allergies, the position at the top of the screen likely results in a habitual reading bias where the likes are read first, followed by the dislikes and the allergies, leading to a memory advantage for the likes. Thus, the observed order effects in Experiment 1a are consistent with reactivity due to processing order.

Experiment 2a

In Experiment 1a, rather than engaging in responsible remembering, participants generally best recalled the likes, followed by the allergies, and recall was worst for the dislikes. Thus, for participants to engage in responsible remembering and overcome this pattern of serial remembering, a metacognitive component may be necessary. Previous work has demonstrated the reactive nature of recall as a result of making metacognitive judgments such that soliciting judgments of learning (JOLs) can improve overall memory performance (e.g., Mitchum et al., 2016; Soderstrom et al., 2015) and may also influence what is remembered. In Experiment 2a, we investigated how making JOLs affects recall for the children's food preferences. Specifically, participants indicated how likely they were to remember the foods in each category for each child and we hypothesised that participants would expect to remember the children's allergies. However, after initially engaging in serial remembering (as seen in Experiments 1a and 1b) and experiencing instances of unexpected forgetting, participants may adaptively prioritise the allergies and subsequently engage in responsible remembering on later lists to avoid negative consequences for forgetting.

Method

Participants

Participants were 28 undergraduate students (age: $M = 20.18$, $SD = 1.91$) recruited from the University of California Los Angeles Human Subjects Pool and received course credit for their participation. A sensitivity analysis indicated that for a repeated measures, within-subjects ANOVA with 3 groups (preferences) and 6 measurements (lists), with a small correlation between repeated measures, assuming alpha = .05, power = .80, the smallest effect size the design could reliably detect is $\eta^2 = .07$. Participants were tested individually or in groups of up to 8 individuals in a laboratory session lasting approximately 1 h.

Procedure and materials

The task in Experiment 2a was similar to the task in Experiment 1a except that after each child's information was presented, participants made judgments of learning for each child's likes, dislikes, and allergies. Participants answered with numbers between 0 and 100, with 0 meaning they definitely would not remember the foods and 100 meaning they definitely would remember the foods. Participants were given 20 sec to study each child's information and 10 sec to make their judgments for all three categories.

Results

The results from Experiment 2a are shown in Figure 3. A 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures, within-subjects ANOVA on JOLs revealed a main effect of preference [Mauchly's $W = .64$, $p = .005$; Huynh-Feldt corrected results: $F(1.54, 38.44) = 4.08$, $p = .034$, $\eta^2 = .14$] such that JOLs for the likes ($M = 32.81$, $SD = 16.56$) were greater than JOLs for the dislikes ($M = 26.29$, $SD = 18.41$), [$p_{adj} = .005$, $d = .63$], JOLs for the allergies ($M = 35.59$, $SD = 20.30$) were greater than JOLs for the dislikes [$p_{adj} < .001$, $d = .88$], but JOLs for the likes and allergies were similar [$p_{adj} = .281$, $d = .33$]. Additionally, results revealed a main effect of list [Mauchly's $W = .15$, $p < .001$; Huynh-Feldt corrected results: $F(3.28, 81.90) = 18.95$, $p < .001$, $\eta^2 = .43$] such that JOLs decreased as the task endured but this did not interact with preference [Mauchly's $W < .01$, $p < .001$; Huynh-Feldt corrected results: $F(5.08, 126.94) = 1.96$, $p = .088$, $\eta^2 = .07$]. Thus, the likes and the allergies were judged as more likely to be remembered than the dislikes and this did not change as the task endured.

To investigate possible differences in recall for the different food preferences, a 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures, within-subjects ANOVA revealed a main effect of preference [$F(2, 54) = 8.00$, $p < .001$, $\eta^2 = .23$] such that the likes ($M = .24$, $SD = .22$) were recalled better than the dislikes ($M = .13$, $SD = .16$), [$p_{adj} < .001$, $d = 1.24$] and the allergies ($M = .15$, $SD = .14$), [$p_{adj} < .001$, $d = .81$], but recall for the allergies and dislikes was similar [$p_{adj} = .807$, $d = .21$]. Additionally, results revealed a main effect of list [Mauchly's $W = .38$, $p = .040$; Huynh-Feldt corrected results: $F(4.20, 113.45) = 2.42$, $p = .050$, $\eta^2 = .08$] such that recall improved with task experience but this did not interact with preference [Mauchly's $W = .01$, $p < .001$; Huynh-Feldt corrected results: $F(7.44, 200.77) = .49$, $p = .851$, $\eta^2 = .02$].

Discussion

Making JOLs did not eliminate the enhanced recall for the likes and result in responsible remembering for the children's allergies. Similar to Experiment 1a, this may be the result of serial remembering due to the location of items in the study phase. However, the metacognitive

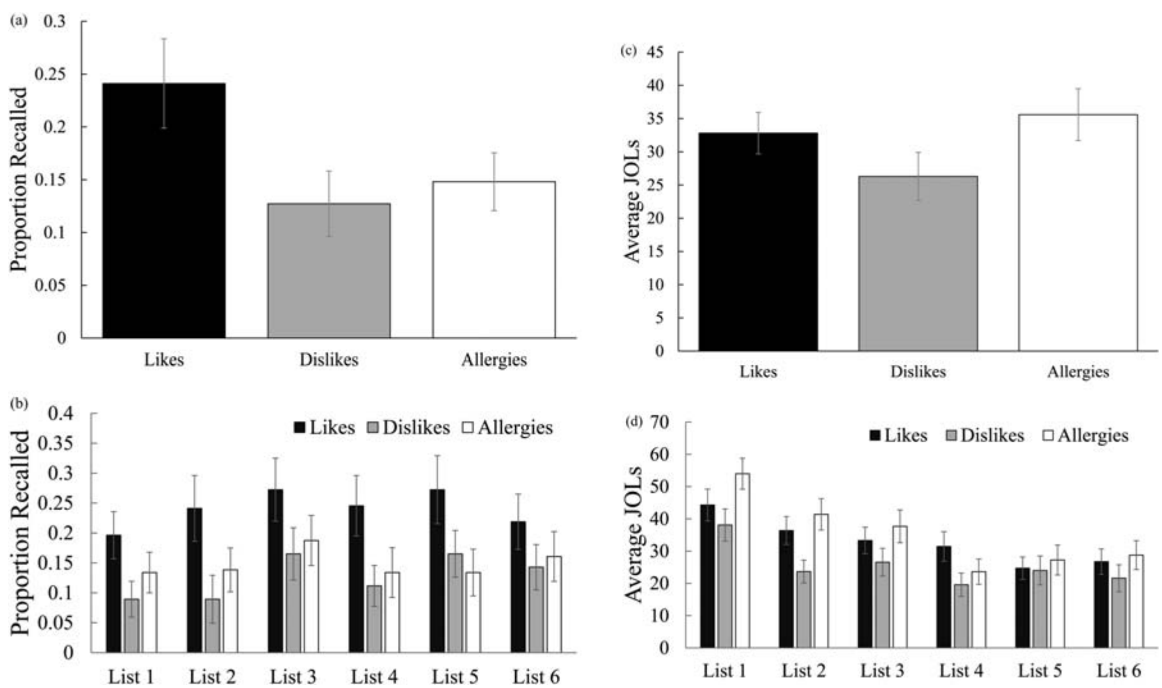

Figure 3. Recall performance collapsed across lists for each preference (a), recall performance for each preference on each list (b), average judgment of learning (JOL) collapsed across lists for each preference (c), and average JOL for each preference on each list (d) in Experiment 2a. Error bars reflect the standard error of the mean.

disconnect between JOLs for the allergies and later recall revealed that participants believed that they were encoding the allergy information as well as the likes and expected to later remember them. These faulty monitoring assessments and the resulting overconfidence for items with consequences if forgotten revealed that younger adults may not be responsible rememberers, or a metacognitive assessment resulting in a more functional form of reactivity may be needed. Specifically, rather than passive measures of metacognitive monitoring like JOLs, a more direct assessment may be needed for participants to shift their prioritisation from likes to the information with dire consequences if forgotten.

Experiment 2b

In Experiment 2a, participants made JOLs for each food preference and recall was best for the foods children liked. Rather than a passive form of metacognitive monitoring, in Experiment 2b participants indicated how important it was to remember the foods in each category for each child. By making judgments of importance (JOIs), participants may engage in metacognitive processes that guide attention and later memory, consistent with the notion of "metacognition modifying attention" towards important information (Castel et al., 2012). As opposed to JOLs which may be more passive and do not engage the metacognition modifying attention processes, monitoring the importance of remembering may cause participants to become more aware of the need to selectively focus on what would have negative consequences if forgotten and overcome the prioritisation of likes found in Experiments 1a and 2a. Thus, we aimed to demonstrate that providing JOIs results in responsible remembering of the children's allergies such that the information rated as most important to remember is best remembered.

Method

Participants

Participants were 29 undergraduate students (age: $M=19.97$, $SD=1.24$) recruited from the University of California Los Angeles Human Subjects Pool and received course credit for their participation. A sensitivity analysis indicated that for a repeated measures, within-subjects ANOVA with 3 groups (preferences) and 6 measurements (lists), with a small correlation between repeated measures, assuming alpha = .05, power = .80, the smallest effect size the design could reliably detect is $\eta^2 = .07$. Participants were tested individually or in groups of up to 8 individuals in a laboratory session lasting approximately 1 h.

Procedure and materials

The task in Experiment 2b was similar to the task in Experiment 2a. Rather than making a judgment of the likelihood of remembering the foods in each category (JOL), participants made judgments as to how important it was to remember (JOI) each child's likes, dislikes, and allergies. Participants answered with numbers between 0 and 100, with 0 meaning not important to remember and 100 meaning very important to remember. Participants were given 20 sec to study each child's information and 10 sec to make their judgments for all three categories.

Results

The results from Experiment 2b are shown in Figure 4. A 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures, within-subjects ANOVA on JOIs revealed a main effect of preference [$F(2, 54) = 41.52$, $p < .001$, $\eta^2 = .61$] such that JOIs for the allergies ($M = 91.41$, $SD = 16.82$) were greater than JOIs for the likes ($M = 50.91$, $SD = 25.49$), [$p_{adj} < .001$, $d = 3.18$], JOIs for the allergies were greater than JOIs for the dislikes ($M = 50.29$, $SD = 26.59$), [$p_{adj} < .001$, $d = 3.04$], but JOIs for the likes and allergies were similar [$p_{adj} > .999$, $d = .10$]. However, results did not reveal a main effect of list [Mauchly's $W = .06$, $p < .001$; Huynh-Feldt corrected results: $F(3.25, 87.78) = 2.25$, $p = .083$, $\eta^2 = .08$] and list did not interact with preference [Mauchly's $W < .01$, $p < .001$; Huynh-Feldt corrected results: $F(5.83, 157.28) = .76$, $p = .600$, $\eta^2 = .03$]. Thus, the allergies were rated as more important to remember than other preferences and this did not vary as a function of task experience.

To investigate possible differences in recall for the different food preferences, a 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures, within-subjects ANOVA revealed a main effect of preference [Mauchly's $W = .78$, $p = .037$; Huynh-Feldt corrected results: $F(1.73, 48.55) = 18.97$, $p < .001$, $\eta^2 = .40$] such that the allergies ($M = .32$, $SD = .25$) were recalled better than the likes ($M = .22$, $SD = .18$), [$p_{adj} < .001$, $d = .71$] and the dislikes ($M = .10$, $SD = .09$), [$p_{adj} < .001$, $d = 1.71$], and the likes were recalled better than the dislikes [$p_{adj} < .001$, $d = 1.27$]. Additionally, results revealed a main effect of list [Mauchly's $W = .35$, $p = .016$; Huynh-Feldt corrected results: $F(4.40, 123.26) = 2.96$, $p = .019$, $\eta^2 = .10$] such that recall improved with task experience but list did not interact with preference [Mauchly's $W = .02$, $p = .001$; Huynh-Feldt corrected results: $F(7.37, 206.24) = .78$, $p = .611$, $\eta^2 = .03$]. Thus, participants engaged in responsible remembering by strategically remembering the items that they rated as most important to remember and with consequences if forgotten (the children's allergies).

Finally, to measure the magnitude of the effect of JOIs on recall for the children's allergies while controlling for memory performance and JOIs, we calculated JOI difference scores for each participant by subtracting their mean JOI for the likes and the dislikes from their mean JOI for the allergies. We then regressed those difference scores on recall difference scores (subtracting participants' mean recall of the likes and the dislikes from their mean recall of the allergies) and the regression revealed that the magnitude of recalling the allergies depends on JOIs

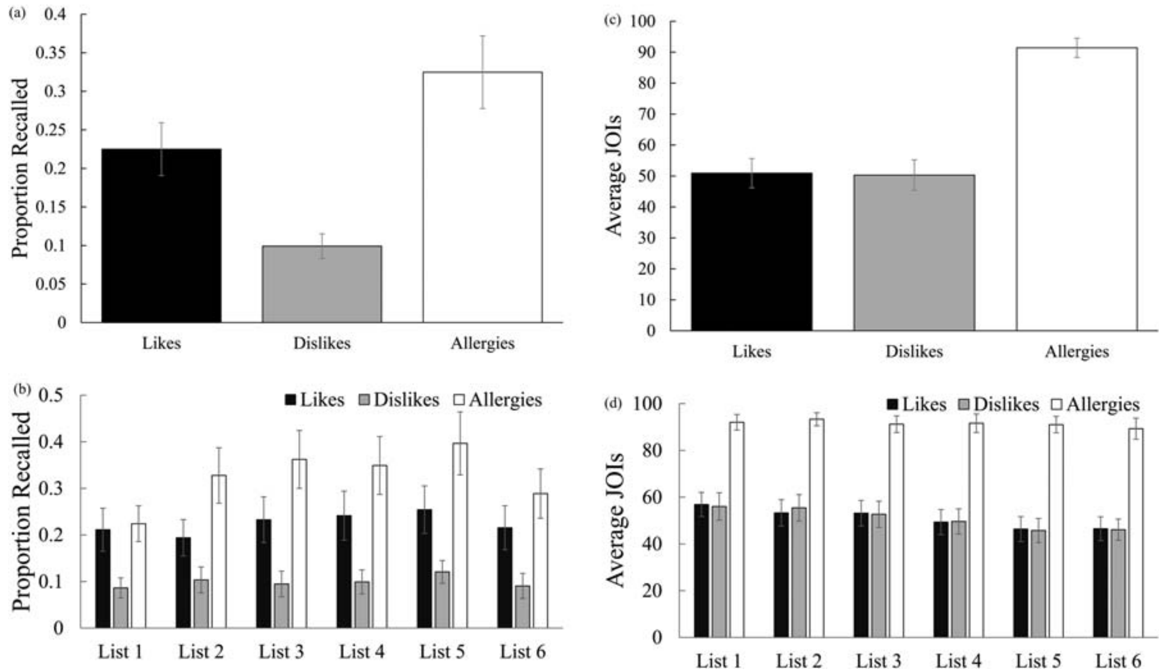

Figure 4. Recall performance collapsed across lists for each preference (a), recall performance for each preference on each list (b), average judgment of importance (JOI) collapsed across lists for each preference (c), and average JOI for each preference on each list (d) in Experiment 2b. Error bars reflect the standard error of the mean.

for allergies [$b = .41$, $t(27) = 2.35$, $p = .027$]. Thus, people that judged allergies as less important to remember tended to recall fewer of the children's allergies, indicating that the misevaluation of importance could lead to forgetting and negative outcomes.

Discussion

Making judgments of importance resulted in enhanced recall for the information with negative consequences if forgotten, the children's allergies, supporting the notion of responsible remembering and exemplifying a useful form of reactivity (Arbuckle & Cuddy, 1969; Double et al., 2018; Double & Birney, 2019; Mitchum et al., 2016; Soderstrom et al., 2015; Spellman & Bjork, 1992). Another potential mechanism that may contribute to the findings is "metacognition modifying attention" (Castel et al., 2012) such that when participants become explicitly aware of which items they feel are important to remember, responsible remembering can be effectively engaged. The findings from Experiments 1a and 2a suggest that when people are not explicitly assigning importance, one may irresponsibly allocate cognitive resources and may not engage in responsible remembering. Additionally, the present results are consistent with previous work where memory for intrinsically valuable information disrupts the intentional learning of other information, but also enhances the incidental learning of this information (Noh et al., 2014). Thus, JOIs appear to have changed the goal orientation process leading to subsequent reactivity and responsible remembering, but also preserved memory for other task-relevant information.

Experiment 3

In Experiment 2a, participants made JOLs for each food preference and recall was best for the foods the children liked. However, in Experiment 2b participants made JOIs for each food preference and rated the information with severe consequences if forgotten as most important and subsequently best recalled this information. In Experiment 3, we provide a within-experiment comparison between the JOL and the JOI and how they influence engaging in responsible remembering.

Method

Participants

After exclusions, participants were 88 undergraduate students (age: $M = 19.13$, $SD = 1.62$) recruited from the University of California Los Angeles Human Subjects Pool and received course credit for their participation. Participants were tested online. Participants were excluded from analysis if they admitted to cheating (e.g., writing down answers) in a post-task questionnaire (they were told they would still receive credit if they cheated). This exclusion process resulted in 1 exclusion. A power analysis indicated that for a repeated measures, between-subjects ANOVA with 2 groups (JOL, JOI) and 3 measurements (preferences), with a high correlation between repeated measures, assuming alpha = .05, power = .80, 37 participants would be needed in each group to reliably detect a medium effect size ($\eta^2 = .10$).

Procedure and materials

The task in Experiment 3 was similar to the task in Experiments 2a and 2b. Participants were randomly assigned to either make a judgment of the likelihood of remembering each category of items (JOL; $n = 44$) or judgments as to how important it was to remember (JOI; $n = 44$) each category of items. Participants were given 20 s to study each child's information but were given as much time as they needed to make their judgments for all three categories.

Results

The results from Experiment 3 are shown in Figure 5. A 2 (condition: JOL, JOI) x 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures ANOVA on judgments revealed a main effect of condition [$F(1, 86) = 66.01$, $p < .001$, $\eta^2 = .43$] such that JOIs ($M = 61.15$, $SD = 16.53$) were greater than JOLs ($M = 32.79$, $SD = 16.27$). Additionally, results revealed a main effect of preference [Mauchly's $W = .63$, $p < .001$; Huynh-Feldt corrected results: $F(1.48, 127.23) = 58.63$, $p < .001$, $\eta^2 = .33$] and condition interacted with preference [$F(1.48, 127.23) = 31.29$, $p < .001$, $\eta^2 = .18$] such that participants making JOIs demonstrated increased ratings for allergies. Moreover, there was a main effect of list [Mauchly's $W = .11$, $p < .001$; Huynh-Feldt corrected results: $F(2.46, 211.53) = 17.57$, $p < .001$, $\eta^2 = .16$] and list interacted with condition [$F(2.46, 211.53) = 5.63$, $p = .002$, $\eta^2 = .05$] such that JOLs declined as the task endured. Preference did not interact with list [Mauchly's $W = .11$, $p < .001$; Huynh-Feldt corrected results: $F(7.23, 622.15) = .71$, $p = .671$, $\eta^2 = .01$] and there was not a three-way interaction between preference, list, and condition [$F(7.23, 622.15) = 1.18$, $p = .312$, $\eta^2 = .01$].

To examine differences in recall for the food categories, a 2 (condition: JOL, JOI) x 3 (preference: likes, dislikes, allergies) x 6 (list) repeated-measures ANOVA did not reveal a main effect of condition [$F(1, 86) = .71$, $p = .403$, $\eta^2 = .01$] such that participants making JOLs ($M = .30$, $SD = .15$) recalled a similar proportion of foods as participants making JOIs ($M = .33$, $SD = .21$). However, results revealed a main effect of preference [Mauchly's $W = .61$, $p < .001$; Huynh-Feldt corrected results: $F(1.45, 125.00) = 28.89$, $p < .001$, $\eta^2 = .23$] and condition interacted with preference [$F(1.45, 125.00) = 9.84$, $p < .001$, $\eta^2 = .08$] such that participants making JOIs demonstrated enhanced recall of allergies, consistent with engaging in responsible remembering. Moreover, there was not a main effect of list [Mauchly's $W = .54$, $p < .001$; Huynh-Feldt corrected results: $F(4.07, 350.39) = 2.02$, $p = .090$, $\eta^2 = .02$] and list did not interact with condition [$F(4.07, 350.39) = .43$, $p = .794$, $\eta^2 = .01$]. Preference did not interact with list [Mauchly's $W = .61$, $p < .001$; Huynh-Feldt corrected results: $F(9.27, 797.54) = 1.07$, $p = .383$, $\eta^2 = .01$] and there was not a three-way interaction between preference, list, and condition [$F(9.27, 797.54) = .47$, $p = .903$, $\eta^2 = .01$].

Finally, to measure the magnitude of the effect of judgments on recall for the children's allergies while controlling for memory performance and judgments, we again calculated judgment difference scores for each participant by subtracting their mean judgment for the likes and the dislikes from their mean judgment for the allergies. We then regressed those difference scores on differences in recall between the allergies and the likes and dislikes, similar to Experiment 2b. Results revealed that the magnitude of recalling the allergies depends on participants' JOIs for the allergies [$b = .56$, $t(42) = 4.33$, $p < .001$] as well as participants' JOLs for allergies [$b = .71$, $t(42) = 11.58$, $p < .001$]. Thus, people that judged allergies as less important to remember or less likely to remembered tended to recall fewer of the children's allergies, indicating the crucial role of metacognitive monitoring in engaging responsible remembering processes.

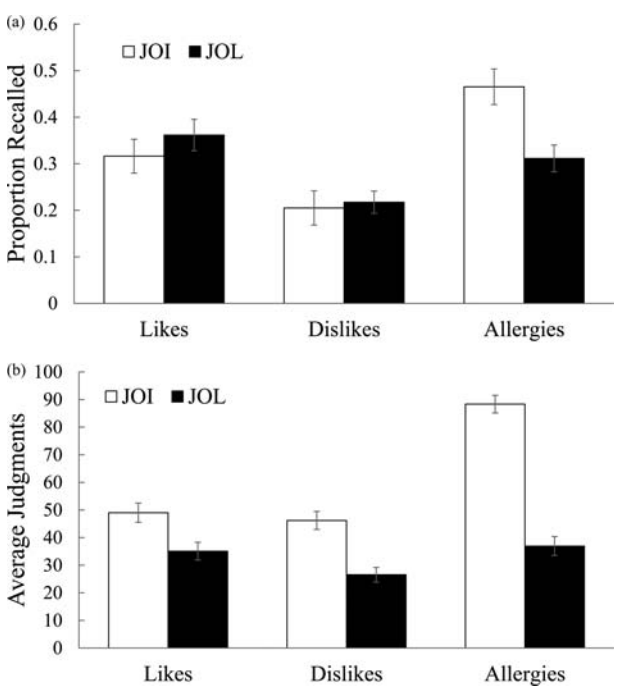

Figure 5. Recall performance for each preference (a) and average judgments (b) collapsed across lists for each preference as a function of condition in Experiment 3. Error bars reflect the standard error of the mean.

Discussion

The results of Experiment 3 generally replicated Experiments 2a and 2b such that when forced to explicitly evaluate the importance of remembering information via JOIs, recall for the children's allergies was enhanced. Thus, rather than more passive metacognitive measures like JOLs, JOIs can result in an adaptive form of "metacognition modifying attention" (Castel et al., 2012) whereby participants become explicitly aware of which items are critical to remember and subsequently engage in responsible remembering.

General discussion

Unfortunately, allergies have become more common in school-aged children (Jackson et al., 2013) and every year, thousands of people die as a result of exposure to known allergens and toxins (Byard, 2018). Thus, remembering to avoid allergies can save lives but there can be extreme consequences if a caregiver forgets a child's allergies. Consistent with the adaptive memory view where there is a memory advantage for information pertaining to survival (Nairne, 2010, 2013, 2015; Nairne & Pandeirada, 2008), when presented with too much information to remember, participants should adaptively engage in responsible remembering by best remembering the information with negative consequences if forgotten.

In real-world settings, responsible remembering can include remembering to take an infant to daycare rather than forgetting them in the back seat of your car, a tragic issue known as *forgotten baby syndrome* (Fantz, 2015). To enhance learning outcomes and avoid tragic consequences for forgetting, like forgetting allergic reactions to known allergens or a child in the back seat, the notion of responsible remembering stems from more accurate metacognition and allows for the strategic allocation of attention toward important information (Murphy & Castel, 2020; see also Murphy & Castel, 2021).

To test this metacognitive mechanism, we administered an associative memory task with which participants were asked to remember more information than they are capable and therefore needed to be strategic about what they focused on. By presenting participants with multiple lists of children and their food preferences, we were also able to examine how task experience and item importance impacts the accuracy and strategic prioritising of associative information. We hypothesised that participants would demonstrate responsible remembering for associations that would be essential for remembering in real life (e.g., children's allergies).

In Experiment 1a, rather than engaging in responsible remembering, participants best recalled foods that the children liked, indicating that a metacognitive assessment may be necessary for participants to engage in responsible remembering. In Experiment 2a, participants judged the likelihood of remembering (JOL) each food preference and we expected them to prioritise important information by best recalling the children's allergies. However, participants again did not engage in responsible remembering but best remembered the foods that the kids liked. If the goal-orienting process had been properly informed of the consequences of forgetting, more cognitive resources may have been focused on the important information leading to an increased likelihood that the children's allergies would be effectively encoded and later recalled.

As opposed to passive JOLs, we hypothesised that a judgment of importance (JOI) would be a better metacognitive assessment for demonstrating the notion of responsible remembering. Although not a standard "second-order" metacognitive measure, in the present context JOIs tap the metacognitive aspect of determining to what extent something is important in terms of prioritising it in memory and JOIs might engage both metacognitive and broader cognitive operations that lead to goal-based memory. We expected that indicating the importance of remembering the items in each category would inform agendas and better relate to memory performance. In Experiment 2b, participants rated the importance of remembering each preference (JOIs) and results revealed that JOIs led to a useful form of reactivity (Double et al., 2018; Double & Birney, 2019; Mitchum et al., 2016; Soderstrom et al., 2015; Spellman & Bjork, 1992). Specifically, participants better remembered information that they rated as most important to remember, exemplifying responsible remembering. Thus, increasing selectivity for information with consequences for forgetting in younger adults may require an intervention in the form of judgments of importance.

Although responsible remembering and adaptive memory views might predict that people focus on remembering important allergies, participants often failed to prioritise memory for the information with negative consequences if forgotten (cf. Friedman et al., 2015; Middlebrooks et al., 2016). The lack of engagement in responsible remembering in the present experiments may be due to negative consequences being taken less into account in experimental situations. In daily life, people may be responsible rememberers without having to explicitly identify the importance of remembering information with consequences for forgetting. However, the present findings are more consistent with a habitual bias (Ariel & Dunlosky, 2013) as demonstrated by the enhanced recall for the information presented on the top of the screen in the study phase in Experiment 1b.

While we intentionally placed the likes and allergies in positions that would likely benefit recall (first and last serial positions), we were most interested in whether learners would utilise and/or overcome any serial position effects to selectively remember what was most important. Rather than pairing information with external objective values (e.g., McGillivray & Castel, 2011), the present work shows that only when correctly identifying subjectively important information with potential consequences if forgotten were participants able to engage in responsible remembering by best remembering the allergies they judged as important to remember.

In sum, estimating the likelihood of later remembering information (JOLs) may not be sufficient to overcome instances of forgetting and engage in responsible remembering. However, when forced to consider the consequences of forgetting, metacognition may become more accurate in situations with the potential for severe outcomes. The present work demonstrates how people may have default biases or make irresponsible decisions that prevent the selective encoding of important information. However, we have shown that when people engage in metacognitive monitoring that draws awareness toward what is important, they can overcome these habits to focus on what is most important to remember. When people must consider the importance of remembering, information with consequences for forgetting is deemed most important and best remembered. Therefore, if people learn to self-assess and prioritise what information will need to be remembered or have negative consequences if forgotten, the recall of said important information can be enhanced, a critical interaction between cognitive and metacognitive processes, and a novel concept that we are calling *responsible remembering*.

Note

1. Bonferroni adjustments were made in all cases of multiple comparison post hoc testing.

Acknowledgments

We would like to thank Tyson Kerr for assistance in the creation of the task and Karina Agadzhanyan, Stephen Huckins, Marissa Pennino, and Jesse Kuehn for assistance with data collection. We also thank Matt Rhodes, Robert Bjork, Elizabeth Bjork, Barbara Knowlton, Alex Siegel, Mary Whatley, Katie Silaj, Shawn Schwartz, and Alex Gordon for helpful comments regarding the project and manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was supported in part by the National Institutes of Health (National Institute on Aging; Award Number R01 AG044335 to Alan D. Castel).

Open practices statement

None of the experiments reported in this article were formally preregistered. Neither the data nor the materials have been made available on a permanent third-party archive; requests for the data or materials are available from the corresponding author upon reasonable request.

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References

Arbuckle, T. Y., & Cuddy, L. L. (1969). Discrimination of item strength at time of presentation. *Journal of Experimental Psychology*, *81*(1), 126–131. https://doi.org/10.1037/h0027455

Ariel, R., Al-Harthy, I. S., Was, C. A., & Dunlosky, J. (2011). Habitual reading biases in the allocation of study time. *Psychonomic Bulletin and Review*, *18*(5), 1015–1021. https://doi.org/10.3758/s13423-011-0128-3

Ariel, R., & Dunlosky, J. (2013). When do learners shift from habitual to agenda-based processes when selecting items for study? *Memory & Cognition*, *41*(3), 416–428. https://doi.org/10.3758/s13421-012-0267-4

Ariel, R., Dunlosky, J., & Bailey, H. (2009). Agenda-based regulation of study-time allocation: When agendas override item-based monitoring. *Journal of Experimental Psychology: General*, *138*(3), 432–447. https://doi.org/10.1037/a0015928

Besken, M., & Mulligan, N. W. (2013). Easily perceived, easily remembered? Perceptual interference produces a double dissociation between metamemory and memory performance. *Memory & Cognition*, *41*(6), 897–903. https://doi.org/10.3758/s13421-013-0307-8

Bonin, P., Thiebaut, G., Witt, A., & Méot, A. (2019). Contamination is "good" for your memory! Further evidence for the adaptive view of memory. *Evolutionary Psychological Science*, *5*(3), 300–316. https://doi.org/10.1007/s40806-019-00188-y

Byard, R. W. (2018). Death by food. *Forensic Science, Medicine and Pathology*, *14*(3), 395–401. https://doi.org/10.1007/s12024-017-9899-9

Castel, A. D., McGillivray, S., & Friedman, M. C. (2012). Metamemory and memory efficiency in older adults: Learning about the benefits of priority processing and value-directed remembering. In M. Naveh-Benjamin, & N. Ohta (Eds.), *Memory and aging: Current issues and future directions* (pp. 245–270). Psychology Press.

Double, K. S., & Birney, D. P. (2019). Reactivity to measures of metacognition. *Frontiers in Psychology*, *10*, 2755. https://doi.org/10.3389/fpsyg.2019.02755

Double, K. S., Birney, D. P., & Walker, S. A. (2018). A meta-analysis and systematic review of reactivity to judgements of learning. *Memory (Hove, England)*, *26*(6), 741–750. https://doi.org/10.1080/09658211.2017.1404111

Dunlosky, J., & Matvey, G. (2001). Empirical analysis of the intrinsic-extrinsic distinction of judgments of learning (JOLs): effects of relatedness and serial position on JOLs. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*(5), 1180–1191. https://doi.org/10.1037/0278-7393.27.5.1180

Fantz, A. (2015, January). After leaving a child in the car, 'that pain never goes away'. https://www.cnn.com/2014/07/03/us/hot-car-deaths/index.html

Fernandes, N. L., Pandeirada, J. N., Soares, S. C., & Nairne, J. S. (2017). Adaptive memory: The mnemonic value of contamination. *Evolution and Human Behavior*, *38*(4), 451–460. https://doi.org/10.1016/j.evolhumbehav.2017.04.003

Finn, B. (2008). Framing effects on metacognitive monitoring and control. *Memory & Cognition*, *36*(4), 813–821. https://doi.org/10.3758/MC.36.4.813

Friedman, M. C., McGillivray, S., Murayama, K., & Castel, A. D. (2015). Memory for medication side effects in younger and older adults: The role of subjective and objective importance. *Memory & Cognition*, *43*(2), 206–215. https://doi.org/10.3758/s13421-014-0476-0

Gretz, M. R., & Huff, M. J. (2019). Did you wash your hands? Evaluating memory for objects touched by healthy individuals and individuals with contagious and noncontagious diseases. *Applied Cognitive Psychology*, *33*(6), 1271–1278. https://doi.org/10.1002/acp.3604

Halamish, V., McGillivray, S., & Castel, A. D. (2011). Monitoring one's own forgetting in younger and older adults. *Psychology and Aging*, *26*(3), 631–635. https://doi.org/10.1037/a0022852

Hanczakowski, M., Zawadzka, K., Pasek, T., & Higham, P. A. (2013). Calibration of metacognitive judgments: Insights from the underconfidence-with-practice effect. *Journal of Memory and Language*, *69*(3), 429–444. https://doi.org/10.1016/j.jml.2013.05.003

Jackson, K. D., Howie, L. D., & Akinbami, L. J. (2013, May). *Trends in allergic conditions among children: United States, 1997-2011. NCHS data brief, no 121*. National Center for Health Statistics. https://pubmed.ncbi.nlm.nih.gov/23742874/

Janes, J. L., Rivers, M. L., & Dunlosky, J. (2018). The influence of making judgments of learning on memory performance: Positive, negative, or both? *Psychonomic Bulletin & Review*, *25*(6), 2356–2364. https://doi.org/10.3758/s13423-018-1463-4

Koriat, A. (1997). Monitoring one's own knowledge during study: A cue-utilization approach to judgments of learning. *Journal of Experimental Psychology: General*, *126*(4), 349–370. https://doi.org/10.1037/0096-3445.126.4.349

Kornell, N., Rhodes, M. G., Castel, A. D., & Tauber, S. K. (2011). The ease-of-processing heuristic and the stability bias. *Psychological Science*, *22*(6), 787–794. https://doi.org/10.1177/0956797611407929

Kostic, B., McFarlan, C. C., & Cleary, A. M. (2012). Extensions of the survival advantage in memory: Examining the role of ancestral context and implied social isolation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*(4), 1091–1098. https://doi.org/10.1037/a0026974

McCabe, D. P., & Soderstrom, N. C. (2011). Recollection-based metamemory judgments are more accurate than those based on confidence: Judgments of remembering and knowing (JORKs). *Journal of Experimental Psychology: General*, *140*(4), 605–621. https://doi.org/10.1037/a0024014

McGillivray, S., & Castel, A. D. (2011). Betting on memory leads to metacognitive improvement in younger and older adults. *Psychology and Aging*, *26*(1), 137–142. https://doi.org/10.1037/a0022681

Middlebrooks, C. D., McGillivray, S., Murayama, K., & Castel, A. D. (2016). Memory for allergies and health foods: How younger and older adults strategically remember critical health information. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *71*(3), 389–399. https://doi.org/10.1093/geronb/gbv032

Mitchum, A. L., Kelley, C. M., & Fox, M. C. (2016). When asking the question changes the ultimate answer: Metamemory judgments change memory. *Journal of Experimental Psychology: General*, *145*(2), 200–219. https://doi.org/10.1037/a0039923

Mueller, M. L., & Dunlosky, J. (2016). How beliefs can impact judgments of learning: Evaluating analytic processing theory with beliefs about fluency. *Journal of Memory and Language*, *93*, 245–258. https://doi.org/10.1016/j.jml.2016.10.008

Murphy, D. H., & Castel, A. D. (2020). Responsible remembering: How metacognition impacts adaptive selective memory. *Zeitschrift für Psychologie*, *228*(4), 301–303. https://doi.org/10.1027/2151-2604/a000428

Murphy, D. H., & Castel, A. D. (2021). Responsible remembering and forgetting as contributors to memory for important information. *Memory & Cognition*. https://doi.org/10.3758/s13421-021-01139-4

Nairne, J. S. (2010). Adaptive memory: Evolutionary constraints on remembering. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 53, pp. 1–32). Academic Press.

Nairne, J. S. (2013). Adaptive memory: Controversies and future directions. In B. L. Schwartz, M. L. Howe, M. P. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp 308–321). Oxford University Press.

Nairne, J. S. (2015). Adaptive memory: Novel findings acquired through forward engineering. In D. S. Lindsay, C. M. Kelley, A. P. Yonelinas, & H. L. Roediger (Eds.), *Remembering: Attributions, processes, and control in human memory* (pp 3–14). Psychology Press.

Nairne, J. S., & Pandeirada, J. N. S. (2008). Adaptive memory: Remembering with a stone-age brain. *Current Directions in Psychological Science*, *17*(4), 239–243. https://doi.org/10.1111/j.1467-8721.2008.00582.x

Nairne, J. S., & Pandeirada, J. N. S. (2010). Adaptive memory: Ancestral priorities and the mnemonic value of survival processing. *Cognitive Psychology*, *61*(1), 1–22. https://doi.org/10.1016/j.cogpsych.2010.01.005

Nairne, J. S., Pandeirada, J. N. S., Gregory, K. J., & Van Arsdall, J. E. (2009). Fitness relevance and the hunter-gatherer mind. *Psychological Science*, *20*(6), 740–746. https://doi.org/10.1111/j.1467-9280.2009.02356.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

Nelson, T. O. (1996). Consciousness and metacognition. *American Psychologist*, *51*(2), 102–116. https://doi.org/10.1037/0003-066X.51.2.102

Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and some new findings. In G. H. Bower (Ed.), *(P 80) The psychology of learning and motivation* (pp. 125–173). Academic Press.

Noh, S. M., Yan, V. X., Vendetti, M. S., Castel, A. D., & Bjork, R. A. (2014). Multi-level induction of categories: Venomous snakes hijack the learning of lower levels. *Psychological Science*, *25*(8), 1592–1599. https://doi.org/10.1177/0956797614535938

Rhodes, M. G. (2016). Judgments of learning. In J. Dunlosky, & S. K. Tauber (Eds.), *The Oxford handbook of metamemory* (pp. 65–80). Oxford University Press.

Rhodes, M. G., & Castel, A. D. (2008). Memory predictions are influenced by perceptual information: Evidence for metacognitive illusions. *Journal of Experimental Psychology: General*, *137*(4), 615–625. https://doi.org/10.1037/a0013684

Rhodes, M. G., & Castel, A. D. (2009). Metacognitive illusions for auditory information: Effects on monitoring and control. *Psychonomic Bulletin & Review*, *16*(3), 550–554. https://doi.org/10.3758/PBR.16.3.550

Serra, M. J., & England, B. D. (2012). Magnitude and accuracy differences between judgements of remembering and forgetting. *Quarterly Journal of Experimental Psychology*, *65*(11), 2231–2257. https://doi.org/10.1080/17470218.2012.685081

Soderstrom, N. C., Clark, C. T., Halamish, V., & Bjork, E. L. (2015). Judgments of learning as memory modifiers. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *41*(2), 553–558. https://doi.org/10.1037/a0038388

Spellman, B. A., & Bjork, R. A. (1992). When predictions create reality: Judgments of learning may alter what they are intended to assess. *Psychological Science*, *5*(5), 315–317. https://doi.org/10.1111/j.1467-9280.1992.tb00680.x

Tauber, S. K., & Rhodes, M. G. (2012). Measuring memory monitoring with judgments of retention interval (JOR). *Quarterly Journal of Experimental Psychology*, *65*(7), 1376–1396. https://doi.org/10.1080/17470218.2012.656665

Tiede, H. L., & Leboe, J. P. (2009). Metamemory judgments and the benefits of repeated study: Improving recall predictions through the activation of appropriate knowledge. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *35*(3), 822–828. https://doi.org/10.1037/a0015122

Appendix

Child Names	Food Items					
Noah	APPLES	DONUTS	ORANGES	BREAD	SALMON	EGGS
Mia	BANANAS	PICKLES	CARROTS	TOAST	POPCORN	PRUNES
Vicky	GRAPES	BURGERS	HAM	BROCCOLI	PEARS	CUCUMBER
Martin	PISTACHIOS	CORN	CABBAGE	MANGOS	SALSA	OATMEAL
Melvin	PINEAPPLE	JELLY	PEACHES	SHRIMP	PRAWNS	LEMONS
Steph	PLUMS	AVOCADO	ARTICHOKES	CHIPS	LIMES	GARLIC
Emma	LOBSTER	SALAMI	SQUASH	HONEY	PUDDING	OLIVES
Liam	HALIBUT	CASHEWS	PEPPERONI	RAMEN	PARSLEY	RAISINS
Sophia	CRACKERS	TACOS	PRINGLES	BRIE	RAVIOLI	POTATOES
Logan	BEETS	WALNUTS	TANGERINE	BEEF	JALAPENOS	SUSHI
Mason	TUNA	CHERRIES	ZUCCHINI	CRABS	TOFU	MUSHROOMS
Amelia	JELLO	APRICOTS	CHILI	WAFFLES	PAPAYA	MACARONI
Daniel	VEAL	FETTUCCINE	OYSTERS	CUTIES	HAVARTI	SARDINES
Olivia	KALE	SCALLOPS	NUTMEG	PECAN	CURRY	KUMQUATS
Aiden	GOUDA	PORK	SOUP	BURRITOS	ASIAGO	PANCAKES
Ethan	YAMS	TOMATOES	LASAGNA	CLAMS	CORNDOGS	GRAVY
Isabell	ANCHOVIES	POKE	ONIONS	PIZZA	NACHOS	JERKEY
Charlotte	FIGS	CHOCOLATE	SORBET	COCONUT	MEATBALLS	CAKE
Lucas	FETA	SPAGHETTI	CHICKEN	GNOCHI	HERRING	CELERY
David	CASSEROLE	PEAS	CHEETOS	YOGURT	GUACAMOLE	MILK
Carter	COOKIES	BAGELS	STRAWBERRIES	PIE	WATERMELON	RICE
Emily	AHI	MUSSELS	RICOTTA	QUAIL	GUAVA	CEREAL
Dylan	CHORIZO	CAVIAR	DATES	TORTOLINI	TILAPIA	STRUDEL
Madison	LINGUINI	SPINACH	QUINOA	JELL-O	TURKEY	BOLOGNA