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COMMENTARY

Habits Are Not Goal-Dependent: Commentary on Buabang et al. (2023)

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People sometimes commit action slips by absentmindedly repeating unwanted responses, such as entering an old password instead of the current one. Most accounts hold that such slips demonstrate stimulus–response habits in which familiar contexts directly trigger well-practiced but now-incorrect responses. In contrast, Buabang et al. (2023) argue that action slips arise due to the continued influence of old, no longer accurate goal outcomes. In a reanalysis, we show that Buabang et al.'s participants actually provide striking evidence of goal-independent S–R habits: They correctly repeated well-practiced responses despite reporting incorrect goals. We also show that Buabang et al. misinterpreted the results of their mediation analyses by overlooking the direct influence of stimuli on responses. Understanding how habits work is important because habit change interventions are unlikely to succeed with goal-directed strategies that overlook context cues' direct activation of practiced responses.

Public Significance Statement
People sometimes slip up and repeat unwanted habits despite intending to act otherwise. We challenge the idea that such slips are based on people's goals and we show instead that they are directly activated by familiar performance environments. This insight is important for designing effective behavior change interventions in daily life. Many recurring, habitual behaviors such as poor diet, social isolation, spending and not saving money, and low productivity at school and work are stimulus-driven and tied to modern social, economic, and physical environments. Accordingly, behavior change interventions will be most effective when altering these environmental cues instead of changing people's goals and choices.

Keywords: habits, goals, behavior change, action slips, instrumental learning

Action slips have fascinated psychologists since James's (1890/1914) description of a person going into their bedroom to change clothes for dinner but finding themselves undressing for bed. Such slips are defined as absentmindedly acting in ways that counter intentions (Norman, 1981). In classic accounts, action slips occur due to stimulus–response (S–R) and habit associations (e.g., Botvinick & Plaut, 2004; Reason, 1979). Habits form as people repeat a response that yields a reward in a particular context. With sufficient repetition, the context comes to directly cue the repeated response (W. Wood et al., 2022). Thus, in most current accounts, people sometimes slip up and use old passwords because the login screen (context) triggers typing in the old, now-obsolete password (response). Such responses are directly activated by context cues and not by conscious or unconscious expectations that the old password will yield the desired outcome.

This goal independence of habits is linked to the architecture of the basal ganglia, in particular the lack of reward-based modulation of neural activity in the sensorimotor loop (Yin & Knowlton, 2006). Indeed, as people repeat a task and form habits, neural activation increases in the putamen, a part of the sensorimotor system (Patterson & Knowlton, 2018). Aligning with this view, considerable research shows that people repeat well-practiced actions when cued by contexts even when they intend to do something else (Gardner, 2015; Limayem et al., 2007).

In an opposing analysis, Buabang et al. (2023) argued that action slips occur when people act on old goal representations. In this view, instead of context cues directly triggering responses, the cue–response link is mediated by well-established goals, so that cues activate (now-incorrect) goals, which in turn activate responses (i.e.,

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instead of a stimulus–response or S–R association, a stimulus–outcome–response or S–O–R association). To test this hypothesis, they conducted a study in which participants were extensively or moderately trained in an online instrumental task. In each trial, participants saw two doors and picked the door that would open onto a reward (left or right). The doors' color signaled the location of the reward (e.g., yellow doors/reward on the left). After learning the task, participants were told the contingencies had changed for two of the door colors (reversed contingency conditions). For these doors, diamonds and rocks were now found in opposite locations (e.g., yellow doors/reward now on the right). Then, under strict time pressure, participants made choices again and reported their goal expectations (e.g., choice of the right blue door gets a diamond or a rock?). Buabang et al. (2023) concluded their findings showed that "action slips are caused by a goal-directed process that involves representations of old, no longer accurate contingencies" (p. 505).

In this reply, we show that Buabang et al.'s findings do not indicate that action slips are goal-driven. Instead, consistent with the direct cuing of responses by contexts, their data show a remarkable dissociation between habitual responses and goal expectations. We conclude by questioning the logic that places goals as the default, unfalsifiable explanation for any behavior. It is of course possible to demonstrate that a specific goal is irrelevant to a behavior. However, given that a behavior can serve several goals (multifinality), discounting one goal leaves open the possibility of different, untested goals that drive action. As De Houwer et al. (2023) acknowledged, "it is always possible to think of some goal-directed account of a finding that seems to favor an S-R account. We agree that a goal-directed perspective is unfalsifiable in this sense" (p. 3).

Participants Confused About Goals but Persisted Acting on Habit

A fundamental problem with Buabang et al.'s (2023) research is the failure to demonstrate that participants were motivated by dual goals: (a) an automatic goal driving habitual responses, which is based on well-learned outcome values and evident under time pressure and (b) a new goal driving thoughtful goal pursuit, which is based on recently learned outcome values. Past research provides good reason to question this differentiation between types of goals. Gawronski and De Houwer's (2014) review identified a large body of research that failed to find older, overlearned goal representations are activated automatically upon encountering a relevant stimulus, whereas more recently acquired outcome knowledge requires controlled processing (pp. 297–298).

Instead of retaining both old and new goal expectations, participants in Buabang et al.'s research simply seem confused. With the locations of diamonds and rocks reversed for two door colors and retained for the other two, participants had to report under time pressure a complex set of outcome expectations acquired at different times. By definition, action slips imply that people understand the correct response but fail to enact it. However, it is not clear that participants understood the goal outcomes in this study.

Confusion was evident when participants reported incorrect goals in the unreversed condition, in which the locations of diamonds and rocks remained the same (i.e., dual goals were not possible). Participants reported incorrect goals 26% of the time in this condition. Although Buabang et al. highlight the slightly higher error rate obtained when outcomes had been reversed (30% errors) as evidence that participants retained old goal representations, this is a statistically significant but meager increase over the errors when goals had not changed (30% in reversed condition vs. 26% errors in unreversed condition). Thus, at least a quarter of the time, participants expected the wrong outcome behind a door because they were confused about the task and not because they held a memory representation of an old, now-obsolete goal.

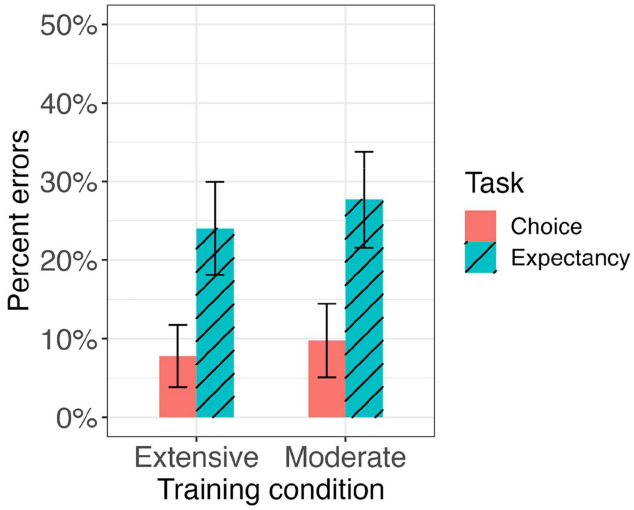
In fact, participants' behavioral choices in the unreversed condition provide striking evidence of habits proceeding independently of goals. That is, participants' door choices were considerably more accurate than they would have been if they were based on outcome expectancies (see Figure 1). After extensive training (left panel), participants continued to choose the correct door 92% of the time (8% errors) despite that they expressed marked confusion when probed for their automatic goal expectancy, reporting the correct door outcome only 76% of the time (24% errors). Even moderate training of 40 practice trials seems to have created a strong enough habit memory to persist under time pressure, with 90% of door choices correct despite only 72% correctly reporting goal outcomes (Figure 1, right panel). This discrepancy between habitual behavior (captured by choice accuracy) and goals (captured by conscious expectancies) is a classic demonstration of S–R habit learning, showing that habitual responses persist regardless of goals.

Buabang et al.'s Findings Were Biased by an Extreme Outlier

The high level of confusion is evident also in an outlier in the extensively trained condition who gave incorrect responses almost 100% of

Figure 1

Percentage of Errors in Unreversed Trials in Buabang et al. (2023)



Note. Comparison of choice and expectancy errors in conditions in which outcomes stayed the same so that an old goal representation was not possible. Data are adapted from Figures 4 and 5 in "A Goal-Directed Account of Action Slips: The Reliance on Old Contingencies," by E. K. Buabang, M. Köster, Y. Boddez, P. Van Dessel, J. De Houwer, and A. Moors, 2023, *Journal of Experimental Psychology: General*, *152*(2), pp. 496–508 (https://doi.org/10.1037/xge0001280). Copyright 2023 by the American Psychological Association. See the online article for the color version of this figure.

the time. The outlier is clearly observable in Figure 2 (available in Buabang et al.'s Open Science Framework code but not reported in the published article). This participant seemed to have completely forgotten the revised contingencies and so did not generate interpretable responses. By including this participant, Buabang et al. substantially bolstered the apparent evidence that action slips depend on goal errors (Buabang et al. note this outlier's influence in Footnote 6 in their article). All of our analyses below exclude this participant.

Past Evidence That Habits Do Not Depend on Automatic Goals

In proposing that automatic goals drive habitual responses, Buabang et al. overlooked existing research that challenge this analysis. For example, Lin et al. (2016) extensively trained participants in an online task to choose carrots when a particular image appeared on the screen. Extensively trained choices persisted even when contingencies changed and M&Ms became available, whereas moderately trained choices did not. However, habit persistence did not depend on a more favorable implicit affect toward carrots or a less favorable affect toward M&Ms. In this research, habit training influenced responding while having no effect on the implicit values of the response outcomes (see also Neal et al., 2012).

Misapplied and Misinterpreted S–O–R Mediation Tests

Buabang et al.'s (2023) second fundamental problem is their use of mediation models to demonstrate that "action slips are caused by a goal-directed process that involves representations of old, no longer accurate contingencies" (p. 505). However, Buabang et al.'s design cannot determine whether such outcome expectations (O) mediate between task stimuli (S) and action slips (R). Causal inferences are not possible when a mediator and outcome are assessed simultaneously (i.e., cross-sectional mediation tests). Although at one point widely used, this application of mediation models has largely been discredited because it is not logically possible for a mediator to cause an outcome occurring at the same time. Thus, such analyses are little more than correlations purporting to reflect causal relations (e.g., Rohrer et al., 2022).

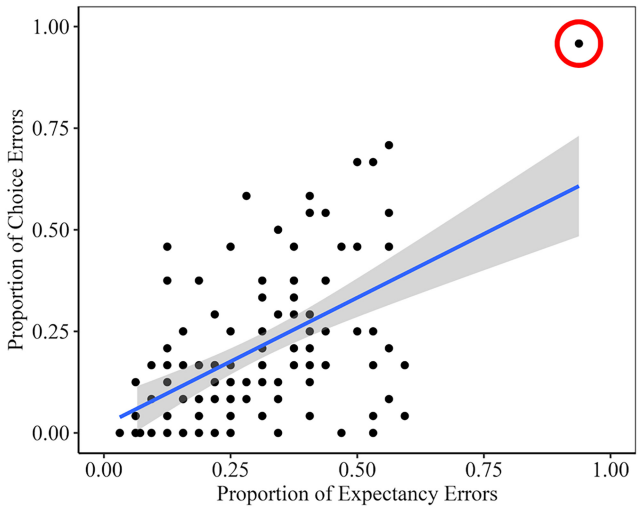
Even if Buabang et al.'s (2023) reported mediation model were interpretable, the results show little evidence that training influenced action slips by establishing incorrect goal expectancies (S–O–R). After excluding the outlier, it is clear that the direct S–R effect was far larger than the indirect S–O–R effect: $b = 0.13$ versus $b = 0.02$, representing nearly a seven-fold difference.[1] Specifically, using the R mediation package (Tingley et al., 2014), we reestimated the model in their Figure 6 and found that goal expectancies mediated only 12% of the effect of extent of training on action slips (after removing the outlier). Thus, the best that Buabang et al. could conclude is that action slips were due largely to direct stimulus–response associations, with only a slight influence of automatic goals. However, they did not acknowledge that the evidence of goal mediation was partial at best—even in their own analyses that included the outlier (see Figure 6). Instead, they went on to conclude that, "the effect of training condition on action slips was mediated by the reporting of old contingencies" (p. 505).

To demonstrate the arbitrariness of using mediation models for simultaneously assessed variables, we tested whether Buabang et al.'s (2023) data are compatible with an alternative model. Specifically, we flipped the mediator and the dependent variable to test whether action slips mediate the effects of training condition on outcome expectations (i.e., S–R–O mediation). Note that this analysis is consistent with a habit interpretation in which participants infer after-the-fact that the direct cuing of habit performance is due to goals (Mazar & Wood, 2022). This model showed complete mediation: The indirect effect of extensive/moderate training on outcome expectancies, via action slips, was significant, whereas the direct effect was not. Thus, Buabang et al.'s data support a habit account in that participants' outcome expectations completely depended on the performance of S–R action slips (see the supplemental materials, which are available on the OSF page https://osf.io/93xh8/?view_only=2edb541679ec4741997d5046a301e9f7). In this view, the R–O inference process explains the correlation Buabang et al. report between action slips and expectancies. Nonetheless, we recognize that this mediation analysis is no more appropriate than the one they report, given the simultaneous measurement of mediators and outcomes.

Further raising questions about Buabang et al.'s mediation model, inferences from mediation analyses are subject to residual confounding (e.g., Bullock et al., 2010; Fiedler et al., 2011; MacKinnon & Pirlott, 2015; Rohrer, 2018; Rohrer et al., 2022; R. E. Wood et al., 2008). We can estimate the sensitivity of mediation results to this unmeasured confounding using a procedure developed by Imai et al. (2010). Specifically, we estimated whether the confounding

Figure 2

Correlation Plot From Buabang et al.'s (2023) OSF Code



Note. The outlying observation is circled. Choice and expectancy errors are calculated as errors on reversed trials (outcome locations changed) minus unreversed trials (outcome locations same). Correlation plot is adapted from "A Goal-Directed Account of Action Slips: The Reliance on Old Contingencies," by E. K. Buabang, M. Köster, Y. Boddez, P. Van Dessel, J. De Houwer, and A. Moors, 2023, *Journal of Experimental Psychology: General*, *152*(2), pp. 496–508 (https://doi.org/10.1037/xge0001280). Copyright 2023 by the American Psychological Association. OSF = Open Science Framework. See the online article for the color version of this figure.

[1] Even when including the outlier, the direct S–R effect, $b = 0.12$, remains about four times the size of the indirect S–O–R effect, $b = 0.03$.

in Buabang et al.'s favored model was sufficient to account for their mediation findings (i.e., would reduce the effect to zero).[2] These analyses revealed that the test of goal-directed choice errors (stimulus [S]–expected outcome [O]–action slips [R]) was susceptible to confounding, reducing to zero given a relatively modest amount of confounding, $|\rho| = 0.24$.

Although Buabang et al.'s (2023) reported mediation model is not interpretable, their data were collected across an experimental session and thus allow testing for some kinds of mediation. For example, we can estimate whether the frequency of expectancy errors in an earlier block (O, the purported mediator) predicts the frequency of choice errors in a subsequent block (R, the supposed outcome), controlling for extensive versus moderate training conditions (S, the independent variable). Specifically, we fit a multilevel linear regression model predicting the difference in choice errors/action slips between reversed and unreversed trials in a given block from training condition (extensive vs. moderate) and the difference score of errors in goal expectancies in the preceding block (reversed errors–unreversed errors). Contrary to Buabang et al.'s hypothesis, the number of expectancy errors in the prior block did not significantly predict subsequent choice errors/action slips, $\beta = .06$, 95% confidence interval [CI] [−0.03, 0.16], $p = .213$. Instead, only a main effect for training condition emerged, indicating that more extensive training led to more action slips on reversed trials, $\beta = .31$, 95% CI [0.18, 0.44], $p < .001$. Given that expectancies failed to drive future action slips, participants do not seem to have relied on expectancies when making choices. Thus, with a mediation model that does not violate temporal precedence, the research provides little evidence that goals mediate S–R relations.

Why This Is Theoretically Important?

Buabang et al.'s research was spurred by a supposed problem in the habit literature. That is, habits are sometimes inferred from null findings of insensitivity to changes in goal outcomes. However, the problem of null findings is overstated, given that features of habits include not just outcome independence but also context dependence, attention shifts, and performance under cognitive load (Bouton, 2021; Foerde, 2018). The best habit research tests multiple of these indicators of habit (see Verplanken & Orbell, 2022).

Although we recognize that goals and values can reflect stable orientations that persist over time and context, the link between enduring goals and any single behavior is less clear. Because of goal equifinality, or substitutability in behavioral means, a goal can activate a variety of behaviors (Kruglanski et al., 2002). Even strongly desired goals that stably characterize people's motives, such as saving money, may yield a strategic orientation to choose among multiple behavioral means, such as clipping coupons, automating savings deposits, and shopping at sales. Thus, unlike habits, goal pursuit, whether deliberate or automatic, does not necessarily promote repetition of particular responses to particular cues.

Although old goals may not mediate between stimulus–response habits, goals, and habits interact in a variety of ways. As we have explained in earlier research, habits often form as people repeatedly pursue goals, goal pursuit can drive exposure to contexts that trigger already-established habits, and habitual responses are sometimes attributed to goal pursuit (Mazar & Wood, 2018; W. Wood & Rünger, 2016). Thus, goal pursuit might put people into situations in which they act out of habit. For example, given a goal of opening a computer or logging onto a website, people perceive familiar login cues, which in turn activates a habitual response of an old, expired password.

Finally, it is worth noting that some research has directly measured the S–R associations in memory that guide habit performance. For example, Neal et al. (2012) found that running locations (but not personal goals) activated thoughts of running among habitual runners, whereas goals (but not locations) brought running to mind for novice or occasional runners. Other research has shown that such cognitive associations predict repeated behavior with greater success than behavioral intentions (Danner et al., 2008; Labrecque et al., 2023). We look forward to future research developments assessing S–R representations in memory.

Why This Is Practically Important?

In daily life, people struggle with unwanted habits that are difficult to change. Many intractable everyday problems can be traced to people repeating nonoptimal behavior, involving poor diet, social isolation, spending and not saving money, and low productivity at school and work. We believe that it is important to recognize the extent to which such recurring behaviors are stimulus-driven and tied to modern social, economic, and physical environments, along with the constraints and opportunities these afford. By arguing that habits reflect goal-driven processes in which responses are selected based on their expected utility, Buabang and colleagues instead focus habit change efforts on people's goals and choices. In this approach, behavior change interventions should, "target the accessibility or effectiveness of different types of goal-directed strategies" (De Houwer et al., 2023, p. 4). We suspect that interventions that change minds, however, are likely to have limited effect for repeated actions (Webb & Sheeran, 2006), especially compared with interventions that focus on changing environments (e.g., Chater & Loewenstein, 2023).

Our argument is not that all behavior persists due to habit. However, given that humans have robust habit-learning mechanisms that track repeated behaviors, contexts, and rewards, much of what we repeat on a regular basis is at least partially due to habit. Substantial habit components are evident even in actions that seem more likely to represent motivated processing, such as posting on social media and spreading misinformation (Anderson & Wood, 2023; Ceylan et al., 2023).

In this broader context, it is surprising that Buabang and colleagues argue for a motivational model that inserts a goal between stimuli and responses, thereby challenging substantial empirical evidence along with theoretical parsimony. Nonetheless, we welcome Buabang et al.'s (2023) focus on situational drivers of behavior and anticipate considerable payoff from a better understanding of the ways that performance contexts influence behavior and potentially goal pursuit. These insights will undergird the discovery of ways to effectively address the behavioral challenges in health, environment, and equity currently experienced in human societies.

[2] This procedure quantifies unmeasured confounding using ρ, representing the association between the error terms of the regression predicting mediator and outcome, then simulating at what value of ρ an effect is reduced to 0. Absolute values of ρ closer to 0 suggest that an effect is more sensitive to unmeasured confounding, whereas values closer to 1 suggest that an effect is more robust.

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