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EMPIRICAL ARTICLE

Autonomic Prospective Memory: Is Remembering Intentions Always Intentional?

Gianvito Laera[1, 2, 3], Nathan Scott Rose[4], Matthias Kliegel[1, 2, 3], and Chiara Scarampi[2, 3]

[1] Department of Psychology, Faculty of Psychology and Educational Sciences, University of Geneva, Switzerland
[2] Centre for the Interdisciplinary Study of Gerontology and Vulnerability, University of Geneva, Switzerland
[3] Swiss National Center of Competences in Research LIVES—Overcoming Vulnerability: Life Course Perspectives, Geneva and Lausanne, Switzerland
[4] Department of Psychology, University of Notre Dame, United States

Prospective memory—the ability to remember future intentions—is crucial for daily functioning, yet failures can have serious consequences (e.g., forgetting a baby in a car). This study examined how intention encoding (explicit vs. nonexplicit) and task relevance (participant vs. experimenter) affect prospective remembering. In our experiment, participants' cell phones (participant-relevant) or consent forms (experimenter-relevant) were collected while participants engaged in laboratory tasks. Under explicit encoding, participants were instructed to retrieve their items before leaving; under nonexplicit encoding, no such emphasis was given. Participants achieved an average performance of 89% in the absence of explicit encoding, suggesting that intentions can be successfully encoded and retrieved in the absence of explicit encoding instruction; only experimenter-relevant tasks benefited from explicit encoding. These findings challenge current prospective memory models, underscoring the importance of autonomic processes and contextual factors contributing to memory performance in critical real-world situations.

General Audience Summary

Prospective memory is the capacity to execute intended actions at the appropriate time while we are engaged with daily activities. While traditional cognitive models emphasize that remembering a future task requires a deliberate, conscious plan—known as explicit encoding—this research explores why certain important intentions are successfully performed without such conscious planning (i.e., nonexplicit encoding). The study compared how effectively individuals remembered two types of items when leaving a laboratory: a personally relevant item (their own cell phone) and an experimenter-relevant item (a consent form). Encoding was manipulated through instructions: In the explicit condition, the experimenter explicitly instructed participants to remember the item, while, in the nonexplicit condition, the experimenter did not mention this. The results showed that participants were significantly more likely to remember the cell phone than the experimenter's consent form. Crucially, providing explicit instructions to remember did not improve the retrieval of the cell phone: It was remembered equally well regardless of whether participants were told to keep it in mind. In contrast, the consent form required explicit instruction to be remembered effectively. By demonstrating that personal relevance can drive memory performance as effectively as deliberate planning, this work suggests that our brains have evolved alternative pathways to prioritize goals that are essential to our daily lives (i.e., internal signals, or the inherent importance of the item, can contribute to intention formation and maintenance outside of conscious awareness). Understanding these mechanisms has profound real-world implications, especially for preventing memory failures that could lead to fatal consequences. In tragic instances such as "forgotten-baby syndrome," the failure is often attributed to neglect; however, this study showed that such lapses can result from genuine memory breakdowns. Although more systematic research is needed, this study contributes to build a scientific framework to better understand memory processes in everyday life.

Keywords: autonomic, encoding, relevance, delayed intentions

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Gianvito Laera https://orcid.org/0000-0002-0589-7334
Nathan Scott Rose https://orcid.org/0000-0002-7619-4441
Matthias Kliegel https://orcid.org/0000-0002-2001-2522
Chiara Scarampi https://orcid.org/0000-0003-0152-1441

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continued

Prospective memory (PM) is the ability to remember future intentions at the appropriate moment while engaged in a background activity usually referred to as ongoing task—OT (Einstein & McDaniel, 1990; Zuber et al., 2024). PM is crucial for daily functioning as it promotes functional autonomy and higher quality of life (Hering et al., 2018; Laera et al., 2021). However, PM failures are frequent and constitute a significant portion of everyday memory lapses (Crovitz & Daniel, 1984; Haas et al., 2020). While most PM errors result in minor inconveniences, others escalate into serious situations. In the most tragic cases, forgetting PM tasks can have life-threatening consequences, such as when caregivers forget children in vehicles, termed the "forgotten-baby syndrome" (Berlinghieri, 2024; Board, 2019; Weingarten, 2009). The issue of caregivers' legal responsibility remains unresolved (Diamond, 2019; Forston & Fradella, 2022). Some scientists argue these incidents result from genuine memory failures rather than neglect (Breitfeld, 2020; Lee-Kelland & Finlay, 2019).

PM involves four stages (Ellis, 1996; Kliegel et al., 2002; Zuber et al., 2024): intention encoding, intention maintenance, intention retrieval, and intention execution. Several theories exist. The preparatory attentional and memory theory argues monitoring is always involved when remembering future intentions (Smith, 2003, 2017). The multiprocess framework (Einstein & McDaniel, 2005; McDaniel et al., 2015) highlights two mechanisms: strategic monitoring (driven by anterior prefrontal cortex) and spontaneous retrieval (depending on cue focality and hippocampal mechanisms). The dynamic multiprocess framework emphasizes context's role in engaging active monitoring and spontaneous retrieval (Scullin et al., 2013; Shelton & Scullin, 2017). While the preparatory attentional and memory theory suggests intention maintenance must be actively retained in working memory, multiprocess frameworks suggest intentions may be retained passively (outside focal attention) until cue-triggered retrieval. Recently, Strickland et al. (2024) introduced the prospective memory decision control model, formalizing PM as a race between evidence accumulators for OTs and prospective intentions, integrating proactive and reactive control strategies (Braver, 2012). No current PM theory fully accounts for real-world PM failures for critical, personally relevant tasks that are not explicitly formed, as in the "forgotten-baby syndrome."

Traditionally, PM is assessed with laboratory tasks where researchers ask participants to explicitly encode intentions; however, many routine tasks may be encoded incidentally or habitually, such as remembering to take a child from the car. Although explicit encoding might prevent such failures, research does not support this, as studies show explicit encoding does not necessarily increase the likelihood of remembering (Kvavilashvili et al., 2013; Rose et al., 2024; Scullin et al., 2018). Rose et al. (2024) recently manipulated item relevance and assessed participants' forgetting rates for tasks with real-world consequences, such as forgetting to retrieve their own cell phone or return a piece of the experimenter's research equipment. While not as tragic and severe as forgetting a child, forgetting one's cell phone is problematic, as it often contains sensitive information and is essential for many daily activities.[1] Rose et al. compared forgetting rates for a participant-relevant intention (retrieving the cell phone when leaving the lab) with an experimenter-relevant intention (returning a movement tracker at the end of the experiment) while manipulating encoding conditions. In the "explicit-instruction" condition, participants were clearly told to remember the item before leaving, whereas, in the "nonexplicit-instruction" condition, they were not given any explicit instruction. The results showed that participants forgot the movement tracker more often than the cell phone, and explicit encoding did not increase remembering (Rose et al., 2024). In a pilot study, we independently replicated the findings of Rose et al., showing no effect of encoding for remembering cell phones (for more info, see preregistration at https://doi.org/10.17605/OSF.IO/VZ3CH).[2]

These results challenge traditional PM theories, which assume that explicit intention encoding is a key element of PM (Ellis, 1996; Kliegel et al., 2002); thus, to explain these results, Rose et al. (2024) introduced the idea of *autonomic encoding*, suggesting that important intentions such as remembering a phone or a child are "autonomically" formed and maintained in a nonexplicit fashion, outside of conscious awareness, analogous to the implementation of bodily functions regulated by the autonomic nervous system. The

[1] It is important to emphasize that, although we draw on everyday items, like the cell phone, to study mechanisms relevant to the "forgotten-baby syndrome," the two phenomena are not directly comparable because the consequences are vastly different: The loss of a child represents an incomparably devastating and painful tragedy that cannot be equated with the inconvenience of misplacing a personal object. Using items such as phones in laboratory studies serves only as a paradigm to investigate cognitive mechanisms behind the phenomena, not to suggest any equivalence in emotional or moral weight.

[2] In the pilot study, participants were asked to deposit their phones and/or watches into a box placed on a shelf. We manipulated the perceptual salience of the box (i.e., salient—well visible on the shelf of the hall—or nonsalient—hidden in the hall) and also how the intention was encoded, providing either explicit or implicit instructions. The pilot study was conducted in the same lab as the present study. In this study, no effect of explicit instruction on PM forgetting rates was found.

responsibility for the content of the publication.

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Correspondence concerning this article should be addressed to Gianvito Laera, Department of Psychology, Faculty of Psychology and Educational Sciences, University of Geneva, 22 Chemin de Pinchat, Carouge, Geneva 1227, Switzerland. Email: gianvito.laera@unige.ch

authors avoided terms like "implicit" or "incidental" because such autonomically encoded tasks must be explicitly and intentionally performed (Rose et al., 2024). Despite its novelty, Rose's study had methodological limitations. The actions for experimenter-relevant and participant-relevant items were not directly comparable (participants returned the tracker to the experimenter but took their phone), which potentially influenced memory. Additionally, the within-subjects design meant tasks were not independently assessed, as one intention's performance could trigger the other's retrieval.

The present study addressed these limitations by modifying the paradigm (autonomic PM task), controlling for intended actions. We applied a between-subjects design ensuring participants performed the same action—taking either the participant-relevant item (cell phone) or experimenter-relevant item (consent form) when leaving. We predicted participants would remember the participant-relevant item more often, and, as in Rose et al. (2024), explicit encoding would not influence PM accuracy. Another important conceptual novelty is how PM remembering was measured. Rose et al. considered both strict (stopping before leaving building) and lenient (distance-based) criteria. We defined PM failure using strict (recalling before leaving laboratory) and lenient (time elapsed between experiment end and intention execution) criteria. We used time-based criteria to capture temporal aspects of PM execution, which has never been investigated in this context, but is crucial to consider because fatal consequences result from temporally delayed actions. By examining encoding conditions and task relevance impacts, we aimed to comprehensively understand PM performance and its real-world implications.

Finally, participants were asked about making "mental notes" during intention formation, and whether spontaneous thoughts about the to-be-remembered item during retention supported performance. Mental note use indirectly indicates self-initiated, more explicit intention formation (Rose et al., 2024). These questions assessed participants' understanding and intentionality toward the PM task, particularly when nonexplicitly encoding the consent form intention, potentially misinterpreted as "optional." Note that, according to university policy, all participants were aware that they were to take the consent form, yet our instructions were consistent across groups. We statistically tested the impact of participants' responses on PM performance and compared effects against encoding and task relevance. To compare to autonomic PM, participants also performed traditional laboratory and naturalistic PM tasks (Einstein et al., 1995; Schnitzspahn, Ihle, et al., 2011; Zuber et al., 2024).

Method

This study was preregistered in the Open Science Framework (https://doi.org/10.17605/OSF.IO/VZ3CH): All task materials, data, metadata, code, and results are available for download and replication (Laera et al., 2023).

Participants

This study was statistically powered to detect small-to-medium differences in performance between experimental conditions. We computed the required sample size a priori using the software G*Power (Faul et al., 2007). The power analysis indicated that to detect an effect size of .30 at 95% power (two-tailed test, $\alpha = .05$) a total sample of 191 participants would be needed for a proportional χ^2 test (binomial outcome: miss vs. hit) with four independent groups (i.e., explicit and participant-relevant, explicit and experimenter-relevant, nonexplicit and participant-relevant, and nonexplicit and experimenter-relevant). To ensure an equal number of participants across groups, we increased the sample size to 192 participants (48 per group; age range: 18–43 years; $M_{\text{age}} = 23.31$; $SD_{\text{age}} = 3.74$; 149 women and one nonbinary). All participants were recruited from the University of Geneva. Participants were included in the analyses if they met the following inclusion criteria: aged between 18 and 35 years, fluent in French, no neurological and psychopathological conditions, and not currently taking psychotropic medication. Such criteria were applied after data collection because most participants were undergraduate students who were required to participate in the study for course assignments to gain first-hand experience with psychological experiments; inclusion criteria were applied a posteriori to ensure equitable and inclusive participation during recruitment—thus allowing all students the opportunity to take part—while restricting the final sample to individuals meeting the predefined eligibility requirements. After exclusions, 140 participants were retained (age range: 18–35 years; $M_{\text{age}} = 23.04$; $SD_{\text{age}} = 3.38$; 110 women and one nonbinary); *N*s for the participant-relevant explicit and nonexplicit, and the experimenter-relevant explicit and nonexplicit conditions were 36, 39, 34, and 31, respectively. All participants provided informed consent before participating in the study. The study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the ethical commission of the University of Geneva (No. CUREG-2023-02-22).

Design and Procedure

The study had 2 (Encoding instruction: nonexplicit vs. explicit) × 2 (Task relevance: participant-relevant: cell-phone vs. experimenter-relevant: consent form) between-subjects design. Participants performed three types of PM tasks: the autonomic PM task adapted from Rose et al. (2024); traditional computerized PM tasks—always performed in the laboratory—and a naturalistic PM task performed at home.

The experimental procedure lasted ~1 hr. At the beginning of the experiment, participants arrived at the laboratory, which consisted of a hall and three testing rooms. Participants entered the lab necessarily through the hall, where they received the instructions and were informed that they would complete a series of questionnaires and cognitive tasks on a computer in one of the testing rooms. They were presented with two copies of a consent form and instructed to read it carefully, ask any questions they might have, and sign it if they agreed to the terms. Participants were then assigned to one of the four experimental conditions and were told the following instructions:

1. Explicit encoding of participant-relevant item: "Could you please put your phone in this box? Please, remember to take the cell phone with you at the end of the experiment before leaving the laboratory";

2. Nonexplicit encoding of participant-relevant item: "Could you please put your phone in this box? We will keep it safe

during the experiment so that you don't use it or get distracted by it";

3. Explicit encoding of experimenter-relevant item: "As required by university policy, please remember to take your copy of the consent form with you at the end of the experiment before leaving the laboratory";

4. Nonexplicit encoding of experimenter-relevant item: "As required by university policy, there are two copies, one for us and one for you."

Participants always knew that their phone was stored somewhere in the hall, as the experimenter was in there for the whole duration of the procedure; however, they did not see exactly where it was stored. After receiving the instructions, participants were escorted into one of the three testing rooms where they completed a series of tasks and questionnaires on a PC; while the participant was in the testing room, the items were placed in a mini chest of drawers on a cabinet located in the hall. Instructions for each task were displayed on the computer screen. Specifically, participants performed two laboratory-based PM tasks on a computer; the two tasks were administered in two separate blocks while always performing a lexical decision task as OT. In the time-based PM task, participants had to remember to press ENTER every 2 min, with the option to check the clock whenever they wanted by pressing the spacebar on the computer keyboard. In the event-based PM task, participants had to remember to press ENTER each time a target syllable ("our") appeared within the string of letters presented in the OT. Each PM task included five PM cues and 126 OT trials (63 words), randomly pulled from a sample of 254 OT stimuli (127 words). All words and nonwords consisted of 5–8 letters and were chosen based on their average scores for standardized accuracy and average *z*-transformed reaction times, following the guidelines established by Ferrand et al. (2010). Each OT trial consisted of a fixation cross displayed for 1 s, followed by the stimulus for 2 s and by a jittered blank interval lasting between .25 and .75 s. The order of administration of the time-based and event-based tasks was counterbalanced across participants to control for learning effects.

Participants performed additional tasks and questionnaires, which are out of the scope of the present study, such as the continuous performance test, as a measure of attentional control (Braver et al., 2009; Riccio et al., 2002), the operation span, as a measure of working memory (Unsworth et al., 2005), the short version of the Metacognitive Prospective Memory Inventory (Rummel et al., 2019), a questionnaire on metacognition and potential manipulations of the PM cues, and the Pittsburgh Sleep Quality Index (Ait-Aoudia et al., 2013). Participants also provided sociodemographic information, including age, gender, education, and health-related issues. Once participants completed all the computerized tasks and questionnaires, they saw a final slide on the computer screen asking them to return to the hall.

At this point, participants either remembered or forgot the item (the cell phone or the copy of the consent form), after being informed by the experimenters that the experiment was over, and that they could leave the laboratory. If participants remembered the phone or the consent form, they were debriefed about the experiment and completed a follow-up questionnaire; in addition, they were instructed about two naturalistic time-based PM tasks (see below) they were to perform the following day. If participants left the laboratory without the phone or consent form, the experimenter contacted them through email after 2 hr, requesting that they return to the laboratory. Upon collecting their phone or consent form, the follow-up questionnaire was administered, and participants were instructed about the naturalistic tasks.

The follow-up questionnaire comprised two questions:

1. Did you make a mental note to remember to retrieve your cell phone/the consent form?

2. Did you think about your phone/the consent form during the experiment?

On one hand, the first questions was helpful to assess the usage of a mental note as an active strategic effort to prevent forgetting during encoding; on the other hand, spontaneous thoughts referred to more «automatic» processes of intention retrieval promoted in the absence of active efforts (similarly to the "spontaneous retrieval" monitoring processes formalized by the multiprocess framework; Einstein & McDaniel, 2005). The naturalistic tasks were adapted from Schnitzspahn, Ihle, et al. (2011) and required participants to send two text messages to the experimenter at specific times: one in the morning and one in the evening (i.e., at 11:00 and at 21:00) on the day following their participation in the laboratory-based experiment. Participants were instructed to text the participant ID code that had been assigned to them during the laboratory session.

Data Analysis

Performance on the autonomic PM task was scored using two criteria. The first criterion (strict) measured whether participants remembered to take the phone or consent form with them before touching the door handle to leave the laboratory, scoring accuracy as 1 = "hit" for correct recall and 0 = "miss" for failures. The second criterion (lenient) considered the time elapsed between when participants left the testing room after completing the computerized tasks and when they remembered the task. This was only measured if participants remembered to collect the cell phone or the consent form within 2 hr. Participants were recontacted by the experimenter after the 2-hr window; those participants were not included in the analysis on PM response timing. For the home-based naturalistic PM task, performance was measured by recording whether participants remembered to send the message(s) on time—that is, ±6 min of the target time was classified as correct PM responses (three levels: 0 = *none*, 1 = *once*, and 2 = *both*). For the laboratory-based tasks, PM performance was assessed using both event-based and time-based measures (Einstein et al., 1995; Joly-Burra et al., 2022, 2025; Park et al., 1997): event-based PM performance was measured by the proportion of correct responses (PM accuracy) and mean reaction times for correct PM trials; time-based PM performance was assessed by responses made within ±6 s (10%) of the 2-min target time (Cona et al., 2012; Vanneste et al., 2016).

Data preprocessing and analysis were performed in R-studio (version: 2024.04.1)—R Version 4.2.1 (R Core Team, 2022). The analyses controlled for responses to the follow-up questions; the first question assessed whether participants used a mental note, while the second question assessed whether they spontaneously thought about the item (i.e., cell phone or consent form) during the retention period; both variables were coded as categorical (0 = *no*, 1 = *yes*). Hierarchical binomial logistic regression was conducted to assess the impact of encoding and task relevance on the likelihood of remembering (Wilson & Lorenz, 2015). Hierarchical negative-binomial regression was utilized to assess the impact of encoding and task relevance on the timing of the autonomic PM response. Negative-binomial regression can capture well the quasiordinal overdispersed behavior of the response timing[3] (Hilbe, 2011). Three models were compared based on their goodness-of-fit: Model 0 (baseline) contained only the intercept; Model 1 incorporated the two responses to the follow-up questions as predictors; and Model 2 added both encoding and task relevance and interaction as predictors. If the interaction effect (Encoding × Task Relevance) of Model 2 was significant, post hoc comparisons were conducted using z-tests with Bonferroni correction for multiple comparisons. Furthermore, we also explored the self-reported usage of mental notes as it can be informative on the presence of self-initiated explicit encoding.

In addition to the traditional frequentist analyses, Bayesian analyses were also conducted to quantify the relative likelihood of the null hypothesis model compared to the alternative hypothesis model. Specifically, the alternative hypothesis posited that there would be a difference in the dependent variable as a function of encoding and task relevance (Beard et al., 2016). We tested the two main effects and their interaction against a Bayesian null model containing all other effects that were not of interest (as well as the effect of participant); this strategy allowed us to evaluate the strength of hypotheses for these effects of interest against all other factors (Wetzels et al., 2015). Hierarchical binomial logistic Bayesian regressions were conducted to assess the impact of encoding and task relevance on the likelihood of remembering; hierarchical hurdle-γ Bayesian regressions were utilized to assess the impact of encoding and task relevance on the timing of the autonomic PM response (Bürkner, 2017); hurdle-γ regressions are able to adequately model excess zeros in the responses and to handle bounded data and quasiordinal outcome variables as naturally as β regression does (Kubinec, 2023). Log-transformed Bayes factor (BF) for the alternative hypotheses (i.e., log-BF_{10}) ≥ 3 was considered as sufficient evidence (Wetzels et al., 2015).

Correlational analyses were performed to examine the relationships among all PM measures (i.e., naturalistic tasks performed at home and in the laboratory, as well as computerized PM tasks). Pearson's correlations (both frequentist and Bayesian) were computed for pairs of continuous variables; in cases where one variable was dichotomous, we applied Kendall-τ correlations.

Results

The frequency of PM responses (misses and hits) is reported in Table 1; descriptive statistics for all PM measures are reported in Table 2.

Autonomic Task

Probability of Remembering (Strict Criterion)

The likelihood ratio test comparing Model 1 to the baseline model (i.e., Model 0 with only the intercept) was significant, indicating that Model 1 provided a significantly better fit to the data, $\chi^2(2) = 32.47$, $p < .001$, log-$BF_{10} > 30$; however, the likelihood ratio test further indicated that Model 2 provided a significantly better fit to the data than Model 1, $\chi^2(3) = 39.65$, $p < .001$, log-$BF_{10} > 30$. The results from Model 2 indicated that making mental notes was associated with higher odds of remembering the intention, $OR = 10.73$; 95% CI [3.47, 41.80], $p < .001$, log-$BF_{10} = 4.46$ (Figure 1, left plot), while spontaneous thoughts about the to-be-remembered item did not significantly predict PM task performance ($p = .406$; log-$BF_{10} = 0.63$). Results showed a statistically significant effect of encoding, $OR = 22.14$; 95% CI [5.07, 96.59], $p < .001$, log-$BF_{10} = 3.38$, but not task relevance ($p = .672$; however, there was moderate Bayesian evidence for the alternative hypothesis: log-$BF_{10} = 2.07$). A significant interaction effect (Encoding × Task Relevance) was found as well, $OR = 77.32$; 95% CI [10.31, 724.15], $p < .001$, log-$BF_{10} = 2.45$ (Figure 1, central plot). Post hoc comparison revealed that, in the participant-relevant condition, the difference between explicit and nonexplicit encoding conditions was not significant (ps > .050); however, in the nonexplicit encoding condition, the probability of remembering was significantly lower for experimenter-relevant items than for participant-relevant items, $z = -4.79$, $p < .001$, $d = -4.05$, 95% CI [−5.72, −2.38], but, in the explicit encoding condition, there was no significant difference between the experimenter- and participant-relevant intentions (ps > .050). In the experimenter-relevant condition, recall of explicitly encoded intentions was significantly higher than for implicitly encoded intentions, $z = 4.12$, $p < .001$, $d = 3.10$, 95% CI [1.62, 4.58].

Timing of PM Responses (Lenient Criterion)

The likelihood ratio test between Model 1 and the baseline Model (i.e., a model with only the intercept) was not significant, $\chi^2(2) = 3.047$, $p = .218$, $BF_{10} = 3.50$; however, the likelihood ratio test indicated that Model 2 provided a significantly better fit to the data than Model 1, $\chi^2(3) = 20.63$, $p < .001$, $BF_{10} = 6.84$. The results from Model 2 indicated that making mental notes did not affect the timing of responses ($p = .373$); however, when running Bayesian analysis, results indicated moderate evidence of a positive effect on PM performance related to the usage of notes (log-$BF_{10} = 1.58$) and spontaneous thoughts about the to-be-remembered item ($p = .107$, log-$BF_{10} = -1.04$) did not significantly predict the timing of the PM responses. Results further showed no effect of encoding ($p = .716$, log-$BF_{10} = -0.62$) but a statistically significant effect of task relevance, $\beta = .57$; 95% CI [0.29, 0.88], $p < .001$, log-$BF_{10} = 1.28$; no significant interaction effect Encoding × Task Relevance was found, ($p = .844$, log-$BF_{10} = -0.26$). Post hoc comparison for the main effect of relevance showed that the response time for performing the PM task was significantly faster for the participant-relevant condition than for the experimenter-relevant item, $z = 3.64$, $p < .001$, $d = -1.19$, 95% CI [−1.84, −0.55] (Figure 1, right plot).

Mental Notes

Table 3 and Figure 2 summarize the frequency of self-reported usage of mental notes across conditions. Overall, 52.1% of responses indicated the use of notes. A chi-square test revealed a significant main effect of encoding, $\chi^2(1) = 11.72$, $p < .001$, such that participants were more likely to use notes when encoding was explicit (55.2%) compared with nonexplicit (31.0%). In contrast,

[3] Models for both accuracy and timing of the response were selected if assumptions were not violated (see repository for more information).

Table 1
Frequency Statistics of PM Performance at the Autonomic Task

			Autonomic PM accuracy		
Relevance	Encoding	Measure	Incorrect (forgotten)	Correct (remembered)	Total
Experimenter	Explicit	Count	6	25	31
		%	19.35	80.65	100.00
	Nonexplicit	Count	28	6	34
		%	82.35	17.65	100.00
	Total	Count	34	31	65
		%	52.31	47.69	100.00
Participant	Explicit	Count	7	32	39
		%	17.95	82.05	100.00
	Nonexplicit	Count	4	32	36
		%	11.11	88.89	100.00
	Total	Count	11	64	75
		%	14.67	85.33	100.00
Total	Explicit	Count	13	57	70
		%	18.57	81.43	100.00
	Nonexplicit	Count	32	38	70
		%	45.71	54.29	100.00
	Total	Count	45	95	140
		%	32.14	67.86	100.00

Note. Frequency statistics of PM performance as a function of encoding (explicit vs. nonexplicit) and task relevance (participant-relevant: cell phone vs. experimenter-relevant: consent form); percentage of the total within each group of task relevance and encoding condition. PM = prospective memory.

the main effect of relevance was not significant, ($p = .516$), suggesting comparable rates of notes when tasks were framed as relevant to the participant (34.3%) versus the experimenter (28.6%). The interaction was significant, $\chi^2(3) = 13.63$, $p = .003$. Follow-up Fisher's exact tests indicated that, within the participant-relevance condition, explicit encoding yielded significantly more notes than nonexplicit encoding ($OR = 0.25$, 95% CI [0.08, 0.70], $p = .005$). A similar but weaker effect emerged for the experimenter-relevance condition ($OR = .34$, 95% CI [0.10, 1.07], $p = .045$). Within the explicit encoding condition, use of mental notes did not differ reliably between participant- and experimenter-relevance ($p = .470$). Within the nonexplicit condition, no effect of relevance was observed ($p = 1.00$).

Correlational Analyses

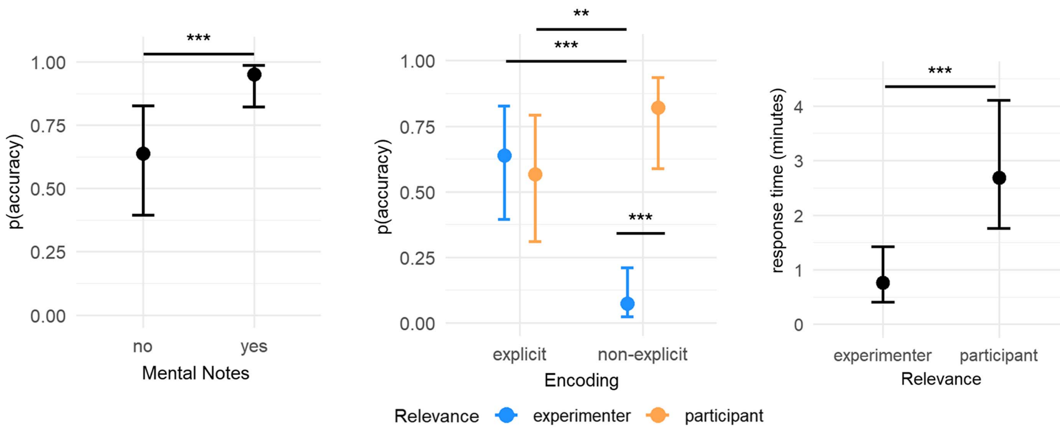
Response time for the autonomic PM task was negatively correlated with the naturalistic PM task at home ($r = -.20$, $p = .020$); however, Bayesian analysis did not provide evidence for this

Table 2
Prospective Memory Performance by Task, Encoding, and Relevance

Task	Measure	Encoding	Relevance	*N*	*M*	*SD*
Autonomic	PM recall before leaving the laboratory	Nonexplicit	Experimenter	34	0.18	0.39
			Participant	36	0.89	0.32
		Explicit	Experimenter	31	0.81	0.40
			Participant	39	0.82	0.39
	Timing of PM response (in minutes)	Nonexplicit	Experimenter	6	0.83	0.75
			Participant	36	2.42	2.22
		Explicit	Experimenter	25	0.64	0.95
			Participant	39	2.10	2.70
Naturalistic (i.e., at home)	PM tasks performed on time	Nonexplicit	Experimenter	34	0.76	0.89
			Participant	36	0.78	0.90
		Explicit	Experimenter	31	0.55	0.72
			Participant	39	1.00	0.92
Computerized	Time-based PM accuracy	Nonexplicit	Experimenter	34	0.97	0.10
			Participant	36	0.93	0.15
		Explicit	Experimenter	31	0.89	0.24
			Participant	39	0.90	0.21
	Event-based PM accuracy	Nonexplicit	Experimenter	34	0.66	0.32
			Participant	36	0.61	0.31
		Explicit	Experimenter	31	0.50	0.36
			Participant	39	0.58	0.37

Note. PM = prospective memory.

Figure 1
Prospective Memory Performance as a Function of Mental Notes, Encoding, and Relevance



Note. Left plot: Probability of remembering the item as a function of subjective reports of forming a mental note (yes vs. no). Central plot: Probability of remembering as a function of encoding (explicit vs. nonexplicit) and task relevance (experimenter-relevant vs. participant-relevant). Error bars represent 95% confidence intervals. Right plot: Timing of autonomic response as a function of task relevance. See the online article for the color version of this figure.
** $p < .01$. *** $p < .001$.

correlation (log-BF_{10} = 0.72). Overall, no other significant correlations were found between laboratory-based PM measures and autonomic or naturalistic tasks ($ps > .050$).

Discussion

Results showed that the effect of encoding differed for the personally relevant versus experimenter-relevant task. Specifically, the participant-relevant item (cell phone) was remembered equally well, regardless of encoding, thereby confirming our predictions and replicating Rose et al. (2024). Although explicit encoding affected remembering probability, the effect was evident only for the consent form (Figure 1). Furthermore, remembering the cell phone was more frequent and faster than remembering the consent form. This supports the idea that explicit encoding is not always needed for successful performance (Kvavilashvili et al., 2013; Scullin et al., 2018), perhaps because personally significant intentions increase motivational and attentional resource allocation (Aberle et al., 2010; Laera et al., 2024). Interestingly, active use of a mental note was significantly associated with increased remembering (both items), while spontaneous thoughts were not significantly helpful. These results suggest that, although participants were not instructed to explicitly encode the intention, a subset nonetheless reported doing so, self-initiating an explicit encoding process. In other words, some participants voluntarily formed explicit intentions without instruction, maybe for strategic reasons (Aronov et al., 2015; Einstein & McDaniel, 2005; Harrington et al., 2025; Shelton & Scullin, 2017; Smith, 2003).

Contrary to our predictions, explicit encoding increased PM accuracy for the experimenter-relevant item (consent form); this was not in line with Rose et al. (2024). A key difference is with the consequence of failing to remember to bring their consent form versus being potentially charged with theft of a ~$100 piece of laboratory equipment. Participants were faster retrieving experimenter-relevant items, suggesting that, although fewer participants remembered consent forms (34 vs. 75), they were faster overall, irrespective of encoding condition. One explanation could be that experimenter-relevant stimuli, although less remembered, are more closely linked to the experimental context and associated with more spontaneous retrieval processes (Einstein & McDaniel, 2005; McDaniel et al., 2015). Indeed, experimenter- and personal-relevant intentions may have differed in memorability for reasons unrelated to personal relevance, such as perceptual salience, semantic congruency, level of familiarity, or frequency of prior exposure. In this regard, it is important to highlight that we cannot totally exclude that

Table 3
Frequency of Usage of Mental Notes as Function of the Experimental Design

Relevance	Encoding	Measure	Mental note No	Mental note Yes	Total
Experimenter	Explicit	Count	15	16	31
		% of total	48.39	51.61	100.00
	Nonexplicit	Count	25	9	34
		% of total	73.53	26.47	100.00
	Total	Count	40	25	65
		% of total	61.54	38.46	100.00
Participant	Explicit	Count	15	24	39
		% of total	38.46	61.54	100.00
	Nonexplicit	Count	26	10	36
		% of total	72.22	27.78	100.00
	Total	Count	41	34	75
		% of total	54.67	45.33	100.00
Total	Explicit	Count	30	40	70
		% of total	42.86	57.14	100.00
	Nonexplicit	Count	51	19	70
		% of total	72.86	27.14	100.00
	Total	Count	81	59	140
		% of total	57.86	42.14	100.00

Note. Percentage of the total within each group of task relevance and encoding condition.

Figure 2
Mental Notes as Function of the Experimental Design

Note. Frequency statistics represented as pie charts of self-report usage of mental notes as a function of encoding (explicit vs. nonexplicit) and task relevance (participant-relevant: cell phone vs. experimenter-relevant: consent form); percentage of the total within each group of task relevance. See the online article for the color version of this figure.

some participants in the nonexplicit condition did not understand that they were to take the consent with them; future studies should improve assessment of nonexplicitly encoded conditions.

Rose et al. (2024) reported that 43% of participants in the experimenter-relevant condition and 17.4% in the participant-relevant condition acknowledged forming a mental note. In our study, proportions were 17.9% and 24.3%, respectively (Table 3 and Figure 2). Several reasons exist for these discrepancies: For example, in Rose's experiment, returning an object belonging to the experimenter could have triggered social processes promoting explicit encoding and/or intention monitoring. Another notable difference was the delay between encoding and retrieval: The present study employed a ∼1-hr delay, while Rose et al. reported variable intervals (5–197 min). Previous research suggests longer retention intervals decrease remembering likelihood over days in naturalistic tasks (Black & McBride, 2024) but not over minutes in laboratory tasks (McBride et al., 2011); however, results are inconsistent (Hicks et al., 2000; Nigro & Cicogna, 2000). Rose et al. reported delay was not associated with forgetting probability. In summary, differences may stem from task demands and item characteristics. Despite procedural differences, findings converge in showing that personally relevant intentions can be successfully remembered without explicit encoding, suggesting that, in such everyday PM tasks, explicit intention formation alone might be not the only process protecting against forgetting intentions.

On one hand, the findings showed that remembering experimenter-relevant items benefited from explicit encoding, which aligns with traditional PM theories (Kliegel et al., 2002; Zuber et al., 2024). On the other hand, remembering participant-relevant items appeared to rely on more automatic, self-initiated processes—likely driven by their personal importance and habitual nature—allowing successful retrieval even without explicit encoding. This phenomenon cannot be adequately explained by traditional cognitive PM theories (Einstein & McDaniel, 2005; Shelton & Scullin, 2017; Smith, 2003). To understand the phenomenon, it may help to appeal to the broader literature on value-based effects on remembering intentions, which consistently shows that high-value intentions (i.e., the cell-phone, as a proxy in experiments) are typically remembered better than low-value ones (Cook et al., 2015; Penningroth & Scott, 2007). At the same time, personal relevance might be conceptually distinct from value: While value paradigms typically manipulate explicit incentives or outcomes, our manipulation targeted the inherent self-relatedness of the intention (e.g., remembering one's own phone vs. the experimenter's consent form); hence, although both approaches emphasize the motivational significance of the intention, personal relevance may engage self-referential and identity-related processes in addition to value-based mechanisms. In this way, our results complement and extend value-based accounts by showing that the source of importance—whether externally incentivized or rooted in personal relevance—can differentially shape prospective remembering. However, results on the use of a mental note suggested that some participants reported a self-initiated explicit encoding process without explicit instruction from the experimenter (Aronov et al., 2015; Einstein & McDaniel, 2005; Harrington et al., 2025; Shelton & Scullin, 2017; Smith, 2003).

Another possible explanation could be that, in specific circumstances, an encoding mechanism driven by interoceptive signals might be activated by contextual cues associated with the PM task (Kliegel et al., 2007; Rothen & Meier, 2017; Umeda et al., 2016). This aligns with theories of somatic markers (Damasio, 1996), which suggest the brain stores not only cognitive traces but also physical and emotional responses associated with a stimulus or task (Thayer & Brosschot, 2005; Werner et al., 2010). These markers, presumably stronger for personally relevant tasks, can be triggered by environmental cues, and their strength influences decision making by prioritizing important tasks, thus facilitating memory retrieval (Carter & Pasqualini, 2004; Dunn et al., 2006). In the PM paradigm, the brain might encode the intention at two levels: explicit (involving voluntary intention formation) and nonexplicit (linking the intention to somatic markers). Irrelevant items are more likely remembered when explicitly encoded, as autonomic encoding of such tasks tends to be weak—participants are less emotionally involved, resulting in fewer somatic markers and decreased likelihood of prospective remembering. In contrast, relevant items are less likely forgotten due to stronger somatic involvement and the gravity of consequences associated with PM forgetting. When we do not have an object typically present with us, somatic signals may help retain the intention that something is "off" and needs to be done. Hence, the intention may be activated and completed through a discrepancy-plus-search retrieval process (Breneiser & McDaniel, 2006; Lee & McDaniel, 2013; McDaniel et al., 2004). Although theoretically plausible, further research is needed to disentangle the nonexplicit processes of intention encoding.

Finally, results showed that computerized tasks did not significantly relate to either autonomic or naturalistic PM, suggesting the two tasks (Rose et al., 2024; Schnitzspahn, Zeintl, et al., 2011) are unlikely to measure similar processes (Rummel et al., 2023) or had poor psychometric properties, hindering detection of reliable associations (Kelemen et al., 2006; Rose et al., 2010); nonetheless, analysis on the full sample showed significant correlations (see Supplemental Materials), indicating the discrepancy might be due to statistical power. PM tasks vary in cue focality, encoding context, motivational relevance, and monitoring demands, reducing intertask reliability even when underlying processes are aligned. Laboratory-based PM tasks involve tightly controlled, short-term intentions with explicit cues, whereas naturalistic and autonomic tasks rely on self-initiated retrieval in less constrained contexts. These methodological differences, combined with limited critical trials and measurement noise, may obscure true associations. Alternatively, ostensibly "similar" PM tasks differ more substantially in cognitive demands than theoretical models assume, highlighting the need for improved task comparability. The single-item PM paradigm entails inherent measurement challenges: Prospective remembering involves infrequent opportunities to perform intended actions, so PM tasks must balance measurement reliability against ecological validity. These challenges underscore the importance of replication and methodological refinement (Blondelle et al., 2020). The present work contributes by replicating and extending prior findings (Rose et al., 2024) and informing future research aiming to improve reliability and theoretical precision of PM paradigms.

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