

**RESEARCH ARTICLE**

# Promoting new habits at work through implementation intentions

Nina Trenz  | Nina Keith

Department of Human Sciences, Technical University of Darmstadt, Darmstadt, Germany

**Correspondence**

Nina Trenz, Department of Human Sciences, Technical University of Darmstadt, Alexanderstraße 10, 64283 Darmstadt, Germany.  
Email: [nina.trenz@tu-darmstadt.de](mailto:nina.trenz@tu-darmstadt.de)

**Abstract**

Habits facilitate automatic behaviours and are resource efficient. Habits at work may be beneficial because they conserve cognitive-attentional resources, thus fostering work engagement and goal progress. In a diary intervention study (2 daily assessments, 10 work days), we asked 72 employees to establish a new habit at work. Half of them additionally completed an intervention on the correct use of implementation intentions. All participants were given access to a follow-up survey. In multi-level analyses, automaticity of the new habitual behaviour predicted work engagement and goal progress at the day-level. Implementation intentions predicted frequency of the habitual behaviour and in turn increased automaticity of this behaviour. The effects of implementation intentions were still evident at follow-up. Contrary to expectations, the intervention did not increase participants' daily use of implementation intentions. The results indicate that implementation intentions might be used in everyday work to establish habits at work, thus increasing employees' efficiency and engagement.

**KEYWORDS**

automatic behaviour, goal progress, if-then planning, work engagement, work routines

## BACKGROUND

More than 100 years ago, William James stated that “habit covers a very large part of life” (James, 1890, p. 104). Today, habits are still considered fundamental in guiding and controlling daily life. Habits facilitate automatic behaviours, which are executed without cognitive effort (Gardner, 2015; Gardner & Lally, 2023; Wood & Neal, 2007). As modern work environments place a variety of complex demands

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### Practitioner points

- Establishing habits at work relates to higher employee engagement and effectiveness.
- Implementation intentions are a planning strategy that supports employees in establishing and maintaining habits at work.

on employees, it seems highly desirable to save resources through automatic behaviours by establishing habits at work. In contrast to habits in other areas of psychological interest, such as health or environmental behaviour (Bamberg, 2002; Gardner, 2015; Gardner et al., 2011, 2012; Holland et al., 2006), habits at work have received little attention in organizational psychology (for exceptions, see Chae & Choi, 2019; Ohly et al., 2017; Sonnentag et al., 2022).

We propose that habits at work increase goal progress and work engagement because they save cognitive-attentional resources (Danner et al., 2007, 2008; Gardner et al., 2012), such as directive attention and working memory capacity (Kanfer & Ackerman, 1989; Kanfer et al., 2017). This is because habits generate behaviours (i.e., habitual behaviours) that are triggered by the context and thus performed automatically (Gardner & Lally, 2023).

We further propose that implementation intentions are a strategy to implement new habits fast and deliberately (Gollwitzer, 1999, 2014). Implementation intentions represent a planning strategy in which a specific situation is linked to an action, specifying exactly when, where and how the action will be performed, for example, “When I have finished work, then I will clean up my desk” (Gollwitzer, 1999, 2012). Implementation intentions have been widely used as a powerful tool for habit formation and habit change, particularly in the context of health psychology (Adriaanse & Verhoeven, 2018; Bamberg, 2002; Verplanken & Faes, 1999; Webb et al., 2010). Implementation intentions drive habit formation because they facilitate action initiation in the specified situations, thus increasing the frequency of an intended behaviour in this situation (Gollwitzer, 1999, 2014; Keller et al., 2020). As habits develop through constant repetition of behaviours in consistent contexts (Lally et al., 2010, 2011), this increased frequency of a specific behaviour in a specific situation may promote habit formation.

Our study contributes to the literature in several ways. We extend recent findings that unwanted habits at work can be reduced with implementation intentions (Sonnentag et al., 2022). We use the strategy of implementation intentions to build new habits at work and focus on the consequences of these new habits for employee's work engagement and goal progress. That is, our study focuses on more distal dependent variables, whereas previous research on habits and implementation intentions at work focused on habit formation as outcome and did not include trickle-down effects of habits. By considering trickle-down effects of habits, we further seek to show that habits can improve self-regulation at work. For this reason, we focus on habit effects on work engagement and goal progress, that is, on outcomes of successful self-regulation at work (Lord et al., 2010; Parke et al., 2018).

In addition, we seek to further explore the causal relationship between implementation intentions and habit formation. To this end, we applied an intervention (i.e., mental contrasting with implementation intentions) designed to increase the use of implementation intentions (Adriaanse et al., 2010; Clark et al., 2021; Oettingen et al., 2015). We derive our hypotheses from theories of habit formation (Gardner et al., 2016; Lally et al., 2010; Wood & Neal, 2007) and research on implementation intentions (Gollwitzer, 1999, 2012). Our research hypotheses are depicted in [Figure 1](#).

## Habits at work

Habits are learned behavioural dispositions that are automatically triggered by features of the context in which that specific behavioural pattern has been performed frequently and consistently (Lally

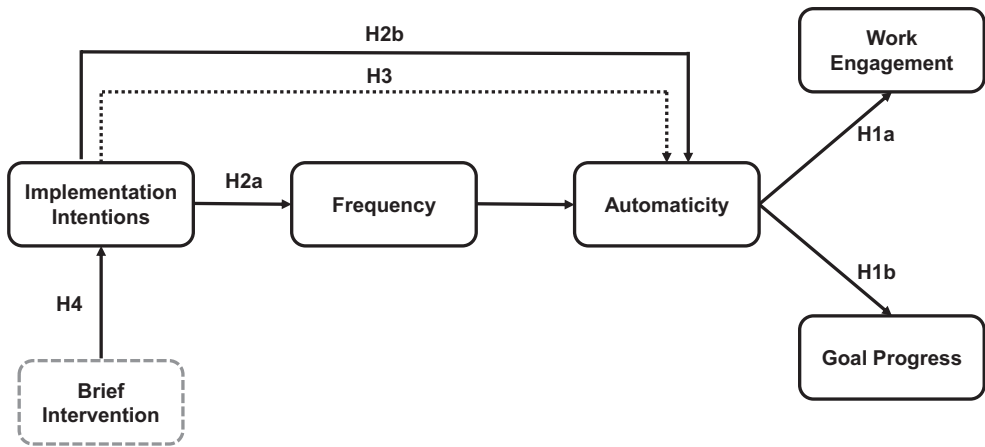


FIGURE 1 Proposed model. *Note:* The dashed arrow represents an indirect effect.

& Gardner, 2013; Wood & Neal, 2007). Habits are dependent on a contextual cue (Arlinghaus & Johnston, 2018; Ohly et al., 2006, 2017). Hence, widely different behaviours can become habitual if they are regularly performed in the same context and thereby linked to contextual cues (Lally et al., 2010). The term habit refers to a cognitive construct, that is, the association between context and behaviour, while the term habitual behaviour refers to behaviour generated by a habit (Gardner & Lally, 2023).

Habits and habitual behaviour can also occur at work (Ohly et al., 2006, 2017; Sonnentag et al., 2022). Based on the general definition of habits, we define habits at work as behavioural dispositions that people learn at work and that are automatically triggered by specific features of the work context. Work habits can be distinguished in task-related habits, habits related to the interpersonal context of work, and nonwork-specific habits (Sonnentag et al., 2022). *Task-related habits* refer to the core job task and represent behavioural dispositions relevant for task performance (Borman & Motowidlo, 1993), for example, fixed writing times. *Contextually embedded habits* refer to the interpersonal context of work and particularly involve contextual performance (Borman & Motowidlo, 1993), for example, shared coffee breaks which encourage group cohesion and productivity (Maspu, 2024; Stroeback, 2013). *Non work-specific habits* are dispositions for behaviours that people engage in at work but that do not necessarily relate to the job, for example, self-reward via healthy or unhealthy snacks (Sonnentag et al., 2022). As each of these habit types can be relevant for performance and well-being at work, all of them fall within the scope of this study. In this study, we assessed the frequency and automatization of an observable behaviour that people show at work. Hence, our hypotheses refer to habitual behaviour at work.

## Positive consequences of habits at work

Automaticity is a central characteristic of habits (Gardner et al., 2012; Lally & Gardner, 2013; Wood & Neal, 2007). More specifically, habitual action control changes from a conscious motivational process to a context-driven mechanism (Gardner, 2015; Lally et al., 2010). Habits are triggered automatically in the presence of a corresponding contextual cue, that is, an external stimulus, a thought, or an emotion (Lally & Gardner, 2013; Wood & Neal, 2007). Habitual behaviours can consequently be fast and efficient and they are executed without conscious thought and effort (Seger & Spiering, 2011; Wood & R niger, 2016). Due to their automaticity, habitual behaviours can be beneficial because they save cognitive-attentional resources such as directive attention and working memory capacity (Chae & Choi, 2019; Morgan & Hancock, 2011; Ohly et al., 2006; Voss et al., 2008). Cognitive-attentional resources are limited in availability, meaning that the more resources invested in a task, the better performance on that task will be, while performance on other tasks will decline

(Kanfer & Ackerman, 1989; Kanfer et al., 2017). Hence, saving cognitive-attentional resources through automatic behaviours means that more of these resources can be invested in other cognitively demanding tasks (Chae & Choi, 2019; Ohly et al., 2006).

In the work context, evidence that automatic behaviours save cognitive-attentional resources is empirically supported by related research on work routines. Specifically, this research showed that work routines are associated with free cognitive resources (Chae & Choi, 2019) or higher levels of energy (Ohly et al., 2017) and positively related to creativity in highly complex jobs (Chae & Choi, 2019; Ohly et al., 2006). Similarly, morning routine disruptions have been shown to enhance cognitive depletion and in turn decrease work engagement and goal progress (McClellan et al., 2021). Routines are observable repetitive behaviours at work that are regularly carried out in the same way and in the same order (McClellan et al., 2021; Piscitello et al., 2019). Routines are similar to habits because both refer to automatic behaviour that is induced by contextual cues (Ohly et al., 2017). However, routines are more complex behavioural sequences that involve sequencing and combining processes, procedures, steps, or occupations which are typically performed by groups rather than individuals. That is, routines have habitual elements, but not all habits are routines (Clark, 2000). Like routines, habits at work might save cognitive-attentional resources, consequently fostering work engagement and goal progress.

## Work engagement

Work engagement, which is defined as a positive, fulfilling, work-related state of mind (Schaufeli et al., 2002), generally depends on resources (Bakker & Demerouti, 2007, 2008; Crawford et al., 2010; Demerouti & Bakker, 2023). That is, employees may be more or less engaged on a specific day depending on resource availability (Tims et al., 2011; Xanthopoulou et al., 2009). In the present study, we refer to resources as cognitive-attentional resources allocated to tasks during goal-striving (Kanfer & Ackerman, 1989; Kanfer et al., 2017). Work engagement is characterized by vigour, dedication, and absorption (Schaufeli et al., 2002). *Vigour* refers to high levels of energy while working. *Dedication* means being strongly involved in one's work, and *absorption* refers to a state of being fully concentrated and happily engrossed in work (Bakker & Demerouti, 2008).

An engaged state requires the presence of energy to be invested in the work tasks, and being fully absorbed in work requires shielding against potential distractors that employees face on a daily basis (Kahn, 1990; McClellan et al., 2021). Habitual behaviours at work save cognitive-attentional resources and time due to their automaticity (Chae & Choi, 2019; Morgan & Hancock, 2011; Ohly et al., 2006; Voss et al., 2008). This results in a higher level of energy to be invested in work tasks (McClellan et al., 2021; Ohly et al., 2017), thus fostering work engagement.

**Hypothesis 1a.** Automaticity of the new habitual behaviour during the workday is positively related to daily work engagement.

## Goal progress

Progress towards a work goal varies within persons, depending on how well cognitive-attentional resources such as directive attention are allocated to the work task within a given episode (Beal et al., 2005; Koopman et al., 2016). The more time is spent on task accomplishment and the more attention is focused on the task, the easier goal progress will be (Beal et al., 2005; Kahneman, 1973). Cognitive-attentional resources saved by automatization increase the cognitive slack and save time, both of which can then be invested in other tasks (Chae & Choi, 2019; Morgan & Hancock, 2011; Ohly et al., 2017; Voss et al., 2008). In addition, habitual behaviour at work might in itself bring positive effects for work performance in terms of goal progress. For example, useful task-related habits such as fixed writing

times or turning off the mail program at certain times might facilitate habitual behaviours that reduce multitasking or task-switching, which has a positive impact on work performance in the short-term and long-term (Junco & Cotten, 2012; Monsell, 2003; Paridon & Kaufmann, 2010).

**Hypothesis 1b.** Automaticity of the new habitual behaviour during the workday is positively related to daily goal progress.

## Implementation intentions and habit formation

Implementation intentions (see Gollwitzer, 1993, 1999, 2014) are plans that specify when, where, and how one will initiate goal-directed behaviours. Various studies show that implementation intentions promote the formation of new habits as well as the abandonment of unwanted ones (Gollwitzer & Sheeran, 2006) with regard to health goals (Adriaanse & Verhoeven, 2018; Verplanken & Faes, 1999; Webb et al., 2010) and to environmental goals (Bamberg, 2002; Holland et al., 2006). In the work context, one study has shown that implementation intentions can change non work-specific habits such as recycling behaviour (Holland et al., 2006). Another recent study demonstrated that implementation intentions can reduce detrimental task-related habits (i.e., habits interfering with work goals), such as task switching, that are enacted at the workplace (Sonnentag et al., 2022).

These positive effects of implementation intentions are thought to occur because implementation intentions facilitate action initiation of an intended behaviour (Gollwitzer & Sheeran, 2006; Keller et al., 2020), thus promoting constant repetition of this behaviour in a specific context. Implementation intentions support the initiation of an intended habitual behaviour in a specific context because they facilitate the shift in action control from top-down to bottom-up processes (Bieleke et al., 2021). This is because implementation intentions facilitate encoding and recall of situational cues (Janczyk et al., 2015) and thus increase awareness of these situational, or contextual, cues (Achtziger et al., 2012). In addition, implementation intentions strengthen the mental connection between a situation and a specific behaviour, so that this behaviour is automatically activated whenever encountering the previously defined situation (Keller et al., 2020; Webb & Sheeran, 2007). Consequently, implementation intentions increase the likelihood that a specific behaviour will be performed in a specific situation. In other words, implementation intentions can increase the frequency with which a certain behaviour (a new habit) is performed in a certain situation (a consistent context). The regular repetition of a specific behaviour in a specific context is supposed to increase the automatization of this behaviour in this context, thus creating a habit (Lally et al., 2010, 2011).

**Hypothesis 2.** Forming implementation intentions in the beginning of the workday is positively related to (a) frequency and (b) automaticity of the new habitual behaviour.

**Hypothesis 3.** The relationship between forming implementation intentions and automaticity of the new habitual behaviour is mediated by frequency of this behaviour.

As described in the previous sections, it seems desirable to establish habits at work. Because implementation intentions promote habit formation and thus might increase effectivity and engagement at work, increasing the use of implementation intentions can be of high practical relevance. From a methodological perspective, manipulating the independent variable increases the internal validity of a study. Interventions that increase the use of implementation intentions open up the possibility to manipulate this variable experimentally, which raises confidence in the causal direction of action (e.g., implementation intentions increase the use of habits and not vice versa). For these two reasons, we aimed at increasing the use of implementation intentions in our study within an intervention group and compare the effects against a control group. In the following, we describe how implementation intentions might

be enhanced with an economic intervention and explain how mental contrasting can contribute to enhancing the use of implementation intentions.

Generally, the strategy of implementation intentions is considered easy to teach due to its simplicity (Keller et al., 2020). Consistent with this assumption, multiple studies demonstrated the effectiveness of interventions with implementation intentions (for meta-analyses, see Gollwitzer & Sheeran, 2006; Keller et al., 2020; Sheeran et al., 2024). The effectiveness of these interventions, and in particular the motivation to use implementation intentions, can be further enhanced by combining them with mental contrasting (Adriaanse et al., 2010; Clark et al., 2021; Duckworth et al., 2018; Oettingen et al., 2015). In these combined interventions, the achievement of a goal is first imagined as positively as possible. The resulting desired state is then contrasted with reality (i.e., mental contrasting), revealing possible obstacles that can then be circumvented with an if-then plan (Gollwitzer & Oettingen, 2019). For our purposes, the main advantage of combining these two strategies is that mental contrasting is supposed to increase the willingness to form implementation intentions. That is, combining implementation intentions with mental contrasting helps to ensure that implementation intentions will actually be applied after the intervention (Duckworth et al., 2011, 2018).

**Hypothesis 4.** A brief intervention (i.e., mental contrasting with implementation intentions) increases forming implementation intentions to establish a new habit at work.

## MATERIALS AND METHODS

### Transparency and openness

We describe our sampling plan, all data exclusions, manipulations, and the measures in the study. Data, analysis code and supplemental materials are available at <https://researchbox.org/1740>. Data were analysed using R (Version 4.2.2), the package lme4 (Version 1.1-31; Bates et al., 2015), the package mediation (Version: 4.5.0; Tingley et al., 2014) and lavaan (Version 0.6-13; Rosseel, 2012). Preregistration of this study's design and its analyses are available at <https://aspredicted.org/ri5mt.pdf>.<sup>1</sup>

Procedures were in line with ethical standards of the German Psychological Society (DGPs), which constitute the German adaptation of the APA's respective ethical guidelines. Formal approval by an ethics committee was not required, as according to the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG), formal approval for psychological research is mandatory only in certain cases (e.g., if participants are exposed to pain, to deception, or to risks that go beyond those of everyday life). Informed consent was obtained from all participants at the first time of measurement.

### Deviations from preregistration

We initially aimed for a sample size of 100 participants to find a good middle ground between Level-1 and Level-2 power. Because of practical constraints (e.g., sharp decline in the number of study registrations despite intensive recruiting efforts), we were not able to acquire more than 72 participants. In general, the power for Level-1 effects in diary studies is usually rather too high than too low (Gabriel et al., 2019). For example, 30 Level-2 units (i.e., people) and five Level-1 units (i.e., days) are sufficient to achieve a power of .80 for a medium Level-1 effect at a medium ICC. In contrast, 100 Level-2 and 12 Level-1 units are necessary to achieve a power of .80 for a medium effect at Level 2 (Arend & Schäfer, 2019, Table 8). Accordingly, the

<sup>1</sup>We refer to the effects of the intervention (Hypothesis 4) in the preregistration only indirectly in the analyses section, but not in the hypotheses section.



deviation from the planned sample size did not limit the power for the reported Level-1 effects. However, the power for Level-2 effects, that is, the effect of the intervention, may have been limited.<sup>2</sup>

We decided not to include the last preregistered hypothesis, which deals with the role of feedback (in terms of goal progress) for forming implementation intentions, in the manuscript because it renders the research question of the manuscript too broad and complex. That is, this hypothesis reverses dependent and independent variables which, in retrospect, did not seem reasonable to us within the same study. The results of this hypothesis test are documented in the section “[Additional Analyses](#)”. In addition, we decided in the review process to revise the position of automaticity and frequency within our theoretical model, as this direction of effect is more in line with the habit literature. This resulted in slight changes of Hypotheses 1 and 3.

## Sample and procedure

The study consisted of three parts: (1) the initial survey that included the intervention, (2) the two-part daily survey (morning and evening over 10 days), and (3) the follow-up (two weeks later). In the initial survey, 203 subjects (94 in the intervention group) participated. During the daily-survey period, these participants completed 700 morning questionnaires and 669 evening questionnaires. Eighty of these participants completed the follow-up survey. We matched the surveys, using the serial number assigned to each person by the survey software. Only individuals who had completed both the initial measurement and the daily survey while missing no more than three days of the daily survey were included in the final sample. In addition, we included several nonsense items as attention checks (Meade & Craig, 2012). One person answered one of these items incorrectly during the initial measurement and was excluded. Further, we excluded four daily surveys because, here, the persons answered the attention check item incorrectly within the respective afternoon survey. The final sample included 611 complete pairs of questionnaires (morning and evening) from 72 participants (34 in the intervention group, 38 in the control group). Follow-up data were available from 63 of these participants.

Participants (61% female, 39% male) were employees from various industries, who we approached through social networks (Xing, LinkedIn, Facebook) and the personal networks of the investigators. We decided to examine one particular occupational field to minimize possible contextual influences. That is, we focused on typical office workers because we assumed that the daily schedule in this work area is predictable and self-determined enough to establish fixed individual habits. To ensure such a work environment, the participants had to fulfil three requirements: work at least five days per week, perform the work activity primarily on a computer, and have access to the Internet at least 50% of the work time. Additionally, we used only complete data sets for the hypothesis tests (no missing variables).<sup>3</sup>

The majority of participants had a bachelor's or master's degree (68%) and worked in an employed relationship (89%). The industries represented were quite heterogeneous, with the provision of economic, financial, scientific, technical or other services being the most represented (49%). Eleven percent worked in public administration, defence or social security, and 8% in manufacturing or processing.

<sup>2</sup>We examined the power for the Level-2 effect of the intervention post hoc on the basis of the empirical ICC. More specifically, we conducted a sensitivity analyses or analysis of the minimum detectable effect size (MDES analysis), adapting the code provided by Arend & Schäfer (2019, Example 1). An MDES analysis is used to calculate the smallest detectable effect size as a function of power, sample size, and  $\alpha$ , as well as in the case of two-level models, the ICC of the dependent variable (Arend & Schäfer, 2019). The empirical ICC of implementation intentions (i.e., which was our primary dependent variable for the expected intervention effects) was .49, which corresponds to a large ICC. Following conventions, we set  $\alpha$  at .05 and power at .80. The resulting MDES for the intervention effect was a medium effect,  $\gamma_{\text{std}} = .34$ . In other words, the MDES analysis indicated that with the given sample size of 72 and an ICC of .49, the intervention effect had to be .34 or larger to be detected in our study.

<sup>3</sup>The multi-level mediation analyses with the package mediation (Version: 4.5.0; Tingley et al., 2014) required complete data sets. We additionally tested all other hypotheses with incomplete data sets (i.e., allowing for missing variables within a day). The results did not alter our conclusions.

Most participants had been working in this industry for a long time (49% for more than 10 years) and were long-time tenured with this employer (40% for more than 10 years).

We conducted the study online, that is, participants accessed the different parts of the study via links sent to them. In the first part, we asked participants to identify an appropriate work-related habit that they would establish over the next two weeks. For this purpose, they could first choose from four different goal categories and were then supported in their habit selection with examples of appropriate habits. After participants had selected their habit, we randomized them into two groups, of which one received a brief intervention (i.e., exercise on mental contrasting with implementation intentions; we will describe this exercise in more detail below). The control group instead reflected on their work environment. In the second part, all participants completed 5-min questionnaires in the morning and evening over a two-week period (i.e., ten workdays), always starting on Monday. Participants received the morning surveys at 7 a.m. and the evening surveys at 5 p.m. The third part was a one-time follow-up survey on the key dependent variables two weeks after the end of the daily survey. We chose this time period of two weeks for the follow-up to be able to explore longer-term effects with as little data loss as possible. Because the duration of complete automatization of a behaviour is highly individual (Lally et al., 2010), we were unable to derive an optimal time period from existing literature. Further, we expected increasing drop-out rates with longer time intervals.

## Measures

We used established measures and made some adaptations. First, we adjusted the time frame of daily scales so that they referred specifically to the day (Ohly et al., 2010). Second, we used items in German language. To keep the response format constant for all scales, participants rated all items on a 5-point scale from 1 (*strongly disagree*) to 5 (*totally agree*).

If available, we used corresponding German versions of the questionnaires. If not, two members of our research group fluent in German and English translated the items into German. In this process, two persons (first author of this paper and a graduate student) first translated the items independently, discussed discrepancies, and agreed on a first version (i.e., parallel translation; Smith, 2004). A third person (second author of this paper) proofread this version of the translation and made final suggestions for changes. The first two persons discussed these suggestions again and integrated them in a final version.

In the initial survey, we assessed different characteristics of occupation and person that we expected to influence habit formation as potential control variables. The inclusion of these control variables, as we will explain later, did not alter the results or conclusions. In the morning survey, we assessed implementation intentions as well as positive and negative affect as potential control variables. We further asked participants to name their selected habit in this survey. In the evening survey, we assessed frequency and automaticity of the habitual behaviour, goal progress, and work engagement. In the follow-up survey, we assessed frequency and automaticity of the habitual behaviour, goal progress, and work engagement again, but with the focus on the past two weeks.

## Implementation intentions

We measured whether participants had formulated implementation intentions on a given day with a scale consisting of five items, as used by Sonnentag et al. (2022). This scale essentially captures whether a plan has been made for “when”, “where” and “how” the new habitual behaviour will be applied and whether a specific place and time has been specified. A sample item is: “I have planned for today how I can show my new habit.” Internal consistencies were high, ranging between .91 and .97.



## Frequency of habitual behaviour

The frequency with which participants were able to demonstrate their new habitual behaviour on a day varied depending on the nature of this habitual behaviour. For example, the habitual behaviour of “learning something new about a work-related topic for 10 minutes once a day” can be followed less frequently per day than the habitual behaviour of “taking a 5-min break after every hour.” Therefore, we chose to use an estimate of the relative frequency, which we measured with a single item as done in other studies (Sonnetag et al., 2022): “Did you perform your new habit today as often as you intended?” The response categories here were 1 (*not at all*), 2 (*less frequently than intended*), 3 (*as frequently as intended*), 4 (*more frequently than intended*), and 5 (*much more frequently than intended*).

## Automaticity of habitual behaviour

We assessed automaticity of the habitual behaviour with the Self-Report Behavioural Automaticity Index (Gardner et al., 2012). This scale is a validated subscale of the Self-Report Habit Index (Verplanken & Orbell, 2003) designed to capture the aspect of automaticity of habits. A sample item is “My new habit is something I do without thinking.” Internal consistencies were high, ranging between .89 and .98.

## Goal progress

We measured progress towards work goals on a given day using six items based on previous work (Beal et al., 2005; Koopman et al., 2016). A sample item is: “I had a productive day today in relation to my work goals.” Internal consistencies ranged between .88 and .95.

## Work engagement

We measured work engagement with the adapted 3-item version of the Utrecht Work Engagement Scale (Schaufeli et al., 2019). This scale included, for example, the item “Today at my work, I felt bursting with energy.” Internal consistencies varied between .84 and .95.

## Control variables

As potential control variables at Level 1, we assessed positive and negative affect (PANAS; Krohne et al., 1996; Thompson, 2007). As potential control variables at Level 2, we assessed autonomy (Work Design Questionnaire; Stegmann et al., 2010), preference for regularity (Habitual Tendencies Questionnaire; Ramakrishnan et al., 2022), and tendency to engage in if-then planning (If-Then Planning Scale; Bieleke & Keller, 2021).

We assessed positive and negative affect as a potential control variable regarding daily work engagement, because affect fluctuates at the day-level and can be a predictor of work engagement (Bledow et al., 2011; Schaufeli & van Rhenen, 2006). We assessed autonomy, because we expected that work autonomy facilitates changing work procedures independently (Kubicek et al., 2017) and consequently individuals with high autonomy may be more likely to integrate a new habit into their daily work. We assessed preference for regularity because individuals differ in the degree to which they value regular daily routines (Ramakrishnan et al., 2022), and we expected that individuals high on preference for regularity may find it easier to establish a new habit. We assessed tendency to engage in if-then planning because we expected that individuals who tend to formulate if-then plans (i.e., implementation intentions) would be more likely to establish a new habit regardless of the implemented intervention. However, none of these variables affected the intervention effects (see Table S2).

## Intervention and habit selection

The selection of habits and the intervention took approximately 15 min. At the beginning, all participants received the following definition for habits along with examples of everyday habits (e.g., brushing teeth): “A habit is a behavior or sequence of actions that is performed repeatedly in a stable (i.e., consistent or similar) context. Regular repetition ensures that the behavior is triggered and performed automatically.” The definition was then expanded to include habits at work and participants selected one of four broad goal categories. Based on these goal categories, the participants selected suitable behaviours to make them a habit with the help of examples. The four goal categories aligned with the habit categories identified by Sonnentag et al. (2022). The goal categories “work more effectively” and “pursue work goals more consistently” were related to task-related habits. The goal categories “increase health at work” and “learn something new” were related to contextually embedded and nonwork-specific habits. By specifying these goal categories and providing relevant examples, we sought to guide participants to select habits from these categories so that the selected habits would be considered habits at work. By further asking participants to choose their own habit, we sought to ensure that participants chose a habit that suited their needs and that they could actually implement.

Participants chose one goal category that was currently most important to them. Participants selected the different goal categories with the following frequencies: “increase health at work”(43.06%), “work more effectively”(38.89%), “learn something new”(12.50%) and “pursue work goals more consistently”(5.56%). After participants had chosen a goal category, we presented suitable examples of habits that could help in achieving goals in this category. Based on the exemplary habits, participants chose a behaviour to make it a habit of their own that would meet the following conditions: Participants could engage in this behaviour at least once a day, the behaviour had to be conducive to the selected goal and to their work in general. To safeguard that this behaviour was desirable and clearly defined, we read through the various behaviours that participants submitted. For example, in relation to the goal “increase health at work” participants decided to “drink more water” or “to take a daily walk”. To “work more effectively”, they planned, for example, to “establish uninterrupted focus work hours to be more productive” or to “divide large tasks into smaller subtasks”.

After participants had chosen their behaviour to make it a habit, the control group received the task of describing their workplace and work environment in detail. The intervention group conducted a mental contrasting exercise with implementation intentions (Adriaanse et al., 2010; Clark et al., 2021; Oettingen et al., 2015). In this exercise, participants were first asked to imagine, as vividly as possible, the extent to which they would benefit from their new habit. Subsequently, they thought about appropriate situations in which they could engage in their new habitual behaviour and which obstacles could prevent them from establishing this habit. Again, the instruction was to describe these thoughts in as much detail and as vividly as possible. Afterwards, participants created two if-then plans: One in which they linked the habitual behaviour to a favourable situation (e.g., “before I sit down at my desk in the morning”) in which they will perform it and one in which they specified how to deal with a possible obstacle (e.g., “distraction by phone calls or other things”). Finally, participants received a handout (i.e., downloaded a writable PDF document) to write down their if-then plans and were instructed to follow them for the next two weeks.

## Analytic approach

To account for the hierarchical data structure (days nested within individuals), we used multi-level modelling for our hypothesis testing. We conducted all analyses with R (Version 4.2.2) using the lme4 package (Version 1.1-31; Bates et al., 2015). We defined intercept-only models for all variables of interest to determine the extent of within-person variance. The data point to a considerable amount of within-person variance, with the lowest intraclass correlation of .21 for goal progress and

the highest intraclass correlation of .65 for automaticity. Accordingly, multi-level modelling seemed appropriate (Musca et al., 2011). To test for intervention effects, we estimated a model predicting daily formulation of implementation intentions with a binary coded variable (0 = control group, 1 = intervention group).

We conducted a set of multi-level analyses for each outcome, centering predictors at the person mean (i.e., group-mean centering) and using fixed-slopes.<sup>4</sup> We further specified multi-level mediation models with the mediation packages (Version: 4.5.0; Tingley et al., 2014) and lavaan (Version 0.6-13; Rosseel, 2012).

## RESULTS

Intraclass correlations, means, standard deviations, and correlations at the day-level as well as at the person-level are presented in Table 1. The results of hypothesis testing are summarized in Figure 2. All parameter estimates of the multi-level analyses are found in Table 2.

### Hypothesis testing

Hypothesis 1 assumed a positive relationship between automaticity of the new habitual behaviour and daily work engagement (1a) as well as daily goal progress (1b). We examined these relationships specifying one multi-level model for each outcome (i.e., work engagement and goal progress). In line with Hypothesis 1a, automaticity of the new habitual behaviour predicted work engagement, unstandardized estimate = .14,  $SE = .05$ ,  $p = .008$ . In line with Hypothesis 1b, automaticity of the new habitual behaviour predicted goal progress, unstandardized estimate = .19,  $SE = .06$ ,  $p < .001$ .

Hypothesis 2 assumed a positive relationship between implementation intentions and frequency (2a) as well as automaticity (2b) of the new habitual behaviour at the day-level. We examined these relationships specifying one multi-level model with implementation intentions as predictor for each outcome. In line with Hypothesis 2a, implementation intentions predicted frequency of the new habitual behaviour, unstandardized estimate = .29,  $SE = .04$ ,  $p < .001$ . In line with Hypothesis 2b, implementation intentions predicted automaticity of the new habitual behaviour, unstandardized estimate = .12,  $SE = .03$ ,  $p < .001$ .

Hypothesis 3 assumed the effects of implementation intentions on automaticity of the new habitual behaviour to be mediated by frequency of this behaviour. In line with Hypothesis 3, multi-level mediation analyses revealed a significant indirect effect of implementation intentions via frequency on automaticity,  $ACME = .09$ ,  $p < .001$ , 95% CI [.06, .12]. The direct effect was no longer significant,  $ADE = .03$ ,  $p = .320$ , 95% CI [-.04, .10].

Finally, Hypothesis 4 assumed that a brief intervention increases the formation of implementation intentions. Contradicting Hypothesis 4, results of a multi-level analysis showed that the intervention did not affect the level of daily implementation intentions, unstandardized estimate =  $-.07$ ,  $SE = .19$ ,  $p = .719$ . Also, the group means (intervention vs. control group) of forming implementation intentions did not differ,  $t(70) = .36$ ,  $p = .718$ .

In summary, the analyses support the assumption that automaticity of the new habitual behaviour increases work engagement and goal progress (Hypotheses 1a and b) and that implementation intentions increase automaticity of this behaviour via an increased frequency (Hypothesis 2 and 3). However, the results contradict Hypothesis 4, as the brief intervention did not increase the use of implementation intentions.

<sup>4</sup>For each model, we also included the person means of the predictors at Level 2 and further specified random-slopes for each postulated relationship. Results were very similar with Level-2 predictors included. Specifying random-slopes did not consistently improve model fit and it did not alter the results or conclusions. For the sake of clarity, we report models with fixed-slopes and Level-1 effects only.

TABLE 1 Descriptive statistics at the day and person-level.

| Variable                      | M    | SD <sub>within</sub> | SD <sub>between</sub> | ICC | 1                | 2                | 3                | 4                | 5                | 6                | 7                | 8                |
|-------------------------------|------|----------------------|-----------------------|-----|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| 1 Implementation intentions   | 3.53 | .72                  | .77                   | .49 | .95              | .14** [06, .22]  | .28*** [20, .35] | .15*** [07, .23] | .15*** [07, .23] |                  |                  |                  |
| 2 Automaticity                | 2.33 | .58                  | .87                   | .66 | .34*** [27, .40] | .95              | .38*** [31, .45] | .18*** [10, .26] | .26*** [18, .33] |                  |                  |                  |
| 3 Frequency                   | 2.50 | .75                  | .61                   | .34 | .52*** [47, .57] | .57*** [52, .62] | –                | .23*** [15, .30] | .39*** [32, .45] |                  |                  |                  |
| 4 Work engagement             | 3.15 | .66                  | .74                   | .49 | .43*** [37, .49] | .25*** [18, .32] | .35*** [28, .41] | .92              | .55*** [49, .60] |                  |                  |                  |
| 5 Goal progress               | 3.65 | .78                  | .51                   | .21 | .40*** [34, .46] | .38*** [31, .44] | .54*** [49, .59] | .57*** [51, .61] | .93              |                  |                  |                  |
| 6 Frequency (follow-up)       | 2.75 | –                    | .83                   | –   | .44*** [38, .50] | .62*** [57, .66] | .68*** [63, .72] | .34*** [27, .41] | .55*** [49, .60] | –                |                  |                  |
| 7 Automaticity (follow-up)    | 2.60 | –                    | 1.16                  | –   | .47*** [40, .53] | .80*** [77, .83] | .53*** [47, .58] | .23*** [15, .30] | .38*** [31, .44] | .75*** [71, .78] | –                |                  |
| 8 Work engagement (follow-up) | 3.33 | –                    | .91                   | –   | .44*** [38, .50] | .22*** [14, .29] | .31*** [24, .72] | .86*** [84, .88] | .42*** [36, .48] | .35*** [28, .41] | .25*** [17, .32] | –                |
| 9 Goal progress (follow-up)   | 3.89 | –                    | .68                   |     | .44*** [37, .50] | .34*** [26, .40] | .42*** [36, .48] | .44*** [37, .50] | .62*** [57, .66] | .60*** [55, .65] | .52*** [46, .57] | .53*** [47, .58] |

Note: b = between persons (i.e., Level 2); w = within persons (i.e., Level 1). Day-level correlations are shown above the diagonal (k = 61). Person-level correlations are shown below the diagonal (N = 72 for variables in daily survey and N = 63 for follow-up measures). Internal consistencies (mean Cronbach's alpha across ten days) are shown on the diagonal. Correlations at the day level were calculated with person mean-centered variables. Values in brackets indicate the 95% confidence interval for each correlation.

Abbreviation: ICC, intraclass correlation.

\*\*\*p < .001.

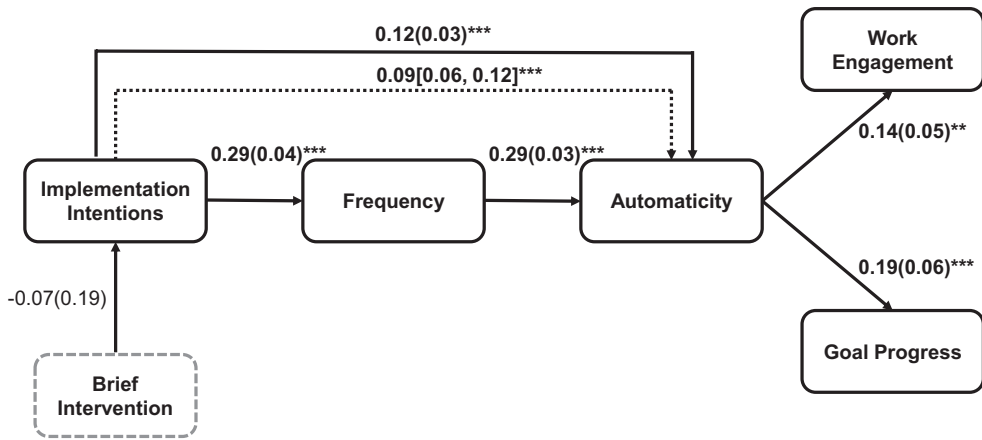


FIGURE 2 Results of multi-level analyses and multi-level mediation analysis. Note: Unstandardized regression coefficients from multi-level analysis using restricted maximum likelihood. The indirect effect (above the dashed arrow) represents the average causal mediation effect (ACME) with the associated confidence interval.  $**p < .01$ ;  $***p < .001$ .

### Follow-up

Two weeks after the end of the daily survey, participants completed a follow-up measurement ( $N = 63$ ), including frequency and automaticity of the new habitual behaviour, goal progress, and work engagement referring to the last two work weeks. To examine whether positive effects of implementation intentions were still evident at this point, we computed mean values of implementation intentions over the days of the daily survey phase (average of ten work days). With this mean value, we performed a set of different regression analyses for each outcome. The mean of implementation intentions formed during the daily survey period predicted follow-up frequency,  $b = .46$ , 95% CI [.22, .70],  $\beta = .43$ ,  $p < .001$ , automaticity,  $b = .37$ , 95% CI [.003, .73],  $\beta = .24$ ,  $p = .048$ , goal progress,  $b = .25$ , 95% CI [.02, .48],  $\beta = .29$ ,  $p = .032$ , and work engagement,  $b = .45$ , 95% CI [.14, .76],  $\beta = .39$ ,  $p = .006$ . That is, individuals who reported a higher degree of implementation intentions during the daily survey phase also engaged in the habitual behaviour more frequently two weeks later and reported higher automaticity of this behaviour, higher work engagement as well as higher goal progress.

### Additional analyses

#### Preregistered hypothesis

In the preregistration, we had additionally hypothesized that daily goal progress on one day would be positively related to forming implementation intentions the next morning. This hypothesis was based on theories of self-regulation at work (Lord et al., 2010). Specifically, we assumed that goal progress might be interpreted as positive feedback, thus increasing continued use of implementation intentions the next day (Fishbach et al., 2010, 2014; Koo & Fishbach, 2008).

We examined this hypothesis in a multi-level analysis, in which we restructured the data so that each evening questionnaire was assigned to the questionnaire of the following morning (i.e., the morning questionnaire of Day 1 and the evening questionnaire of Day 10 were omitted). The resulting data set included 538 observations from 71 persons. Contradicting our prediction, the relationship between goal progress in the evening and forming implementation intentions the next morning was not significant, unstandardized estimate = .01,  $SE = .04$ ,  $p = .860$ .

TABLE 2 Results of multi-level analyses predicting automaticity, work engagement and goal progress.

| Effect                         | Automaticity        |     |                   |     | Work engagement     |     |                   |     | Goal progress       |     |                   |     |
|--------------------------------|---------------------|-----|-------------------|-----|---------------------|-----|-------------------|-----|---------------------|-----|-------------------|-----|
|                                | Unconditional model |     | Conditional model |     | Unconditional model |     | Conditional model |     | Unconditional model |     | Conditional model |     |
|                                | Estimate            | SE  | Estimate          | SE  | Estimate            | SE  | Estimate          | SE  | Estimate            | SE  | Estimate          | SE  |
| Intercept                      | 2.32***             | .10 | 2.32***           | .07 | 3.16***             | .09 | 3.16***           | .09 | 3.66***             | .06 | 3.66***           | .06 |
| Implementation intentions      |                     |     | .03               | .03 | .08*                | .04 | .08*              | .04 | .04                 | .04 | .04               | .04 |
| Frequency                      |                     |     | .29***            | .03 | .15***              | .04 | .15***            | .04 | .35***              | .05 | .35***            | .05 |
| Automaticity                   |                     |     |                   |     | .14**               | .05 | .14**             | .05 | .19***              | .06 | .19***            | .06 |
| Residual variance (w)          | .37                 |     | .32               |     | .50                 |     | .46               |     | .68                 |     | .56               |     |
| Residual variance (b)          | .72                 |     | .73               |     | .49                 |     | .49               |     | .19                 |     | .20               |     |
| AIC                            | 1344.24             |     | 1275.58           |     | 1471.04             |     | 1448.20           |     | 1590.88             |     | 1501.93           |     |
| BIC                            | 1361.90             |     | 1297.65           |     | 1484.29             |     | 1474.70           |     | 1604.12             |     | 1528.42           |     |
| Deviance                       | 1336.24             |     | 1265.58           |     | 1465.04             |     | 1436.20           |     | 1584.88             |     | 1489.92           |     |
| $\Delta\chi^2$ ( $\Delta df$ ) |                     |     | 86.97 (2)***      |     |                     |     | 42.30 (3)***      |     |                     |     | 107.85 (3)***     |     |

Note: b = between persons (i.e., Level 2); w = within persons (i.e., Level 1). Estimation is based on 611 observations of 72 persons. The unconditional model corresponds to the model without predictors. Regression coefficients were estimated using restricted maximum likelihood (for comparison of model fit, the models were refitted with maximum likelihood).

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .



## Control variables

We replicated the hypothesis tests with the addition of the control variables. We found no evidence for an influence of these variables on the hypothesized relationships (see [Tables S1](#) and [S2](#)).

## Habit type

To rule out the possibility that the results were influenced by the type of goal category and the associated nature of habitual behaviour, we created three dummy variables to represent the four goal categories and analysed main effects and cross-level interactions. We found no evidence for an influence of goal category (or habit type) on the postulated relationships. However, daily goal progress was higher for participants who had selected the goal category “work more effectively” than for the other participants, unstandardized estimate = .48,  $SE = .20$ ,  $p = .015$  (see [Table S3](#)).

## Relationship between automaticity and frequency

Theories of habit formation suggest that automaticity of the new habitual behaviour might increase over the course of the study. This is because the participants acquired this behaviour anew and the automatization of a behaviour is supposed to increase with constant repetition (Gardner, 2015; Lally et al., 2010, 2011). Accordingly, we conducted a single-factor repeated measures analysis of variance with linear contrasts to analyse the time trend of automaticity. This analysis revealed a linear increase in automaticity over the course of the daily survey, unstandardized estimate = 16.88,  $SE = 3.26$ ,  $F(1, 40) = 28.36$ ,  $p < .001$ .

## Serial mediation

Our theoretical model could imply serial mediation in which implementation intentions increase the work outcomes via the frequency of the new habitual behaviour via automaticity of the new habitual behaviour. We conducted two serial mediation analyses that showed significant indirect effects of implementation intentions via frequency via automaticity on work engagement,  $b = .01$ ,  $SE = .01$ ,  $p = .014$ , 95% CI [.003, .023] and goal progress,  $b = .02$ ,  $SE = .01$ ,  $p = .004$ , 95% CI [.006, .030].

## DISCUSSION

This research explored whether habits at work can increase goal progress and work engagement as well as whether and how the establishment of these habits can be increased through implementation intentions. Results showed that engaging in habitual behaviours at work positively relates to daily work engagement and daily goal progress. Furthermore, results indicated that implementation intentions promote frequency and automaticity of such habitual behaviours.

## Theoretical implications

First, the results contribute to habit literature by demonstrating positive effects of habitual behaviours in a rather new context. Extensive research on habits in other (particularly in health) contexts shows that a large part of self-regulatory processes (i.e., action initiation and execution) is controlled by habitual processes (Lally & Gardner, 2013). For example, a meta-analysis showed that eating habits have a stronger influence

on eating behaviour than conscious intention (Gardner et al., 2011). Our finding that habitual behaviours at work promote work engagement and goal progress demonstrates that the shift from a conscious motivational process to a context-driven mechanism associated with this type of behaviour (Gardner, 2015; Lally et al., 2010) also facilitates self-regulation at work. This is because both work engagement and goal progress are the result of successful self-regulation (Lord et al., 2010; Parke et al., 2018). As both work engagement and goal progress are associated with various positive outcomes such as job satisfaction, organizational commitment or decreased burnout (Bipp et al., 2020; Judge et al., 2005; Koestner et al., 2002; Mazzetti et al., 2023; Wong et al., 2017), our results imply that habitual behaviours at work might have a wide positive impact. Regarding the applicability of habits in the work context, our study extends research that revealed positive relationships of the related construct of work routines with creativity (Chae & Choi, 2019; Ohly et al., 2006). This is because our results indicate that habitual behaviours are beneficial not only for specific, creative tasks, but possibly applicable in a broader range of work areas and tasks.

Second, this study demonstrates that implementation intentions promote habit formation at work. Specifically, we extend previous research, demonstrating that habits at work can be modified by implementation intentions (Holland et al., 2006; Sonnentag et al., 2022) because we consider the relationship between automaticity and frequency at the day-level. Our study illustrates that the daily use of implementation intentions increases the frequency of a new behaviour in a specific situation and in turn the automaticity of this behaviour. Additional analyses further showed that automaticity of the new habitual behaviour increased over the course of the study. Taken together, these results indicate that implementation intentions promote constant repetition of a behaviour in the same context and thereby accelerate the process of habit formation.

Our results also allow for tentative conclusions about the longer-term impact of implementation intentions. Consistent with other results (Sonnentag et al., 2022), the positive effects of implementation intentions were also evident at follow-up. Individuals who had formed implementation intentions to a higher extent within the daily survey phase reported higher work engagement, higher goal progress, and higher frequency and automaticity of the habitual behaviour two weeks later. Studies disagree on the durability of the effects of implementation intentions. On the one hand, within-designs with discontinuous presentation of implementation intentions suggest that the effects of implementation intentions decline rapidly (Breitwieser et al., 2021; Luers et al., 2019). In these studies, implementation intentions only affected behaviour on days when participants received the prompt to form implementation intentions. On the other hand, between-designs show that effects of interventions with implementation intentions on outcomes are detectable even two years later (Brandstätter et al., 2003; Martin et al., 2011). Even though the follow-up survey period was comparatively short at two weeks, our results suggest that the effects of implementation intentions do not disappear immediately, but are durable for a longer period of time.

## Practical implications

Our findings further provide practical insights for organizations and individuals. Results show that the establishment of habits at work can be used to increase goal progress and engagement at work. Hence, employees might be encouraged to promote habits at work that are consistent with work goals (and that at the same time do not interfere with important personal goals). This could be achieved by educating employees in training courses or e-learning about the positive impact habits can have on their productivity and well-being.

In addition, the results imply that implementation intentions contribute to habit formation in the work context. Hence, implementation intentions might be used in practice to improve individual habits at work. In theory, implementation intentions are very easy to teach (Keller et al., 2020). Numerous exercises exist that employees can use to learn this planning strategy. These exercises can be provided in different formats such as online versus face-to-face (Keller et al., 2020; Oettingen et al., 2015). In this regard, the online exercise we conducted showed no effects. As positive effects of similar exercises in face-to-face training have been demonstrated (Adriaanse et al., 2010; Oettingen et al., 2015), we would

recommend teaching the strategy in face-to-face formats, for example, in corresponding workshops or training.

## Limitations

By using an exercise on mental contrasting with implementation intentions, we sought to manipulate the extent to which individuals formulate implementation intentions to establish a new habit. However, we did not find an intervention effect which is inconsistent with other studies in which effects were achieved with very similar interventions (Adriaanse et al., 2010; Clark et al., 2021; Oettingen et al., 2015). We cannot provide a definitive explanation from the available data. However, as mentioned earlier, other studies differ from ours in that they chose a face-to-face format instead of an online format. It is possible that motivation was lower in an online format or that the instructions were not sufficiently understood.

Another explanation could be that we asked all participants, including those in the control group, daily whether they had formulated implementation intentions. Asking about implementation intentions might have prompted participants in the control group to form implementation intentions, resulting in the non-significant group differences. This design choice may have contributed to the lack of effectiveness of our intervention. One possibility to control for question-behaviour effects (Wood et al., 2016) is the inclusion of several control days on which participants do not receive questionnaires on implementation intentions and including day of data collection as a control variable in the multi-level analyses, as has been done in other studies (Sonnentag et al., 2022).

Apart from these methodological limitations, it is possible that the intervention did not increase the formation of implementation intentions because people used this strategy to varying degrees irrespective of the intervention. In fact, recent studies show that there are inter-individual differences in the tendency to formulate implementation intentions that are relatively stable over time (Bieleke & Keller, 2021).

As the intervention did not have the expected effects, our results are now based on a correlational design capturing implementation intentions in the beginning of the workday and frequency and automaticity of the habitual behaviour, work engagement, as well as goal progress at the end of the workday. Consequently, we were unable to test a causal effect of implementation intentions on frequency of the habitual behaviour. We further relied on self-report measures and did not separate the measurement points for mediator and criterion. This means that we examined some of the independent variables (automaticity, frequency) and dependent variables (work engagement, goal progress) at the same time and with the same method. Hence, it cannot be ruled out that a common method bias led to the overestimation of these effects (Podsakoff et al., 2003, 2012).

## Future research directions

We did not test the mechanism directly that the relationship between habitual behaviours and work outcomes might be explained by higher availability of cognitive-attentional resources. As previous studies relied on self-report (Chae & Choi, 2019; McClean et al., 2021; Ohly et al., 2017), an investigation of this mechanism with different methods would be beneficial. Future studies could, for example, incorporate cognitively demanding tasks to objectively measure the availability of cognitive-attentional resources.

As our study provides further evidence that implementation intentions promote the establishment of habits at work, it is of great interest to find alternative means to encourage the use of implementation intentions. For example, it would be valuable to compare different intervention formats (online vs. face-to-face training) in further studies or to expand interventions to include other elements such as daily prompts.

## CONCLUSION

In a diary intervention study, we showed that automaticity of a new habitual behaviour at work was associated with higher work engagement and goal progress at the day-level. Daily implementation intentions predicted daily frequency and automaticity of this habitual behaviour. However, this relationship was independent of the intervention implemented. Habits at work facilitate automatic behaviours that positively relate to employee engagement and efficiency. Implementation intentions represent a promising strategy for promoting habits at work, the antecedents of which might be further explored.

## AUTHOR CONTRIBUTIONS

**Nina Trenz:** Conceptualization; methodology; formal analysis; writing – original draft; writing – review and editing; visualization; investigation; project administration. **Nina Keith:** Conceptualization; methodology; writing – review and editing; supervision; project administration; resources.

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## CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available at <https://researchbox.org/1740>.

## ORCID

Nina Trenz  <https://orcid.org/0000-0003-4060-1233>

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

### Table S1.–S3.

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