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Conceptual Article

Unveiling the Multidimensional Nature of the Intention–Behavior Gap

Dynamics of Intentions and Behaviors

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Abstract: The intention-behavior gap (IBG) is a central challenge in health psychology, with significant implications for behavior change and health promotion. Prevailing approaches to IBG assessment involve quantifying it as either the proportion of unexplained variance in behavior attributable to intention or the ratio of unsuccessful intenders to all intenders. While these concepts provide insight into IBG variation at the between-person level, the major part of the variation of intentions and behaviors is at the within-person level. This paper addresses these limitations by introducing a novel framework, in which the IBG is mathematically conceptualized as a multidimensional difference between an individual's behavioral intention and the individual's subsequent observed behavior. Key tenets of this framework include: (1) Recognizing the dynamic nature of intentions as a fundamental driver of IBG, with the timing of intention measurement playing a crucial role in predicting behavior. (2) Highlighting the importance of within-person factors and contextual intricacies in influencing the translation of intentions into behavior. (3) Emphasizing the need for intensive longitudinal data with frequent measurements within individuals to capture the dynamic intention-behavior relation in daily life. This framework also highlights implications for study designs, theory, and interventions in health psychology and offers promising avenues for reducing the IBG and improving health behavior outcomes.

Keywords: intention, behavior, stability, intention-behavior gap, dynamics, within-person variation

The mitigation of many serious chronic health conditions, such as coronary heart disease, type 2 diabetes, and cancer, depends significantly on the adoption of protective health behaviors (Lacombe et al., 2019; Zhang et al., 2020). These behaviors include consistent engagement in activities such as regular physical activity and maintaining a healthy diet. Achieving substantial health benefits requires the consistent and frequent performance of these health-protective behaviors (Reiner et al., 2013), typically on a daily or several times-a-week basis. Despite this understanding, only a small proportion of adults adhere to the recommended levels for these behaviors at any given time – for instance, 27.5% meet physical activity guidelines (Guthold et al., 2018), and less than 20% meet fruit and vegetable intake guidelines (Frank et al., 2019).

Within the realm of health psychology, the intention-behavior gap (IBG) represents a central challenge in comprehending and facilitating behavior change endeavors (de Bruin et al., 2012). Early research by Kuhl (1985) on the theory of action control, and by Carver and Scheier (1982) on control theory and self-regulation, laid the foundation for understanding these discrepancies. Ajzen's (1985) work on the theory of planned behavior further expanded this understanding, recognizing that intention alone is not always sufficient to predict behavior. The phenomenon of the IBG denotes the discordance between individuals' intended actions and their subsequent behavioral enactments (Sheeran & Webb, 2016). Extensive exploration of the intention-behavior relationship consistently revealed a positive correlation of 0.48, 0.51, and 0.53 between intention and behavior (Hagger et al., 2002; McEachan et al., 2016). These collective findings underscore the robust relationship between intention and behavior, which accounts for approximately 23% to 28% of the variance in behavioral outcomes. Despite evidence of a positive correlation between intentions and actions, a considerable part of behavior variance remains unexplained, emphasizing the complex nature of behavior change. Notably, experimental studies suggest that a substantial increase in intention yields only a minimal effect (d = 0.15) on behavior (Rhodes & Dickau, 2012). More recently, Feil et al. (2023) found that only 52.4% of people who intended to engage in a certain level of physical activity were successful in doing so.

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The majority of research examining the relationship between intentions and behavior tends to focus on between-person variation, analyzing the links between an individual's typical intention and their typical behavior (Maher et al., 2016). It suggests that there is a general IBG, which is independent of time and context. However, this approach may have limitations, as a considerable body of research has shown that the intention-behavior relationship is highly dependent on time and contextual factors (e.g., Maher & Dunton, 2020; Maher et al., 2016; Pickering et al., 2016). Recent studies employing intensive longitudinal data and ecological momentary assessment reveal substantial variability in both intentions and behaviors across different time frames and contexts (Conroy et al., 2013; Conroy et al., 2011; Dunton, 2017; Maher & Conroy, 2016, 2018). According to Molenaar (2004), most psychological processes are nonergodic. Broadly speaking this means that intra-individual and inter-individual variations are not equivalent. Consequently, findings at the between-person level may not accurately represent the behavior of individuals over time (Hamaker, 2012; Hunter et al., 2024; Molenaar & Campbell, 2009; Voelkle et al., 2014). Thus, relying solely on between-person comparisons to quantify the IBG is inadequate, as it fails to account for individual variations in both intended and actual behavior across varying temporal and contextual conditions.

Hence, the objective of this paper is to formulate a comprehensive framework for understanding the IBG that not only considers variation among individuals but also explicitly accounts for variation across time and context. However, before delving into this novel approach, we first provide clear definitions of intention and behavior, along with an overview of existing conceptions of the IBG. Subsequently, we introduce our innovative perspective on IBG as a multidimensional difference between an individual's intended behavior and their subsequent enacted behavior. We delineate the fundamental assumptions underlying the IBG concept, followed by an exploration of how temporal factors influence IBG and the mathematical formalization of intention stability over time. Finally, we discuss potential avenues for future research, examine implications for intervention, and offer concluding reflections.

Defining Intention and Behavior

Intention Concept

Intentions, as conceptualized by Bratman (1987), are not merely momentary desires or simple resolutions, but rather part of a coordinated and structured plan that guides and shapes human action over time. These plans serve as a guide for future actions and decisions while retaining certain flexibility to adapt to changing circumstances or information. Early theories, such as Kuhl's (1985) theory of action control, emphasized the role of intentions in guiding behavior through self-regulatory processes. Similarly, Carver and Scheier's (1982) control theory highlighted the importance of feedback loops in maintaining goal-directed behavior. In the domain of health psychology, the concept of behavioral intention pertains to an individual's conscious deliberation and decision to engage in a specific behavior at a defined point in time prior to its actual enactment (Ajzen, 1991). Several theoretical frameworks, including the Theory of Planned Behavior (TPB; Ajzen, 1985), the Protection Motivation Theory (Rogers, 1983), and the Health Action Process Approach (Schwarzer et al., 2011), have substantially contributed to elucidating the role of intention in predicting behavior. The TPB highlights the pivotal role of intention as an immediate and proximal determinant of behavior, mediating the influences of other determinants like attitudes, social norms, and perceived behavioral control, alongside more remote determinants of behavior.

In examining the diverse definitions of intention, Rhodes and Rebar (2017) draw attention to two distinct conceptions prevalent in health behavior theories. On the one hand, intention can be viewed as a *decisional intention*, a binary decision to perform or not to perform a behavior (Rebar et al., 2018). In this view, individuals are divided into two categories: those who have formed an intention to engage in a particular behavior and those who have not (cf., Sheeran, 2002). On the other hand, intention is regarded as a process reflecting a continuum of motivational intensity or intention strength (Rhodes & Rebar, 2017). *Intention strength* is conceptualized as a continuous construct representing the level of commitment, determination, or motivation associated with an individual's intention to carry out a specific behavior (cf., Fuchs et al., 2017; Rebar et al., 2019).

To clarify, the focus of this paper is on behavioral intentions, which are the immediate precursors to specific actions, as opposed to goal intentions, which involve broader aspirations that may lead to different behavioral paths depending on the strategies chosen to achieve those goals (Conner & Norman, 2022). Behavioral intentions are the specific, actionable decisions to engage in a particular behavior (e.g., deciding to exercise three times a week), while goal intentions are more general and may include various potential behaviors (e.g., intending to improve physical fitness). We define behavioral intentions as psychological constructs that represent a person's conscious and goal-directed decision to engage in a specific behavior. They consist of two key components: a motivational component, which reflects the individual's commitment and drive to achieve the goal, and a decision component, which marks the precise moment when the decision is made to actively pursue that goal.

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Behavior Concept

Behavior can be defined as the potential and expressed capacity for physical, mental, and social activity (Hogan, 2015), encompassing a wide range of activities from reflexive responses to complex cognitive actions that are fundamentally observable and quantifiable (Sam, 2013). What humans understand by behavior depends on the mental representation of one's own actions and is processed primarily in episodic memory (Gaesser, 2020). Tulving (1983) proposes that behavior, including health behavior, is best understood as a series of sequential episodes represented in episodic memory, a memory system characterized by the ability to organize memories in the form of "episodes" or concrete, experienced events. For instance, a workout session constitutes an episode of physical activity, while a meal represents an episode of eating behavior. From the perspective of health psychology, it makes particular sense to view health behaviors as a sequence of behavioral episodes, as only health behaviors that are continuously and regularly repeated (e.g., regular exercise) have a positive effect on health (Dohle & Hofmann, 2019; Dunton, 2018).

When defining 'acting' or 'behavior,' it is important to differentiate between accumulated and one-off behaviors. Accumulated behaviors, such as aiming for 150 minutes of moderate-to-vigorous physical activity over a week, can be recorded gradually (Finne et al., 2019; Jekauc et al., 2015). For example, if an individual completes 120 minutes of the intended 150 minutes, this can be seen as 80% implementation. On the contrary, one-off behaviors, such as attending a course, are measured according to the all-or-nothing principle, where the behavior is either performed or not. Understanding 'acting' in these context-specific terms allows for a more precise and meaningful analysis of behaviors and their corresponding intentions.

Existing Conceptions of the Intention-Behavior Gap

Recent literature has highlighted this phenomenon, with two main conceptual frameworks dominating the discussion of understanding and addressing the IBG.

IBG is Proportion of Unexplained Variance in Behavior due to Intention

The IBG has been frequently approached as the proportion of unexplained variance in behavior attributed to intention (Sheeran, 2002). This approach seeks to understand the extent to which between-person variations in intention can account for between-person variations in observed behavior. The IBG is quantified by computing the residual variance in behavior that remains unaccounted for by the predictor variable, intention. This is often represented as the complement of the determination coefficient or $1 - R^2$ (Equation 1), where R^2 denotes the coefficient of determination in regression models examining the relationship between intention and behavior. IBG can be interpreted as the proportion of residual variance to total variance or the percentage of unexplained variance in behavior.

$$IBG = 1 - R^2 = \frac{\sum_{i=1}^{n} (B_i - f(I_i))^2}{\sum_{i=1}^{n} (B_i - \bar{B})^2} \tag{1}$$

B_i = Behavior of person i
$\bar{B}$ = Average behavior in the sample
$f(I_i)$ = Predicted behavior from intention of the person i

Despite its widespread use, the approach of quantifying IBG as the proportion of unexplained variance in behavior due to intention has certain limitations. Notably, this perspective mainly characterizes *IBG* as a between-person construct, focusing on individual differences in the strength of intention and its association with behavior. Consequently, it cannot investigate within-person factors that may influence whether individuals successfully translate their intentions into behavior in varying circumstances. This between-person perspective overlooks the importance of within-person dynamics and contextual intricacies that can be critical in comprehending the intention-behavior relationship (Conroy et al., 2013). While these designs provide valuable insight into the correlation between intentions and behavior at the between-person level, they do not provide a basis for estimating the magnitude of the differences between intended and actual behavior, nor do they provide a basis for estimating within-person variation. Empirical evidence suggests that more than half of the variability of intention and behavior is attributable to within-person variance (Maher & Dunton, 2020; Scholz et al., 2009; Scholz et al., 2008).

IBG as the Proportion of Unsuccessful Intenders

Sheeran (2002) proposed another approach to analyze the IBG by decomposing it into a 2×2 matrix, considering positive and negative intentions in relation to subsequent behavior performance or non-performance (McBroom & Reed, 1992; Orbell & Sheeran, 1998). This matrix allows the distinction of four groups of participants: "inclined actors" with positive intentions who subsequently act,

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"disinclined abstainers" with negative intentions who do not act, "inclined abstainers" with positive intentions who fail to act, and "disinclined actors" who perform the behavior despite negative intentions (Sheeran, 2002). Rhodes and de Bruijn (2013b) further developed this analysis, referring to it as the Action Control Framework. In this framework, individuals are said to be successful intenders if their demonstrated behavior meets or exceeds the level of intended behavior ($I \leq B$). On the contrary, individuals for whom intention exceeds actual behavior are referred to as unsuccessful intenders ($I > B$). Rhodes and de Bruijn (2013a) define IBG as "the ratio of unsuccessful intenders to successful intenders" (p. 304), and calculate it as the ratio of unsuccessful intenders to all intenders (see also Feil et al., 2023).

$$IBG = \frac{\sum_{i=1}^{n} \mathbf{1}(I_i \leq B_i)}{\sum_{i=1}^{n} \mathbf{1}(I_i > B_i) + \sum_{i=1}^{n} \mathbf{1}(I_i \leq B_i)} \tag{2}$$

Where:
IBG = General Intention Behavior Gap as proportion of unsuccessful intenders to all intenders.
$\sum_{i=1}^{n} \mathbf{1}(I_i > B_i)$ = Sum of intenders whose intention (I) exceeds the actual behavior (B) (unsuccessful intenders)
$\sum_{i=1}^{n} \mathbf{1}(I_i \leq B_i)$ = Sum of intenders whose behavior B meets or exceeds the level of intention (I) (successful intenders)
The indicator function **1** evaluates to one if the expression following it is met and to zero otherwise.

The authors conclude "the ratio of unsuccessful intenders to successful intenders shows that the IBG for physical activity represents 46% of the sample" (Rhodes & de Bruijn, 2013a, p. 304). While this approach provides a structured way to classify and quantify the intention-behavior gap, it is built on several assumptions that limit its applicability and accuracy in real-world settings. First, the binary classification into successful and unsuccessful intenders assumes that intentions and behaviors can be easily categorized. This overlooks the oftentimes continuous nature of intentions (Inauen et al., 2016). Second, the method primarily focuses on between-person information, thereby neglecting within-person variations. By categorizing individuals as either successful or unsuccessful intenders based on aggregate behavior, this approach ignores the intra-individual variability and the context-dependent nature of intentions and behaviors (Conroy et al., 2011). Third, the approach assumes that intentions remain constant until the behavior is performed or not performed. In reality, intentions are often fluid and can be influenced by immediate circumstances, new information, or changes in personal priorities (Cooke & Sheeran, 2004).

IBG is a Multidimensional Difference Between Intention and Behavior

In the preceding section, we expounded upon two predominant approaches for conceptualizing the IBG. In contrast to these antecedent conceptions, the novel perspective introduced here defines IBG as the difference between an individual's intention to engage in a specific behavior and their subsequent observed behavior. In its most general form, this definition can be represented mathematically as expressed in Equation 3:

$$IBG = I – B \tag{3}$$

IBG = Intention Behavior Gap
I = Intended behavior of an individual
B = Observed behavior of an individual

In alignment with the aforementioned discourse, "intention" signifies the actions an individual plans to take referring to the decisional intention (Rhodes & Rebar, 2017), while "behavior" denotes the actual actions observed in practice. In our concept, we use the term intended behavior as a specification of behavioral intention that refers to a particular behavioral episode (e.g., exercising at the gym on Wednesday evening). In contrast to the IBG frameworks mentioned above, our conceptual framework requires a precise correspondence between intended behaviors and their observable manifestations at the behavioral level, facilitating empirical observation and evaluation. The difference between intended behavior and actual behavior, encapsulated by Equation 3, characterizes the essence of the IBG. A positive value for IBG suggests a partial realization or complete abandonment of the intended behavior, while a negative value may signify that the individual's behavior exceeded their initial intention. A value of zero denotes that the person executed the behavior exactly as intended.

It is important to emphasize that intention, behavior, and IBG are not static, as individuals may move between different behavioral episodes, whether on a monthly, weekly, or daily basis. To describe this variability, we adopt a framework akin to Cattell's (1952) covariation chart, which distinguishes three fundamental dimensions: persons, time, and attributes, for characterizing variations. Consistent with this framework, we postulate that intention, behavior, and IBG exhibit covariation across three primary dimensions, and we additionally introduce a fourth dimension, type of behavior, as a relevant source of covariation within the IBG framework:

(i) Persons: Signifying the diverse interindividual variances molded by cognitive, emotional, motivational, and personality attributes.

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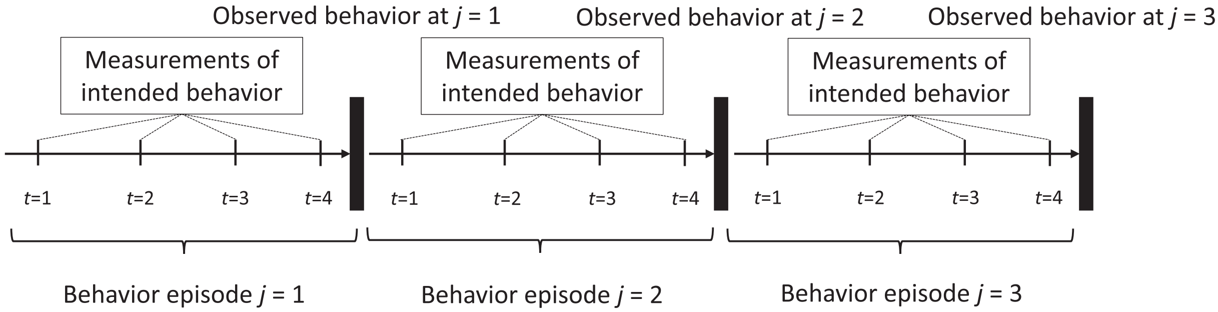

Figure 1. Framework for variation of intention-behavior gap over time.

(ii) Time: Encompassing the dynamic shifts over time within individuals, quantified through recurrent occurrences of intention and behavior pertaining to a specific behavioral category.
(iii) Contexts: Acknowledging the contextual influence that shapes the dynamic interplay between intention and behavior. This contextual scope encompasses distinctions such as weekday engagement versus weekend activities, or the differentiation between the domestic environment and vacation settings.
(iv) Types of Behavior: Recognizing the spectrum of variance across various categories of behavior. For instance, within the domain of physical activity, this encompasses multifarious actions such as exercising at a fitness center, engaging in jogging sessions, or participating in leisure-time activities like tennis or ice hockey (for a broader conceptualization see: Nigg et al., 2012).

Variation Across Persons

Variation across *persons or individuals* means that there are interindividual differences in people's intentions and behavior shaped by a unique blend of cognitive, emotional, motivational, social, and personality characteristics. Building upon the previously proposed Equation 3, the person variable i plays a critical role in defining the *IBG*.

$$IBG_i = I_i – B_i \tag{4}$$

Where:
IBG_i = Intention-Behavior Gap of a given person i
I_i = Intended behavior of a given person i
B_i = Observed behavior of a given person i

The IBG, as represented by Equation 4, encompasses the difference between an individual's intention (I_i) and their corresponding behavior (B_i). This discrepancy can vary substantially from one person to another, reflecting the heterogeneity of human cognitive and motivational processes. While previous research has often emphasized the influence of interindividual differences in explaining the *IBG* (Rhodes et al., 2022), our proposed model recognizes that these differences constitute just one dimension among several that contribute to the phenomenon.

Variations Across Time

To understand IBG, it is important to analyze not only variation between individuals but also variation within an individual (Conroy et al., 2011; Inauen et al., 2016; Rebar et al., 2016). Specifically, these variations pertain to repeated measurements of intentions and/or behavior for an individual regarding potential fluctuations within the same category of behavior. Although time constitutes a continuous dimension, in the context of health behaviors, it can be usefully described as a sequence of behavioral episodes that end when the intended behavior is performed or not performed. Variations across time can be decomposed into two components: variation of intention and behavior across behavioral episodes and variation of intention within these episodes (see Figure 1). Thus, the intentions can vary both within and across the behavioral episodes and behavior only across behavioral episodes. Within this framework, the intention, behavior, and *IBG* exhibit variations over time, which can be expressed mathematically as:

$$IBG_{i,t,j} = I_{i,t,j} – B_{i,j} \tag{5}$$

Where:
$IBG_{i,t,j}$ = Intention Behavior Gap for a given person i, measured at an occasion t within a specific behavior episode j.
$I_{i,t,j,}$ = Intended behavior of a given person i, measured at occasion t within a specific behavior episode j.
$B_{i,j}$ = Observed behavior of a given person i in a specific behavior episode j.

In the field of physical activity research, a growing number of studies have demonstrated that much of the variance is at the within-person level (Arigo et al., 2022; Bond et al., 2013; Conroy et al., 2013; Conroy et al., 2011; Maes et al., 2022; Maher et al., 2016; Maher et al., 2017; Pickering et al., 2016; Schumacher et al., 2021), underscoring the need to conduct intra-individual analyses in order to reveal meaningful insights not apparent from inter-individual

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comparisons. For physical activity, Conroy et al. (2013) found that 54% of the variance in intention and 67% of the variance in behavior were within individuals. For eating behavior, Inauen et al. (2016) found that 50% of the intention variance and 94% of the behavior variance was at the within-person level. Additionally, Maher et al. (2016) showed that the relationship between intentions and physical activity behavior varied throughout the day, with intentions predicting subsequent physical activity in the morning and evening on weekdays, and intentions not being associated with physical activity at any time on weekend days. However, it is important to note that these estimates of within-person variance might be inflated due to the methodology of ambulatory studies, which often neglect error variance. Thus, the reported within-person variance may represent overestimates. In general, these studies highlight the importance of examining variations across time to gain a comprehensive understanding of the dynamic nature of the IBG.

Variation Across Contexts

Contexts or settings refer to the environmental, situational, or social circumstances in which intention and behavior occur. These factors can significantly impact the relationship between intention and behavior (Maher & Dunton, 2020; Maher et al., 2016), creating variations in the *IBG*. Contexts or settings include aspects such as physical location, social environment, cultural norms, situational demands, and time constraints (Papini et al., 2020), which may either facilitate or hinder the enactment of intended behavior. The role of contexts or settings on the *IBG* is represented as follows:

$$IBG_{i,t,j,k} = I_{i,t,j,k} – B_{i,j,k} \tag{6}$$

Where:
$IBG_{i,t,j,k}$ = Intention-Behavior Gap for a given person i, measured at an occasion t within a specific behavior episode j in the context k.
$I_{i,t,j,k}$ = Intended behavior of a given person i, measured at occasion t within a specific behavior episode j in the context k.
$B_{i,j,k}$ = Observed behavior of a given person i within a specific behavior episode j in the context k.

The environments in which health-related behaviors take place, encompassing settings and situational contexts, wield substantial influence over the degree to which individual intentions translate into actual behaviors (Conroy et al., 2013). These contextual factors can manifest in diverse scenarios, exemplified by differences in dietary choices between work and vacation periods (Waterhouse et al., 2005), where individuals tend to consume more calories and fat while consuming fewer fruits and vegetables during the vacation season (Hart et al., 2011). Furthermore, research has shown that motivations for physical activity differ between home and holiday settings, with a greater emphasis on decompression during holidays (Osti et al., 2018). The contextual elements exert a discernible impact on the cognitive processes governing intention formation and the relationship between an individual's intentions and subsequent behaviors (Maher et al., 2016).

Variations Across Types of Behavior

The IBG is not only subject to variations across different individuals, times, and contexts but also manifests substantial variability across distinct behaviors (Conroy et al., 2011). This variation across behaviors signifies that the IBG for specific behaviors (e.g., exercising in gym vs. jogging), even within the same individual, can differ considerably. Such diversity is particularly evident when comparing behaviors that vary in complexity, frequency, familiarity, or personal significance. Different types of behavior are represented by index l:

$$IBG_{i,t,j,k,l} = I_{i,t,j,k,l} – B_{i,j,k,l} \tag{7}$$

Where:
$IBG_{i,t,j,k,l}$ = Intention-Behavior Gap for a given person i, measured at an occasion t within a specific behavior episode j in the context k for a specific behavior l.
$I_{i,t,j,k,l}$ = Intended behavior of a given person i, measured at occasion t within a specific behavior episode j in the context k for a specific behavior l.
$B_{i,j,k,l}$ = Observed behavior of a given person i within a specific behavior episode j in the context k for a specific behavior l.

The analysis of the variation in *IBG* across behaviors could illustrate the inherent multifacetedness of the health behavior, which might be determined by different circumstances and contexts in which health behaviors take place. For example, the IBG for Behavior 1 (exercising regularly at the gym) might be relatively low if the individual has a well-established routine, clear goals, and accessible resources. Conversely, the IBG for Behavior 2 (eating healthy foods every day) might be relatively high if the individual faces barriers such as high cost, limited availability, or lack of knowledge about nutritious choices.

Representing the IBG as shown in Equation 7 highlights the possibility that intention, behavior, and IBG can vary across all four dimensions: persons, time, context, and types of behavior. However, in many research studies, the focus may be limited to a single behavior (e.g., exercising in a weekly class), a single measurement occasion, and within a specific context. In such cases, the dimensions of the type

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of behavior, time, and context would be omitted from consideration, simplifying the analysis. All equations are presented in Table 1.

Assumptions of the Framework

The application of the IBG framework is based on certain assumptions that must be fulfilled in order to make valid statements about IBG. Here, we expound upon the fundamental assumptions that underlie the IBG model:

Conceptual and Temporal Equivalence

The conceptual and temporal equivalence assumption within the IBG model posits a critical requirement that intended behavior and observed behaviors must exhibit an exact match in their conceptual and temporal meaning (Ajzen, 1991, p. 185). In other words, for this particular model of IBG to operate correctly, the intended behavior must relate to the exact same *category* of behavior and for the same *period of time*. If, for example, the intention refers to regular physical activity over 4 weeks and the behavior refers to the fulfillment of the physical activity guideline for the last week, there must inevitably be a deviation between intention and behavior, since the two constructs have a different reference point conceptually and temporally. In addition, the conceptual and temporal equivalence assumption extends to the measurement level, emphasizing that the measures employed to assess both intended behavior and observed behavior should share the same metric. This ensures that the application of the model remains meaningful and mathematically sound when calculating the difference score that characterizes IBG.

Behavioral Episodes

The multidimensional IBG framework operates on the premise that behavior is best understood when viewed as distinct and well-defined behavioral episodes. A behavioral episode serves as a clearly defined, identifiable, and measurable instance of action, partial action, or inaction. These episodes are typically demarcated by specific temporal and situational parameters, providing a bounded context for understanding behavior. For example, exercising during a particular class at a particular time and date is one such behavioral episode. It's important to note that the model is not designed to accommodate behaviors characterized by continuous evolution, such as the gradual increase in the number of steps taken throughout the day. Instead, the model necessitates the summarization of behavior over a defined period (e.g., the total number of steps taken during the day) to establish a connection with a cognitively representable behavioral unit. This representation, grounded in discrete behavioral episodes, forms the basis for linking behavior to an associated intention within the IBG framework.

Continuous vs. Dichotomous Representation

In the exploration of the IBG, it is crucial to recognize the potential multidimensional nature inherent in both intention and behavior. The distinction between accumulated and one-off behaviors significantly affects the mathematical underpinnings of the IBG model. When deciding whether to use continuous or dichotomous representation, accumulated behaviors, such as aiming for a certain number of exercise minutes over a week, can be measured gradually. This allows for a more nuanced understanding of behavior implementation. In contrast, one-off behaviors, such as attending a scheduled class, follow the all-or-nothing principle, providing a clear binary outcome of whether the behavior was performed or not.

The conceptual and temporal correspondence between intention and behavior requires that both be defined in the same way, either as cumulative or one-off behaviors. In this paper, we limit ourselves to scenarios where both intention and behavior are treated as dichotomous constructs. However, it is crucial to underscore that Equations 3–7 remain applicable to both categorical and continuous conceptions of intention and behavior as long as we assume their manifestation in time is discrete (i.e., t and j are treated as discrete). Depending on the distribution of these two variables, distinct statistical models and estimation procedures arise. Therefore, extending the framework to continuous variables is a possibility and warrants further investigation in subsequent work.

Dynamics of Intentions as the Key to Overcoming IBG

Understanding the IBG requires acknowledging the dynamic nature of intentions (Conroy et al., 2011). This gap signifies individuals' struggles in translating intentions into observable behaviors, largely driven by the inherent mutability of intentions (Arigo et al., 2022; Dunton, 2017; Inauen et al., 2016). The stability of intentions, or lack thereof, plays a crucial role in this dynamic. Studies have shown that stable intentions are more likely to lead to consistent behavior, whereas fluctuating intentions can lead to a higher variance in the intention-behavior relationship (Cooke & Sheeran, 2004). Our conceptual framework posits that intentions are not static but rather fluid, subject to recalibration over time (Bratman, 1987). Individuals can adjust their intentions in response to changing circumstances, which is crucial for effective behavior realization. Two important aspects of the intention-behavior relationship emerge from the dynamic intentions: the stability of intentions over time and the time span between the measurement of the intention and the implementation of the behavior.

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Table 1. Mathematical Formulations of the Intention-Behavior Gap

Equation	Purpose	Variables
$IBG = 1 - R^2 = \frac{\sum_{i=1}^{n}(B_i - f(I_i))^2}{\sum_{i=1}^{n}(B_i - \bar{B})^2}$	Measure the proportion of variance in behavior that is not explained by intention.	B_i = Behavior of person i $\bar{B}$ = Average behavior in the sample $f(I_i)$ = Predicted behavior from intention of the person i
$IBG = \frac{\sum_{i=1}^{n}\mathbf{1}(I_i \leq B_i)}{\sum_{i=1}^{n}\mathbf{1}(I_i > B_i) + \sum_{i=1}^{n}\mathbf{1}(I_i \leq B_i)}$	Determine the ratio of unsuccessful intenders to all intenders.	$\sum_{i=1}^{n}\mathbf{1}(I_i > B_i)$ = Sum of intenders whose intention (I) exceeds the actual behavior (B) (unsuccessful intenders) $\sum_{i=1}^{n}\mathbf{1}(I_i \leq B_i)$ = Sum of intenders whose behavior B meets or exceeds the level of intention (I) (successful intenders) The indicator function **1** evaluates to one if the expression following it is met and to zero otherwise.
$IBG = I - B$	Represent the general form of IBG as the difference between intention and behavior.	I = Intended behavior of an individual B = Observed behavior of an individual
$IBG_i = I_i - B_i$	Represent IBG as the difference between intention and behavior for a specific individual.	I_i = Intended behavior of a given person i B_i = Observed behavior of a given person i
$IBG_{i,t,j} = I_{i,t,j} - B_{i,j}$	Represent IBG across different time points within a behavior episode.	$I_{i,t,j,}$ = Intended behavior of a given person i, measured at occasion t within a specific behavior episode j. $B_{i,j}$ = Observed behavior of a given person i in a specific behavior episode j.
$IBG_{i,t,j,k} = I_{i,t,j,k} - B_{i,j,k}$	Represent IBG across different contexts.	$I_{i,t,j,k}$ = Intended behavior of a given person i, measured at occasion t within a specific behavior episode j in the context k. $B_{i,j,k}$ = Observed behavior of a given person i within a specific behavior episode j in the context k.
$IBG_{i,t,j,k,l} = I_{i,t,j,k,l} - B_{i,j,k,l}$	Represent IBG across different types of behavior.	$I_{i,t,j,k,l}$ = Intended behavior of a given person i, measured at occasion t within a specific behavior episode j in the context k for a specific behavior l. $B_{i,j,k,l}$ = Observed behavior of a given person i within a specific behavior episode j in the context k for a specific behavior l.
$MSSD_{i,j,k,l} = \sum_{t=1}^{T-1}(I_{i,j,k,l,t} - I_{i,j,k,l,t+1})^2/(T-1)$	Measure the variation in intention within a behavior episode.	$MSSD_{i,j,k,l}$ represents one possible measure of intention variation for person i within behavior episode j in the context k for a specific behavior l. I_t *and* I_{t+1} denote the intention measurements at two adjacent time points.
$logit\ (P(IBG_{i,t,j,k,l} = 1)) = b_1 \cdot lag_{i,t,j,k,l} + b_0$	Model the extent to which temporal distance influences IBG.	$logit(P(IBG_{i,t,j,k,l} = 1))$ signifies the log-odds of the event where an intention-behavior discrepancy (IBG = 1) occurs for person i at the observation point of intention t within behavior episode j in the context k for a specific behavior l. b_0 represents the intercept in the logistic regression. It captures the baseline probability (log of the odds) of observing an intention-behavior discrepancy (IBG = 1) when all other predictor variables (i.e., the lag) are zero. b_1 serves as the regression coefficient for the time $lag_{i,t,j,k,l}$ encapsulating the effect of the temporal distance of intention and behavior enactment $lag_{i,t,j,k,l}$ denotes the time difference between the intended behavior ($I_{i,t,j,k,l}$) and the observed behavior ($B_{i,j,k,l}$) for person i at observation point of intention t within behavior episode j in the context k for a specific behavior l.

Temporal Stability of Intention

According to Ajzen (1991), intentions can only predict behavior if intentions show a certain stability over time (p. 185). Intention stability denotes the degree of consistency in an individual's intentions over time (Conner & Norman, 2022) and the significance of intention stability in bridging the IBG has been supported by extensive research (Rhodes et al., 2022). Stable intentions reduce the variance in the intention-behavior relationship, as consistent intentions are more likely to predict corresponding behaviors reliably. A considerable number of studies, such

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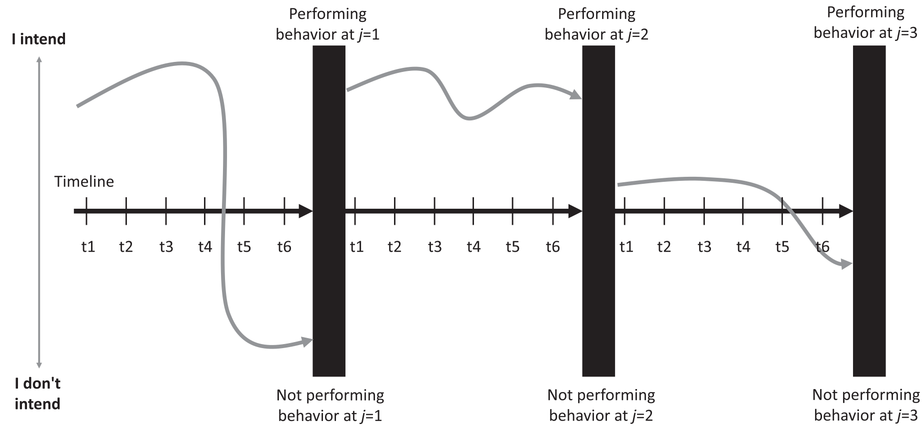

Figure 2. Development of intention in behavior episodes.

as those by Abraham and Sheeran (2003), Conner et al. (Conner et al., 2013; Conner et al., 2016; Conner et al., 2000, 2002, 2006), Cooke and Sheeran (2004, 2013), Godin et al. (2005, 2010), Keer et al. (2014), Kwan and Bryan (2010), Li and Chan (2008), Rhodes et al. (2010), Rowan et al. (2017), Sheeran and Abraham (2003), and Sheeran et al. (1999) provide evidence that stable intentions are more likely to be translated into actual behavior. The meta-analysis by Cooke and Sheeran (2004) identified that the stability of intentions over time notably influences the correlation between intentions and behaviors, particularly highlighting that stable intentions lead to stronger associations, especially in physical activity contexts. Likewise, intention stability was found to be one of the most consistent moderators of intention-physical activity correlations in over 80% (10/13 tests) of the papers reviewed by Rhodes et al. (2022).

We believe that the (in)stability of intention is best reflected in the variation of the different values of intention. Therefore, to quantify the variability of intention *within a behavioral episode*, we propose the Mean Square of Successive Differences (MSSD; von Neumann et al., 1941) given in Equation 8:

$$MSSD_{i,j,k,l} = \sum_{t=1}^{T-1} (I_{i,j,k,l,t} - I_{i,j,k,l,t+1})^2 / (T-1) \qquad (8)$$

Here:
$MSSD_{i,j,k,l}$ represents one possible measure of intention variation for person i within behavior episode j in the context k for a specific behavior l.
I_t *and* I_{t+1} denote the intention measurements at two adjacent time points.

In the context of models utilizing binary expressions of intention and behavior, the MSSD index offers insight into the proportion of intention switches relative to all intention comparisons occurring within a behavioral episode. A higher value of within-person intention variation indicates a greater frequency of changes in an individual's intention throughout the course of a behavioral episode. When an individual maintains a consistent intention throughout the entirety of the episode, the within-person intention variation is zero. Conversely, as intention variation becomes increasingly pronounced, accompanied by frequent shifts in intention, the MSSD value tends toward one.

Temporal Distance

From the vantage point of dynamic intentions, predicting intended behavior becomes contingent on the timing of intention measurement, potentially leading to an underestimation of the influence of intentions (see Figure 2). Specifically, the proximity of intention measurement to the intended behavior assumes significance – the closer the measurement to the behavior, the more predictive intention becomes of behavior (Cooke & Sheeran, 2004). Given the dynamic disposition of intentions (Conroy et al., 2011; Pacherie, 2006), a pivotal inquiry arises concerning the state of intention immediately preceding the intended behavior. If intention is present just before the planned behavior, it is highly likely to incite the behavior's execution. However, if the intention shifts prior to the behavior, the originally intended behavior will likely not be enacted. As illustrated in Figure 2, for behavioral episode j = 1, the intention shift occurs between t4 and t5, resulting in intention failing to accurately predict behavior enactment at t = 1 – t = 4, but becoming predictive at t = 5 and t = 6. In the case of behavioral episode j = 2, where no intention shift occurs, intention accurately predicts behavior at all measured points from t = 1 to t = 6. Finally, for behavioral episode j = 3, the intention shift takes place between t = 5 and t = 6, causing intention to accurately predict behavior only at t = 6.

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Several studies have shown that the interval between measuring intention and behavior is negatively related to the magnitude of the intention-behavior correlation (Sheeran & Orbell, 1998; Trafimow & Miller, 1996). This time-related decrease in intention-behavior correlation probably stems from the exposure to new information that may alter plans between intention measurement and behavior enactment (Bratman, 1987; Pacherie, 2006). To quantify the impact of time on the IBG, one approach involves employing hierarchical logistic regression analysis. In this analytical method, IBG is treated as a binary outcome, categorized as 0 (indicating no intention-behavior discrepancy) or 1 (indicating an intention-behavior discrepancy). The primary objective is to predict this binary outcome using the variable "time", which represents the time lag between the measurement of intention at a given time point t and the subsequent behavior within a specific behavior episode j. The modeling of the influence of temporal distance as a moderator of the IBG can be achieved through Equation 9:

$$logit\left(P(IBG_{i,t,j,k,l} = 1)\right) = b_1 \cdot lag_{i,t,j,k,l} + b_0 \qquad (9)$$

In this Equation:

$logit\left(P(IBG_{i,t,j,k,l} = 1)\right)$ signifies the log-odds of the event where an intention-behavior discrepancy (IBG = 1) occurs for person i at the observation point of intention t within behavior episode j in the context k for a specific behavior l.

b_0 represents the intercept in the logistic regression. It captures the baseline probability (log of the odds) of observing an intention-behavior discrepancy (IBG = 1) when all other predictor variables (i.e., the lag) are zero.

b_1 serves as the regression coefficient for the time $lag_{i,t,j,k,l}$ encapsulating the effect of the temporal distance of intention and behavior enactment

$lag_{i,t,j,k,l}$ denotes the time difference between the intended behavior ($I_{i,t,j,k,l}$) and the observed behavior ($B_{i,j,k,l}$) for person i at observation point of intention t within behavior episode j in the context k for a specific behavior l.

Equation 9 provides a way to model the extent to which temporal distance influences the alignment between intended behavior and observed behavior. In this hierarchical logistic regression model, the coefficients b_1 and b_0 need not be fixed and could be treated as random across the four dimensions: persons, behavior episodes contexts, and types of behavior. However, it is essential to clarify that these coefficients do not vary *within* a specific behavior episode (i.e., time). A positive b_1 suggests that as the time lag increases, the probability of an IBG also increases. Conversely, a negative b_1 value indicates that shorter temporal distances lead to a larger IBG. The examination of the temporal lag between the measurement of intentions and intended behavior represents a crucial initial step in understanding the IBG phenomenon. All nine equations with their intended purpose and description are shown in Table 1.

Future Directions for the Measurement and Analysis of the IBG

The preceding sections underscored the pivotal role of intention fluctuations in shaping the IBG. It is evident that conventional cross-sectional and longitudinal studies with extended measurement intervals are inadequate for capturing these nuanced fluctuations. To gain a comprehensive understanding of intention dynamics and their developmental trajectory, a sophisticated measurement approach integrating ecological momentary assessment and mixed methods is imperative.

Ecological Momentary Assessment

Presently, the forefront methodology for capturing fluctuations in behavior and behavioral cognitions within the realm of social science is known as ecological momentary assessment (EMA), which proves particularly advantageous for the investigation of the IBG (Inauen et al., 2016; Maher et al., 2017). The ubiquity of mobile phones, coupled with their user-friendly interfaces, has facilitated the rapid collection of data from extensive participant pools (Dunton et al., 2012). The collected data can be seamlessly transmitted to remote servers in a minimally intrusive manner. EMA studies are characterized by their collection of intensive longitudinal data within natural settings, affording a high degree of ecological validity (Reichert et al., 2020). This approach promises the possibility of flexible measurement of all four dimensions of IBG and brings with it a number of advantages such as capturing data in real-time and real-life settings with timely high density through repeated measurements as well as gathering insights on both between and within-subject levels (Shiffman et al., 2008).

For example, in the context of physical activity research, a handful of studies have been conducted using EMA to examine IBG (e.g., Arigo et al., 2022; Bond et al., 2013; Conroy et al., 2013; Conroy et al., 2011; Maes et al., 2022; Maher et al., 2016; Maher et al., 2017; Pickering et al., 2016; Schumacher et al., 2021). Overall, the studies show that both intentions and behaviors are dynamic and that a large part of the variance is at the within-person level, suggesting the necessity for intensive longitudinal data analyses (Dunton, 2017; Maher et al., 2016; Maher et al., 2017). Furthermore, these studies show that the magnitude of the IBG varies with temporal contexts (e.g., morning vs. evening; weekday vs. weekend) and life contexts (e.g., cardiovascular prevention,

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college students, general adult population) in which different mechanisms of action manifest. The stability of intention emerges as an inconsistent predictor, yielding both positive and negative effects on IBG across diverse contexts.

To illustrate, consider a potential data scenario in which EMA is used in a study to record the stability of intentions and their influence on behavior in relation to participation in a weekly prevention course. Participants are asked daily over a period of 4 weeks to state their intentions to attend the next course session and to report once a week whether they have attended the course. This approach will generate 28 data points per participant, allowing researchers to analyze within-person variation and contextual influences on the IBG. The data could reveal how stable the intention to attend the course sessions is over time and how the IBG varies depending on the time elapsed between the measurement of intention and the actual behavior (e.g., attending the course session). Such findings would provide insights into the temporal dynamics of intention stability and its impact on behavior.

Mixed-Methods Approach

An extension of the EMA approach to understanding the IBG is the mixed-methods approach, in which the quantitative data (e.g., obtained via EMA) is combined with qualitative data (Creswell & Creswell, 2017). In particular, the use of qualitative data to analyze the IBG has so far only taken place in individual studies (e.g., in the context of consumer behavior; Carrington et al., 2014), whereby the enrichment of quantitative studies with qualitative elements could create a new quality of studies (Tashakkori et al., 2009). This approach offers a holistic perspective enabling researchers to capture the variability of intentions, behaviors, and IBG while also understanding the contextual and motivational factors that drive IBG.

EMA provides real-time and real-life data on intention and behavior, capturing the dynamic nature of these constructs and the magnitude of IBG. Qualitative methods, such as interviews or daily diaries, can complement EMA data by offering in-depth insights into the context, motivations, and experiences surrounding intention and behavior. This combination allows for a more comprehensive understanding of IBG, as it integrates both quantitative and qualitative dimensions.

To illustrate, consider the 4-week EMA study mentioned above, where participants report their daily intentions to attend a weekly prevention course and whether they actually attended the course. If shifts in intention are observed in the EMA data, follow-up qualitative interviews can be conducted to explore the reasons for these changes. For example, if a participant's intention to attend the course declines after the second week, an interview can provide insights into potential barriers, changes in motivation, or contextual factors influencing this shift. By integrating these qualitative insights with the quantitative EMA data, researchers can explore predictors of intention change or stability, providing a richer, more nuanced understanding of the factors driving the IBG.

Implications for Theory and Interventions

The investigation of the IBG within this paper not only impacts the selection of study designs and methodologies but also holds considerable implications for advancing theoretical perspectives and shaping strategies for behavioral interventions.

Comparison With Alternative Conceptions of IBG

The conceptualization of IBG introduced here diverges in several key aspects from the predominant conceptions of IBG, namely the unexplained variance approach (Hagger et al., 2002; McEachan et al., 2016) and the action control framework (Rhodes & de Bruijn, 2013b). This comparative analysis will center on four crucial dimensions of IBG.

Definition of IBG

In our conceptualization, IBG is mathematically defined as the difference between intended behavior and actual behavior. In contrast, the unexplained variance approach and the action control framework define IBG as the lack of a strong correlation between intention and behavior or as the ratio of unsuccessful intenders to all intenders (Rhodes & de Bruijn, 2013a). These distinct definitions of IBG give rise to disparities in mathematical and methodological considerations.

Consideration of IBG Dimensions

Our approach to IBG differs by encompassing multiple dimensions compared to the two alternative models. While the unexplained variance approach and the action control framework primarily examine the relationship between intention and behavior through interindividual variation, our IBG concept emphasizes a multidimensional perspective. Here, the dimensions of time, context, and the type of behavior become salient in addition to the dimension of individual differences. The temporal dimension, in particular, is instrumental in identifying IBG, as it manifests as the difference between intention and behavior, always occurring at the individual level and necessitating the analysis of intraindividual variation.

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Research Questions

Our IBG conceptualization engenders different research questions compared to the other two frameworks. While past research on IBG primarily centered on the moderators of the intention-behavior relationship (Rhodes et al., 2022), this line of inquiry becomes less relevant within our framework. Our approach shifts the focus towards understanding the stability of intention, the factors influencing intention formation, pinpointing the time points at which intention shifts occur within a behavioral episode, probing the reasons behind such shifts, elucidating their implications for subsequent behavioral episodes, and exploring the interplay between intention and behavior across multiple behavioral episodes.

Interplay Between Intentions, Plans, and Habits

For effective interventions in behavior change, it is essential to place the IBG in the context of other predictors, with dual-process theories being particularly useful for this purpose (Hohberg et al., 2022). According to dual process theories, human behavior is influenced by two distinct types of cognitive processes: reflective (explicit) processes, which are deliberate and effortful, and impulsive (implicit) processes, which are automatic and affective (Brand & Ekkekakis, 2018; Strack & Deutsch, 2004). In the context of health behavior, the Physical Activity Adoption and Maintenance (PAAM) Theory by Strobach et al. (2020) suggests that intentions represent explicit processes involving conscious planning and decision-making aimed at achieving specific goals. However, intentions alone are often insufficient for sustained behavior change (Jekauc et al., 2015). Habits, which are implicit processes, develop through repeated behavior in stable contexts and become automatic responses to environmental cues (Gardner et al., 2020). The PAAM Theory suggests that while intentions initiate behavior change, habits maintain it over the long term (Jekauc et al., 2024; Strobach et al., 2020).

A connecting component between intentions as explicit processes and habits as implicit processes can be action and coping planning in the context of health psychology (Schwarzer & Hamilton, 2020). Plans are conscious, often detailed strategies that help translate intentions into specific, actionable steps (Gollwitzer, 1999). This process often requires detailed reasoning, estimating resources, determining timeframes, and developing step-by-step instructions to achieve the desired goal. Plans can be understood as cognitive schemata, which are mental structures that organize and guide patterns of thoughts, perceptions, and behaviors (Mooney, 1990). They can be modified as circumstances change, allowing individuals to respond effectively to changes in the environment (Bratman, 1987).

The transition from plans to habits begins with the formation of detailed plans that guide specific actions toward achieving a goal. These plans, when executed repeatedly in consistent contexts, start to become more automatic (Stojanovic et al., 2022). For example, an individual might plan to exercise every morning. Initially, this requires conscious effort and adherence to a structured plan. With repeated execution, the behavior guided by the plan becomes more consistent (Aarts et al., 1998). The individual starts associating specific cues (e.g., morning time, exercise clothes) with the planned action (exercise). Over time, the repeated execution of the plan under consistent conditions leads to the formation of a stable cognitive schema (Markus, 1977). These schemata encapsulate the sequence of actions, the associated cues, and the expected outcomes. The plan becomes a cognitive template that can be activated with minimal conscious effort (Martiny-Huenger et al., 2017). The behavior then becomes automatic, triggered by specific environmental cues without the need for detailed planning each time (Lally & Gardner, 2013).

This process highlights the importance of both explicit planning and the gradual development of implicit habits for sustained behavior change (Feil et al., 2021). Understanding this dynamic interplay provides insights for designing effective interventions that promote long-term adherence to desired behaviors (Finne et al., 2022).

Implications for Interventions

The insights gained from our examination of the IBG hold significant promise for informing strategies and approaches to promote behavior change and enhance intention adherence. One of the critical implications stemming from our exploration of the IBG lies in the development of personalized just-in-time interventions stabilizing intentions (Tong et al., 2021). These interventions are designed to provide timely and contextually relevant support precisely when individuals need it most (Hardeman et al., 2019). Just-in-time interventions align perfectly with the dynamic nature of intentions, as they can be triggered by shifts in intention states (Nahum-Shani et al., 2015).

In addition to just-in-time interventions, understanding the interplay between intentions, plans, and habits provides further insights for designing effective behavior change strategies. Interventions should include components that encourage individuals to create specific action plans, set clear, actionable steps, determine the necessary resources, incorporate potential cues (to allow the habit-building process to be integrated), and establish timeframes for each step (Gollwitzer, 1999). Furthermore, interventions should incorporate coping planning, which helps individuals anticipate potential obstacles and develop strategies to overcome them (Schwarzer, 2008).

Interventions grounded in the implementation intention approach leverage the fundamental principles of linking

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situational cues with goal-directed actions and aligning with intention stability and adaptation (Bélanger-Gravel et al., 2013). These interventions recognize the critical role of situational cues in shaping behavior. By helping individuals create clear, specific plans that link environmental cues to intended actions, these interventions facilitate the translation of intentions into behavior (Rhodes et al., 2020).

Conclusion

This article presents a novel conceptualization of the IBG, augmented by mathematical formulations, which surpasses prevailing approaches to IBG. We define IBG as the difference between individuals' intended behaviors and their actual actions, recognizing it as a complex interplay across four dimensions: person, time, context, and type of behavior. Particularly, we underscore the temporal dimension as pivotal, allowing for the exploration of stability effects and temporal proximity between intention measurement and behavior observation. Additionally, we strongly emphasize the within-person nature of the intention-behavior dynamics. Given the lack of ergodicity, these cannot be easily inferred from interindividual differences (Molenaar, 2004). The envisaged dynamics among intention, behavior, and IBG necessitate innovative measurement tools and study designs, embracing methodologies such as EMA coupled with qualitative interviews. These methodological advancements enable researchers to enrich and broaden our comprehension of IBG, fostering the development of more efficacious strategies for promoting healthy behaviors.

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