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Thomas W. Ferratt
University of Dayton, ferratt@udayton.edu

Jayesh Prasad
University of Dayton, jprasad1@udayton.edu

E. James Dunne
University of Dayton, dunne@udayton.edu

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Fast and Slow Processes Underlying Theories of Information Technology Use

Thomas W. Ferratt[1], Jayesh Prasad[2], E. James Dunne[3]
[1]University of Dayton, ferratt@udayton.edu
[2]University of Dayton, jprasad1@udayton.edu
[3]University of Dayton, dunne@udayton.edu

Abstract

Although theories of information technology (IT) use have been widely researched, organizations continue to struggle with insufficiently utilizing their IT assets. Those interested in understanding and managing IT use need both novel theoretical development and new directions for future research. In this paper, we address both of these needs. Regarding the first need, we develop novel theory by explaining two types of cognitive processes—one fast and one slow—that underlie theories of IT use. The impetus for our explanation of underlying processes (EUP) comes from studies of IT use that have found moderating effects of previous interaction with IT. With these results, researchers have concluded that cognitions are less important in determining IT use as the use of that IT increases. Consistent with that conclusion, our EUP posits that, as learning from prior use occurs, the influence of fast, automatic, unconscious (type 1) cognitive processes increases while the influence decreases for slow, controlled, conscious (type 2) cognitive processes. Type 1 processes automatically generate a default type 1 response; type 2 processes have the potential to generate an intervening type 2 response. The intervention potential is highest for initial use of the target IT and lowest when learning is high such that use of the IT has become automatic. From our EUP, we develop three insights: 1) that the cognitions that lead to a default response are not necessarily the cognitions found in extant theories of IT use, 2) that both type 1 and type 2 processes are subject to bounded rationality, and 3) that the relationship between learning and the intervention potential for a type 2 response, although negative, may not be linear. To address the second need that we note above, we suggest new directions for future research, which includes investigating the cognitive control problem (i.e., when type 2 processes intervene) and exploring the effects of heuristics, nudges, and bounded rationality on decisions to use IT. Beyond the hope that the suggested directions for research will yield solutions for addressing the underutilization of IT assets, the fundamental advances in theoretical understanding that we present here suggest notable implications for practice, including developing brief, simple, cognitively unconscious messages directed at nudging decision makers toward a default response to use the target IT.

Keywords: Information Technology Acceptance and Use, Theory of IT Use, Fast and Slow Processes, Dual-Process Theories, Type 1, Type 2, EUP, TAM, TPB, UTAUT, UTAUT2, Continuing Use of IT, Habitual Use of IT.

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1 Introduction

Although much research has examined the factors that affect the adoption and continued use of information technology (IT), organizations still have reason to be concerned about getting people to use IT to support their work. In discussing organizations' "huge investments in information technology over the last 25 years", Jasperson, Carter, and Zmud (2005, p. 526) conclude that "existing evidence strongly suggests that organizations underutilize the functional potential of the majority of this mass of installed IT applications". More recently, Veiga, Keupp, Floyd, and Kellermanns (2014) have reiterated concerns about underutilization of ERP systems in the business domain. Venkatesh, Zhang, and Sykes (2011, p. 524) note similar concerns beyond the business domain with healthcare systems. The fact that businesses continue to invest in ERP systems emphasizes the importance of these concerns; indeed, Scavo (2014) reports that ERP investment rates are the highest of over a dozen technologies. Similarly, substantial investments in electronic health records (EHR) by hospitals (Herman, 2014) further emphasize the importance of these concerns beyond the business domain. Understanding the underlying processes by which individuals move from adoption to continued use to automatic use would provide a foundation for addressing these concerns.

A large body of research has focused on the use of IT; however, from reviewing this research, we found that research has not adequately explained the movement from initial use of specific IT functionality to continued use and beyond (e.g., automatic use of that functionality or use of additional functionality). We focus on providing that explanation and identifying new directions for future research, which should provide a basis for infusing this body of research with a new vitality. Inspired by Evans (2011, 2008), we describe the relationship of fast, automatic, unconscious (type 1) cognitive processes and slow, controlled, conscious (type 2) cognitive processes as IT use shifts from initial to continuing use and beyond. Type 1 processes provide a default response to use or not use a target IT. Type 2 processes may intervene to override or reinforce that response. We suggest factors that affect intervention by type 2 processes. We discuss how researchers may use our explanation of these fast and slow processes and resulting insights to provide new directions for research and point to immediate actions to address the underutilization of significant IT assets.

Before explaining the fast and slow processes that underlie individuals' decisions to use a target IT, we begin with needed clarifications in cognitive theories of IT use. First, we identify and address specific problems in the literature about the several constructs used to represent previous interaction with IT (namely, experience, prior use, and habit). Previous interaction with a target IT is a basis for learning, an important element of our explanation, so we need to address the noted problems. Next, we explain an inadequately developed implication of the moderating effect of previous interaction with IT, which serves as the impetus for the core of our explanation. As a brief preview, our theoretical elaboration is consistent with a common interpretation of the moderating effect of previous interaction with IT on the relationship between cognitions and use of IT. As Kim, Malhotra, and Narasimhan (2005) and Limayem, Hirt, and Cheung (2007) report, cognitions have a decreasing influence on IT use as previous interaction with IT increases. This moderating effect reflects learning. Moreover, our EUP is also consistent with a less clearly developed implication of the moderating effect of previous interaction: conscious and automatic processes jointly occur in an individual. This latter implication contrasts with an espoused alternative view that such processes do not occur simultaneously in individual users (Kim and Malhotra, 2005, p. 746). However, since this latter implication that both conscious and automatic processes jointly occur is a logical extension of a moderating effect, which we discuss later, the logic of our theoretical elaboration is more persuasive than the espoused alternative view.

After more fully developing and addressing the need for clarification of use-related constructs and an inadequately developed implication of the moderating effect of previous interaction with IT, we focus on developing the core of our contribution: that is, we focus on explaining the underlying type 1 and type 2 processes and their relationship along the continuum of IT use from 1) initial use to 2) continuing use to 3) automatic use. As part of our explanation, we introduce the cognitive control problem, which deals with the question of when slow, controlled, conscious (type 2) processes intervene to reinforce or override the default fast, automatic, unconscious (type 1) response. We present four scenarios to illuminate when type 2 processes intervene. We then discuss how our EUP relates to selected prior research. Finally, we discuss future research opportunities and implications for practice. This discussion directly addresses the underutilization of significant IT assets by focusing on concerns about getting people to use IT more fully to support their work whether in business, health care, or other domains.

A preview of essential elements of our EUP and related insights includes:

- Learning, from prior decisions to use IT and from actual use of the IT, is incorporated into type 1 and type 2 processes and related cognitions.
- Cognitions that lead to a default type 1 response are not necessarily the cognitions found in extant cognitive theories of IT use.

- Slow, controlled, conscious (type 2) cognitive processes are more likely to intervene to reinforce or override the default fast, automatic, unconscious (type 1) cognitive response when there is little or no learning from prior use of the target IT (which includes similar IT) or related instruction. Thus, type 2 processes are dominant over type 1 processes when there is little or no prior use of the target IT.
- Type 2 processes are less likely to intervene to reinforce or override the default type 1 response as learning occurs. Thus, the influence of type 2 processes decreases as learning occurs.
- Type 2 processes are basically unlikely to intervene to reinforce or override the default type 1 response when high learning has occurred from prior use of IT. Thus, type 1 processes dominate type 2 processes when extensive learning has occurred.
- In the cognitive control problem, intervention potential represents the likelihood that type 2 processes will intervene. When the intervention potential is high enough (i.e., exceeds the intervention threshold), type 2 processes intervene. The relationship between extent of learning (or prior use) and intervention potential, however, may not be linear.
- Both type 1 and type 2 processes are subject to bounded rationality.

We develop the essential elements of our EUP and related insights in the sections that follow. We build on those elements and insights to discuss how our work relates to prior research and develop suggestions for future research and practice.

2 Need for Clarifications in Cognitive Theories of IT Use

Much work has focused on initial acceptance and use of information technology (IT). For example, Venkatesh, Morris, Davis, and Davis (2003) review eight theories that have been prominent in the literature. Beyond that literature, works have emerged that include a focus on understanding continuing IT use, including automatic use (e.g., Bhattacherjee, 2001; Jasperson et al., 2005; Karahanna, Straub, & Cherveny, 1999; Kim & Malhotra, 2005; Kim et al., 2005; Limayem et al., 2007; Wu & Kuo, 2008; Kim, 2009; Ortiz de Guinea & Markus, 2009; Venkatesh, Thong, & Xu, 2012; Polites & Karahanna, 2012, 2013; Setterstrom, Pearson, & Orwig, 2013; Lowry, Gaskin, & Moody, 2015; Xu, Abdinnour, & Chaparro, 2017).

To explain continuing use, researchers have supplemented cognitive-based explanations of initial acceptance of IT, such as the technology acceptance model (TAM) (Davis, 1989), the theory of planned behavior (TPB) (Ajzen, 1991), and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003), with use-related constructs—experience, prior use, and habit (e.g., Limayem et al., 2007; Kim, 2009; Venkatesh et al., 2012). Some researchers have studied initial acceptance and use as well as continuing IT use (e.g., Aggarwal, Kryscynski, Midha, & Singh, 2015; Benlian, 2015; Sun, Fang, & Zou, 2016). Generally, these works propose that continuing IT use is based on both:

1. Cognitions, such as perceived usefulness and perceived ease of use (from TAM); attitudes, subjective norms, and perceived behavioral control (from TPB); and performance expectancy, effort expectancy, social influence, and facilitating conditions (from UTAUT); and
2. A user's previous interaction with the IT.

Researchers have incorporated additional constructs beyond those in TAM, TPB, and UTAUT into other models that explain IT use, such as enjoyment (Van der Heijden, 2004; Xu et al., 2017), social networks (Sykes, Venkatesh, & Gosain, 2009), co-worker advice (Robert & Sykes, 2017), emotions (Beaudry & Pinsonneault, 2010; Stein, Newell, Wagner, & Galliers, 2015), and mindfulness of technology in conjunction with task-technology fit (Sun et al., 2016). From reviewing research that has examined or extended UTAUT or integrated it with other theoretical frameworks, Venkatesh, Thong, and Xu (2016) propose a revised model of technology acceptance and use that includes main effects from UTAUT and UTAUT2 (an extension to UTAUT by Venkatesh et al. (2012)) and individual and higher-level contextual factors. However, these additional constructs, extensions, integrations with other theoretical frameworks, and contextual factors do not change the role of cognitions and, where included, previous interaction with the IT.

Since the several constructs used to represent previous interaction with IT—experience, prior use, and habit—can create confusion, we discuss those use-related constructs next and suggest some clarifications. Subsequently, we argue against the view that conscious and automatic processes do not occur simultaneously in an individual. This logically inconsistent interpretation of the moderating effect of previous interaction with IT led us to develop our explanation of the processes that underlie the decision to use IT.

2.1 Use-related Constructs

Although the literature has a variety of conceptualizations of system use (Burton-Jones & Straub 2006) and has conceptualized user behavior more broadly than system use (Beaudry & Pinsonneault, 2005), researchers have used three use-related constructs—experience, prior use, and habit—in studies with previous system use. These variations on previous system use have implications for learning and the influence of underlying fast and slow processes. We discuss each construct below.

In presenting UTAUT2, Venkatesh et al. (2012, p. 161) describe experience as the "opportunity to use a target technology" that "is typically operationalized as the passage of time from the initial use of a technology by an individual". If one follows Venkatesh et al.'s (2012) conceptual and operational definitions, experience does not represent interaction with the IT; rather, it represents only the opportunity to interact with a specific technology. For some individuals, that opportunity could mean that they interacted to a great extent and learned a great deal about the IT. For others, who had the same opportunity, it could mean that they had little or no interaction and learned nothing. As a result, defining experience as Venkatesh et al. (2012) do has a significant limitation. Those defining experience in this way must clearly explain how this version makes an interpretable contribution to understanding IT use.

Others have conceptually defined experience to include more than just an opportunity to interact with the technology. For example, Thompson, Higgins, and Howell (1994) refer to experience conceptually as past use of IT (e.g., use of a spreadsheet), which makes experience similar to prior use (see below). To limit confusion when including experience in a study of IT use, we suggest clearly specifying its conceptual and operational definitions and referencing other works that are consistent with those definitions to help situate the work in the literature.

Prior use, also called past use or past usage, has been a construct in various studies (e.g., Kim & Malhotra, 2005; Kim et al., 2005; Wu & Kuo, 2008; Kim, 2009). Typically, prior use is a single-dimensional construct that reflects the extent of the user's previous interaction with a specific IT. Kim et al. (2005) use a two-item measure that reflects the extent of a user's interaction with the IT (in this case, frequency and duration of use).

Variations on prior use that rely on frequency or extent of a user's previous interaction with a specific IT include both extended use and proficient use. Extended use "refers to using more of the technology's features to support an individual's task performance" (Hsieh & Wang, 2007, p. 217; similarly, see Benlian, 2015). Veiga et al. (2014, p. 694), in effect, build on extended use in operationalizing proficient use as the "extent to which individuals fully utilize the core, integrative applications within a specific software platform that are designed and intended to enhance their performance on essential, job-related tasks". Others have referred to deep structure use rather than proficient use (e.g., Robert & Sykes, 2017).

We offer several suggestions regarding prior use. First, we suggest using the extent of the user's interaction with the IT for the definitions of both 1) prior use and 2) use of technology since these use-related constructs represent the same behavior just at different times. We also suggest that, when the extent of learning, expertise, or proficiency regarding the IT is appropriate for a study, researchers should consider including that construct explicitly or represent it via prior use and its moderating effect. Finally, note that prior use can take on values over a wide range of previous interaction with IT—from none to highly extensive for a specific application or an extended set of features or applications. Thus, prior use can be used in theories that explain both initial use, where prior use is none, and continuing use, where prior use could vary from very little to highly extensive.

Habit is the most complex of the three use-related constructs. A recent, multi-dimensional definition of habit comes from Polites and Karahanna (2013, p. 224; 2012, p. 25): "learned sequences of acts that have become automatic responses to specific cues and are functional in obtaining certain goals or end-states". In their work, habit has:

> *Four dimensions of* intentionality, awareness, controllability, *and* mental efficiency*…. Intentionality does not refer to planned or conscious decisions to take action…as intention has been defined in both the psychology and IS literature.... Rather, habits are* intentional *in that they are functional or goal-oriented in nature. Nevertheless, habits occur outside of awareness, in that the individual may be unaware of the situational trigger leading them to perform the behavior, or unaware of how the trigger is interpreted at the moment it occurs.… Further, habits are difficult to control, in that it may be difficult to resist the urge to perform a task in a particular way, especially if it is part of a larger automatized work routine. Finally, habits are mentally efficient, meaning that they free the individual's attentional resources to do other things at the same time…. (emphasis in original) (Polites & Karahanna, 2013, p. 224)*

Others focus on limited dimensions of this definition, particularly awareness. For example, Limayem et al. (2007, p. 709) refer to habit as a mind-set and define IS habit as "the extent to which people tend to perform behaviors (use IS) automatically because of learning". Given the multi-dimensional definition of habit, we suggest that researchers who rely on limited dimensions clarify and justify the dimensions that they focus on.

2.2 Interpreting the Moderating Effect of Previous Interaction with IT

We begin our discussion of the moderating effect of previous interaction with IT by explaining the model in Figure 1. It shows a generic reason-based model supplemented with a generic use-related construct, "past behavior", which represents specific use-related constructs that previous studies have employed. This model shows that past behavior affects various cognitions and continued use. It shows that various cognitions mediate the effects of past behavior on continued use and that past behavior moderates the effect of various cognitions on their consequences. Examples of cognitions other than intention to use technology include attitudes, subjective norms, and perceived behavioral control from TPB.

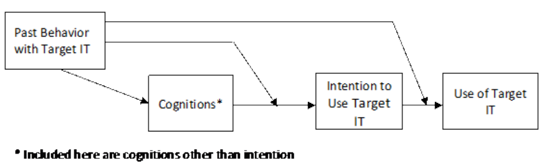


Figure 1. A Model of Technology Use with Cognitions and Past Behavior

Graphical models such as Figure 1 can often be represented with a corresponding estimated statistical model. For example, consider a model that could represent the portion of Figure 1 that has intention to use target IT (INT) and past behavior with target IT (PAST) jointly influencing use of target IT (USE):

$$USE = b0 + b1*INT + b2*PAST + b3*INT*PAST \quad (1)$$

Focusing on this portion of the model in Figure 1 allows one to discuss essential features of theories of IT use across the continuum of IT use. For initial use, only intention affects use since there is no past behavior (PAST = 0), which makes the last two terms in Equation 1 each equal 0. With those terms equal 0, the implication is that b1 > 0 such that, as intention increases, use increases. The moderating effect of past behavior, which the interaction term (b3*INT*PAST) represents, applies to continued and automatic use when past behavior is greater than zero.

Moderating effects reflect learning. As past behavior increases, learning occurs through repetition. The influence of cognitions decreases as past behavior and learning increase. As learning occurs, behavior becomes more routine, which means that conscious processing of cognitions becomes less influential. At the ultimate level of learning, a learned sequence of acts is automatically evoked in response to specific cues. If this explanation of learning is valid and the moderating effect (b3*INT*PAST) in Equation 1 appropriately represents it, b3 will be negative as Kim and Malhotra (2005) found. Notice that, as past behavior increases, the negative value of b3 indicates that the influence of intention (a cognition) on IT use decreases. To reiterate, this decrease in influence that a negative b3 shows (i.e., this moderating effect of past behavior on the relationship between intention and use of technology) reflects learning.

A common implication of this moderating effect is that automatic behavior, at the right end of the continuum of technology use, involves no cognitive processes or, at least, no conscious processing. For example, Kim et al. (2005, p. 420) state that "as past use increases, automatic processing displaces conscious processing, and in this automatic mode, evaluations/intention will no longer exert their effects on subsequent use". Venkatesh et al. (2012, p. 164) note that, once behavior has become automatic, "being in a similar situation is sufficient to trigger the automatic response without conscious cognitive mediation (i.e., attitude or intention)". Similarly, given that behavior has become automatic, Limayem et al. (2007, p. 719) state that "cognitive processing is not required…on encountering the relevant environmental cue(s)".

Explanations that cognitions or conscious processing do not affect automatic behavior are consistent with the interpretation of moderating effects as represented in Equation 1. To illustrate with a slight re-arrangement of terms from Equation 1, the influence of intention on technology use is (b1 + PAST*b3)*INT. At the right end of the continuum of technology use is automatic behavior, where intentions "no longer exert their effects on subsequent use" (i.e., where the ultimate level of learning has occurred such that behavior is automatic). That is where the coefficient of INT equals zero.

We use Equation 1 illustratively here to discuss essential features of theories of IT use across the continuum of IT use. If the theory and assumptions hold and the statistical model adequately represents the theory, then an empirical test of the theory should support the hypothesized relationships. For example, the theory could be that use increases with greater intention, but learning reduces the effect of intention on use. An assumption could be that the context is stable. The portions of the statistical model that represent the theory could be b1*INT (for the effect of intention on use) and b3*INT*PAST (for the effect of learning; that is, the moderating effect of past behavior). An empirical test that supports the theory would find b1 > 0 and b3 < 0.

2.3 Learning from Previous Interaction with IT: Problem with Prior Research

When an individual moves toward automatic behavior, the moderating effect of previous interaction with IT has an important implication that the literature has not clearly developed. Specifically, after initial use but prior to fully automatic use, a changing mix of conscious cognitive processing and unconscious (i.e., automatic) cognitive processing must jointly determine use of IT. Others implicitly recognize this shifting mix, but they do not explicitly recognize or explain the underlying processes. For example, Limayem et al. (2007, p. 719) explain:

> *As a consequence of repeating the same behavior successfully over and over again, the increasing automaticity of the behavior suppresses, more and more, the need to engage in active cognitive processing [citation omitted]. In the extreme, this process continues until it reaches a point where intention no longer exerts any influence on the behavior.*

Although not necessarily obvious, this explanation implicitly means that, with repetition but before behavior becomes fully automatic, conscious cognitive processing does not fully determine use of IT. To some extent, automatic processes suppress conscious cognitive processing in determining use of IT. That partial suppression means that conscious cognitive processes play some part of the role in determining use of IT and that, for that same decision, automatic, unconscious processes play the other part.

Even though Kim et al. (2005, p. 420) state that "as past use increases, automatic processing displaces conscious processing, and in this automatic mode, evaluations/intention will no longer exert their effects on subsequent use", they do not recognize the logical implication that both conscious cognitive and unconscious automatic processes influence an individual's decision to use IT between initial and automatic use of IT. Specifically, Kim and Malhotra (2005, p. 746) state: "Note that we do not expect an individual user to follow both conscious and automatic processes simultaneously". Limayem et al. (2007) do not explicitly comment on this fundamental, but not necessarily obvious, logical inconsistency that Kim and Malhotra espouse. Neither do Venkatesh et al. (2012) nor any other researchers whose work we have examined. Thus, we need to address this inconsistency and lack of clear theoretical explanation of the underlying processes.

Previous interaction with the IT influences the future use of the IT, which Figure 1 illustrates via the mediated and moderating effects of past behavior. The mediated effects operate through cognitions. As one can see from our discussion above, the effects of cognitions in conjunction with use-related constructs (namely, the moderating effects of past behavior illustrated in Figure 1) have been the subject of much study and discussion (e.g., Venkatesh et al., 2012; Limayem et al., 2007; Kim et al., 2005). The major thrust of the moderating effects that guide our work is that greater past behavior reduces the strength of the relationship between cognitions and intention and between intention and use. These moderating effects occur because of the effects of learning based on repeated system use.

In our theoretical clarification, we focus on the underlying processes that occur any time a decision to use IT occurs (i.e., all along the continuum of IT use from initial use to continuing use to automatic use). These underlying processes are useful in explaining the moderating effects that we note above. Empirical evidence establishes that increasing use of the technology lessens the effect of intention (e.g., Kim et al., 2005; Limayem et al., 2007). Kim et al.'s (2005) and Kim and Malhotra's (2005) explanations of this moderating effect provide a basis for further discussion.

Kim et al. (2005, p. 431) characterize their explanations as highlighting "the role of habit/automaticity as an underlying mechanism shifting from conscious processing to automatic processing". The habit/automaticity perspective (HAP):

> *Maintains that conscious behavior is characterized by the mental representation of why-, what-, and how-level goals and their corresponding links. However, with repetition of the same behavior over time, the same set of mental links tends to be repetitively formulated. In such a routinized situation, the knowledge structure linking situational cues and a subsequent action becomes hard wired in the mental representation. As a result, IT use occurs automatically without the process of establishing associated goals…. In IS research, this "ingrained cognitive script" is assumed to activate subsequent use automatically without requiring conscious processing…. [A]s past use increases, automatic processing displaces conscious processing, and in this automatic mode, evaluations/intention will no longer exert their effects on subsequent use. (Kim et al., 2005, pp. 419-420)*

In the instant activation perspective (IAP), an alternative to HAP:

> *Conscious processing would involve the formation of judgments and intention, and that with repeated performance, such cognitions would become stabilized and ultimately stored in memory. However, contrary to HAP, Ajzen (2002) maintains that the stored judgments and intention would be "instantly activated" in a routine environment and thereby guide subsequent behavior. (Kim et al., 2005, p. 420)*

Based on their statistical finding of the moderating effect of prior use, which reduced the effect of cognitions on behavior with increasing prior use, Kim et al. (2005, p. 428) conclude that HAP, rather than IAP, is an appropriate view of user behavior. Kim and Malhotra (2005, p. 746) elaborate:

> *System usage will be driven by conscious intention when the linkage between stimuli and action is not fully developed. However, once IS use becomes routine—performed frequently in a stable environment—past use is likely to be a good proxy for habit and a reliable predictor of future use…. Note that we do not expect an individual user to follow both conscious and automatic processes simultaneously.*

Although Kim et al. (2005) focus on comparing HAP and IAP as explanations of automatic behavior rather than the entire continuum of IT use, their explanation could imply an abrupt shift from cognitive to automatic processes for individuals completing the shift to automatic use. According to their explanation, automatic processes play no role in determining use of IT until the automatic processes are fully developed. Our explanation of the underlying processes addresses this problem in the literature and clarifies that this shift is not an abrupt step function. At the extremes, automatic use contrasts with slower, controlled, conscious use that occurs with first-time use. In between is where, over time, the shift occurs due to learning. Our explanation entails a shift that involves both conscious and automatic processes operating jointly in an individual user.

3 Explanation of Processes that Underlie Decisions to Use IT

The core of our theoretical explanation focuses on clarifying the processes underlying an individual's potential movement from initial IT use through continued use to automatic use. In the sections that follow, we present various layers of our EUP with the assistance of three figures, which graphically depict the EUP from different perspectives. In the first layer, we explain the underlying type 1 and type 2 processes, their relationship along the continuum of IT use, and the role of learning. Given these basic elements of our explanation, we then explain the cognitive control problem, which concerns whether default type 1 or intervening type 2 processes control the individual's decision to use IT. We use four scenarios to illustrate when type 2 processes intervene and then further elaborate on the cognitive control problem. We conclude our explanation of processes underlying decisions to use IT by briefly relating our EUP to two other theories in the literature: the elaboration likelihood model (ELM) and self-regulation.

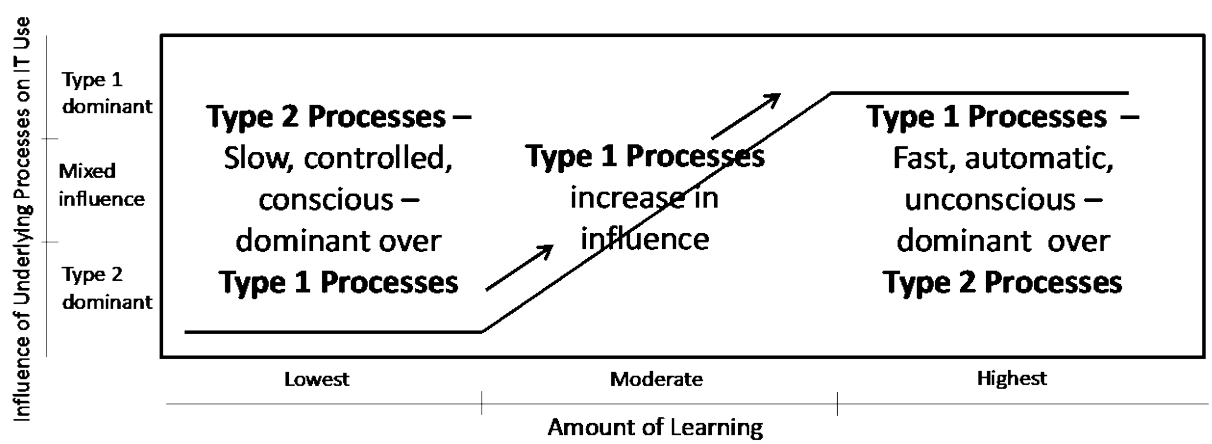
To explain the shift from slower to automatic cognitive processes that determine use of technology, we found inspiration from Evans (2011, 2008). His discussion of dual-process theories of reasoning refers to two specific types of cognitive processes, type 1 and type 2. Type 1 processes are fast, automatic, and unconscious. They produce a default response. Type 2 processes are slow, controlled, and conscious. They may intervene to reinforce or override the default type 1 response. Evans (2011) refers to the determination of when to intervene as the cognitive control problem. While we mostly discuss this problem in the next section, we note here that, at initial use of a target IT, type 2 processes are more likely to intervene, which makes them dominant; as learning increases, type 2 processes are less likely to intervene such that the influence of type 1 processes increases. Type 2 processes require access to a single, capacity-limited central working memory resource; type 1 processes do not.

Consider the following explanation of how underlying cognitive processes determine IT system use and their relationship over the continuum of IT use (see Figure 2). It is the first explanation in the literature we know of that is explicitly based on a shift from a dominance by type 2 cognitive processes (slow, controlled, conscious) to increasing influence of type 1 cognitive processes (fast, automatic, unconscious) as use and learning increase. Contrary to other explanations (e.g., Kim & Malhotra, 2005), type 1 and type 2 processes work in tandem as influence shifts from type 2 to type 1 processing. Compared to distinctly different explanations of novel IT use and automatic IT use, the shift from type 2 to type 1 processes offers a single logical explanation for the movement from novel IT use to continuing use to automatic IT use. The explanation spans initial IT use and post-adoption (or repeated/continued and even automatic) IT use. The major cause of the shift in influence is learning that results from repetition of both 1) the decision behavior that determines IT use and 2) IT system use behavior.

For a novel IT, no system use has occurred (assuming the novel IT is not similar to any other system use), so no learning has occurred directly related to decision behavior determining use of that novel IT or the behavior of using that IT (see the left side of Figure 2). Building on Evans (2011, 2008), type 1 processes—

fast, automatic, and unconscious—are relatively undeveloped since no learning regarding the novel IT system has occurred. The type 1 processes evoke cognitions associated with environmental cues based on the individual's general history (i.e., other past behavior), but they are not directly related to using the novel IT.

Type 2 processes—slow, controlled, and conscious—intervene and dominate type 1 processes, which are limited at this point (e.g., supplying relevant content, such as assumptions from other past behavior, into working memory). Using the theory of planned behavior (Ajzen, 1991) for illustrative purposes, an individual cognitively combines attitude, subjective norm, and perceived behavioral control regarding the target IT to obtain an intention to use the IT; in addition, the individual cognitively combines intention and perceived behavioral control to determine use of that IT. Because these cognitive processes occur for the first time with a novel IT, the initial cognitions are estimates that may be inaccurate and, thus, have uncertainty. It takes the individual time to have these estimates ready for processing. The process of combining them is a novel process that takes more time than if the process were familiar. Altogether, the mental effort to process these cognitions fits the characteristics of type 2 processes—slow, controlled, and conscious.



Notes:
1. Type 1 processes generate a default type 1 response.
2. Type 2 processes are more likely to intervene when learning is low; with increased learning, they are less likely to intervene.
3. See Figures 3 and 4 for additional perspectives; further, as discussion suggests, influence may not be linearly related to learning.

Figure 2. The Shift in Influence of Processes as Learning Occurs

As learning occurs via continued IT use, a shift in the influence of type 1 and type 2 processes reflects the effect of learning (see the middle of Figure 2). Mental efficiency in processing cognitions increases as learning occurs, which reduces demand on the capacity-limited central working memory resource. Estimates of the cognitions are likely to become more accurate and, thus, more certain, which makes processing simpler. Also, in contrast with initial IT use, repeated IT use makes estimates of cognitions (e.g., attitude, subjective norm, and perceived behavioral control) more readily available for processing. They are no longer novel but have been accessed previously and updated via learning from IT use.

Besides learning via repeated IT use leading to better estimates, faster access, and faster processing of cognitions, repeated IT use also allows the individual to learn to use the IT system more efficiently. Learning the IT system functional capabilities and the procedures or routines to use those capabilities (i.e., becoming more expert in using the IT) increases with deliberate practice (Ericsson, Krampe, & Tesch-Romer, 1993).

As learning increases with 1) additional episodes that evoke decision behavior to use a specific IT system and 2) practice with using the IT system, mental efficiency in the decision to use the system is reflected in an individual's developing simpler procedures for processing learning-refined cognitions to determine continuing IT use. With repeated situational cues that evoke repeated decisions regarding continuing IT use, the individual accesses and processes the learned cognitions and learning-refined processing rules for determining IT use faster, more automatically, and with less consciousness. As Figure 2 shows, this shift to faster, more automatic, and less conscious decision making occurs as learning increases; that is, type 1 processes increase in influence while type 2 processes decrease in influence.

When learning has reached a level that supports automatic behavior, the effect of the learning that has occurred via repeated decisions and use of the IT system is reflected in a shift to type 1 processes dominating the decision process (see the right side of Figure 2). Thus, processes for accessing and processing cognitions are fast, automatic, and unconscious. At this learning level, both decision and system use behaviors are habitual behavior. The individual makes the decision to use a specific IT system intentionally (i.e., directed at achieving a function or goal), unconsciously, automatically, and efficiently.

Our explanation of the underlying process for determining initial, continuing, and automated use of an IT system focuses on the effect of learning on the decision to use IT. It is not experience, prior use, or habit that is the causal factor determining IT use; rather, it is learning. Learning occurs as the individual goes through type 1 and type 2 processes to decide whether to use an IT system. This learning leads to changes in the type 1 and type 2 processes and associated cognitions, which then affects decision making when the individual encounters the next similar decision to use the target IT system. With repeated use, these changes result in greater efficiency in accessing and processing cognitions. This greater efficiency results in the increasing influence of type 1 processes and the reduced influence of type 2 processes.

As the individual engages in IT system use behavior, learning beyond the learning from repeated decisions to use IT also occurs. This learning via IT system use includes updates of cognitions regarding use of the IT that make them more accurate and more certain. Learning also includes improved recognition (conscious or unconscious) of situational cues, more complete knowledge of the IT's functional capabilities and outcomes associated with use, and the development of efficient behavioral routines for IT use.

Figure 3 supplements Figure 2's view of the relationship of type 1 and type 2 processes. The addition of "other past behavior" recognizes that initial cognitions about the novel IT come not from past behavior with the target IT but from the individual's general history. In effect, omitting type 1 processes and other past behavior from Figure 3 would yield a figure that corresponds conceptually with Figure 1 and extant theories that incorporate past behavior. Instead of using the moderating effects of past behavior to reflect learning as in Figure 1, Figure 3 represents learning directly through feedback from 1) the decision to use the target IT and 2) use of the target IT.

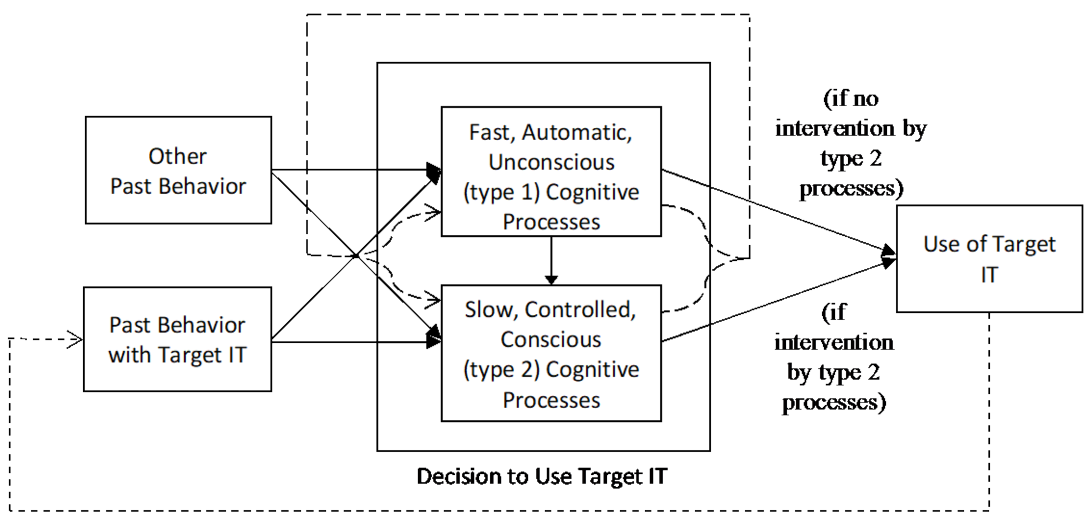


Figure 3. Fast and Slow Processes Underlying Theories of IT Use[1]

[1] See Figures 2 and 4 for additional perspectives; the default type 1 response determines use of technology unless type 2 cognitive processes intervene. For first-time use, general history (i.e., other past behavior) influences type 1 and type 2 cognitive processes; for continuing and automatic use, past behavior with target IT influences type 1 and type 2 cognitive processes. Long- and short-dashed lines represent learning from decision to use IT and use of target IT, respectively; given the inclusion of learning, we do not include the moderating effects of past behavior (see Figure 1) here.

Given the explanation of the type 1 and type 2 processes and the learning associated with decisions to use IT and with actual use of IT, we state an essential element of our EUP as:

> *Type 1 and type 2 processes and related cognitions incorporate learning from prior decisions to use IT and from actual use of IT.*

We note several other essential elements and related insights from our EUP as we present scenarios that illuminate when type 2 processes intervene to override or reinforce default type 1 responses and further explain the cognitive control problem.

3.1 Further Clarification: The Cognitive Control Problem

Evans (2011) presents a default-interventionist dual-process theorist's explanation of the way type 2 and type 1 processes work together. Type 1 processing produces a rapid and intuitive default response. Slower, deliberative type 2 processing may intervene.

A major question is: "When will type 2 processing intervene?" In Figure 3, that question corresponds to asking: "When will the default response generated by type 1 processes govern use of the target IT, and when will an intervention by type 2 processes govern use of the target IT?". Evans (2011) refers to this question as the cognitive control problem. He identifies two high-level factors—motivation and cognitive resources—that affect cognitive control. Among the motivational factors, he includes instructions that guide the individual to make the decision and the individual's confidence in an intuitive decision or feeling how right it is. Among the cognitive resources, he includes time and working memory, which are limited due to the demands of competing tasks (i.e., bounded rationality applies). We use these examples of factors with four scenarios to illustrate when type 2 processes intervene.

3.1.1 Context of the Four Scenarios

The four scenarios we present have two types of individuals: a newly hired sales associate and an experienced sales associate. They have the responsibility to complete a variety of tasks in a fast-paced environment, such as taking orders from customers, filling those orders, checking and reordering inventory, obtaining customer feedback, and providing input for product design. The IT for these tasks varies in the following areas: functional support, shortcuts built into the IT for those with greater IT expertise, training and help built into the IT to facilitate task completion or develop expertise; in addition, training and help that the organization provides varies. The newly hired sales associate has received organizational instruction on using the IT but only for taking a normal sales order. The experienced sales associate takes normal and unusual sales orders routinely using the IT but has learned only the basics of some of the other IT and has not learned to use the IT for providing input for product design.

3.1.2 Scenario 1: Newly Hired Sales Associate Takes the First Order

On the continuum of initial use to automatic use of any of the IT that supports sales associates, this person is on the left end of the continuum toward initial use. When taking the first sales order, assume that the sales associate's default response from type 1 processes was not to use the IT to enter the order. Assume further that the instruction on taking a sales order emphasized that using the IT was the best alternative for taking the order. The influence of the instruction on this sales associate suggests that type 2 processes would intervene. Moreover, the sales associate's confidence in the intuitive decision not to use the IT would be limited by no prior context that would reinforce that intuition. In other words, the associate would not feel right in not using the IT, which suggests that type 2 processes would intervene even though the fast pace of work and the demands on working memory of the sales associate's new work tasks would limit the time and working memory capacity for type 2 processes to intervene.

3.1.3 Scenario 2: Newly Hired Sales Associate Encounters an Unusual Order

After additional training and a little use of the IT, assume that the sales associate's default response from type 1 processes changed to use the IT to take orders and that the sales associate was in the process of taking an order when an unusual aspect of the order occurred. Assume further that the sales associate's default response from type 1 processes was not to use the IT for the unusual aspect of this order. Further assume that the training had included steps for using the IT with unusual aspects of orders, including, for example, asking for assistance from another sales associate. That may make the sales associate more confident in using the IT, which suggests that type 2 processes intervene. As in the first scenario, the fast pace of work and the demands on working memory of the sales associate's new work tasks would limit the time and working memory capacity for type 2 processes to intervene; however, the sales associate's limited history of use could have led to some limited learning to cope with the pace and demands, which would have effectively modestly increased the associate's time and working memory. Taken together, these examples of the factors that affect cognitive control in this scenario suggest that the associate would exercise type 2 processes to control the decision to use IT for the unusual aspect of taking the order. The associate would use slower, more controlled, conscious type 2 processes to determine whether to use the IT at this point.

3.1.4 Scenario 3: Experienced Sales Associate Takes an Order

This person is on the right end of the continuum of initial use to automatic use of IT for this task. The default type 1 response to the task of taking an order is to use the associated IT. Unless some unusual event occurs in the task environment, the type 1 response to use the IT is invoked. Type 1 processes dominate type 2 processes. Taking an order by using the IT is habitual with this sales associate. Presented with the cues for taking an order, the response is automatic.

3.1.5 Scenario 4: Experienced Sales Associate Checks Inventory

Although an automatic user of IT for taking an order, this sales associate has learned only the basics of using the IT for taking physical inventory. The default type 1 response to the task of taking inventory is to use the basic IT rather than the IT with greater functionality that would complete the task with less work and time but would take time to learn. Even though training is available, the sales associate is confident in the default type 1 response, which suggests that type 2 processes do not intervene. Furthermore, the fast pace of work and the demands on working memory of the sales associate's other work tasks indicate that there would be little time and working memory capacity for type 2 processes to intervene. The intervention of type 2 processes is likely to occur, however, if there were explicit instructions that significantly encouraged the individual to learn the greater functionality of the IT, changes that increased the individual's confidence in learning and using that IT in the current constraints of the job, or other changes that effectively increased the individual's time and working memory to make it feasible for that individual to consider learning and using the greater functionality of the IT.

These scenarios illustrate factors that affect the cognitive control problem (i.e., the potential intervention of type 2 processes after a default type 1 response to a situation in which a decision to use IT occurs). One could also include other specific factors beyond those that we illustrate, such as the importance of the decision. In these scenarios, an unusually large order could exemplify a very important decision. Rather than a factor that affects the intervention of type 2 processes, such an order could represent a change in the environment or task cues that would disrupt an automatic default type 1 response for a routine sales order by presenting a different decision situation. In any case, we do not suggest that we provide an exhaustive list of factors that affect the cognitive control problem; however, the illustrated factors provide a starting point for future research.

The default type 1 response occurs quickly and without conscious deliberation. As Shleifer (2012, p. 1089) notes when reflecting on Kahneman (2011) (a default-interventionist dual-process theorist who refers to system 1 and 2 rather than type 1 and 2 processes):

> *The main lesson I learned is that we represent problems in our minds, quickly and automatically, before we solve them. Such representation is governed by System 1 [type 1] thinking, including involuntary attention drawn to particular features of the environment, focus on these features, and recall from memory of data associated with these perceptions. Perhaps the fundamental feature of System 1 [type 1] is that what we focus on, and what we recall is not always what is most necessary or needed for optimal decision making. Some critical information is ignored; other—less relevant—information receives undue attention because it stands out.… [H]ighly selective perception and memory shape what comes to mind before we make decisions and choices.*

From this explanation, we state a second essential element of our EUP:

> *Cognitions that lead to a default type 1 response are not necessarily the cognitions found in extant cognitive theories of IT use.*

We note several other essential elements and related insights from our EUP after we further elaborate the cognitive control problem in the next section.

3.2 The Cognitive Control Problem: Further Elaboration

Figure 4 summarizes the cognitive control problem and the discussion of intervention by type 2 processes to override the default type 1 response generated at the time that the context for IT use evokes the type 1 processes. Note that Figure 4 focuses on immediate factors that affect the generation of type 1 and type 2 responses. It omits learning and past behavior, which Figure 3 shows. These omissions simplify Figure 4. Nevertheless, learning and past behavior are part of the context of Figure 4 and part of the discussion that follows.

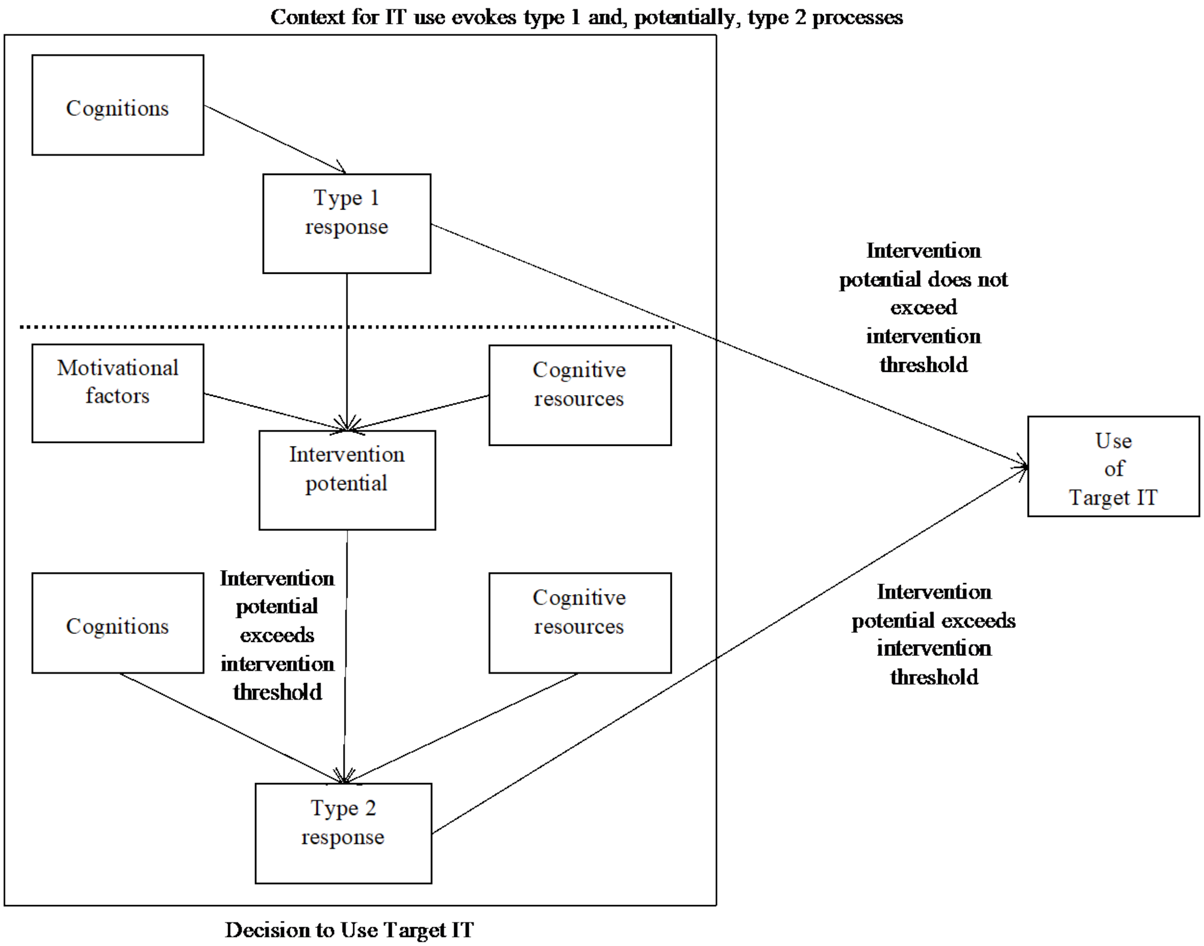


Figure 4. Default Type 1 Processes and Intervention by Type 2 Processes[2]

Type 1 processes quickly generate a default response through unconscious selective attention to cognitions and without demands on limited working memory. The basic type 1 responses are decisions to use or not use the target IT. Variations of interest to organizations that seek to address the underutilization of IT assets include decisions to learn to use the target IT or not learn it. Based on considering the type 1 response in conjunction with motivational factors and cognitive resources, a potential for intervention by type 2 processes occurs. As we note above, motivational factors that affect intervention potential include instructions that guide the individual making the decision and the individual's confidence in an intuitive decision or feeling how right it is. Cognitive resources include time and working memory, both of which are limited due to the demands of competing tasks, which suggests bounded rationality. If the intervention potential is high enough (i.e., exceeds some intervention threshold), type 2 processes generate a type 2 response. We expect that an individual who faces a novel IT without instruction would have little confidence in any type 1 response and, thus, a high potential to think through the decision, which will lead to a type 2 response. At automatic use, when learning is high, we expect the cognitions that generate a type 1 response to reflect both repeated decisions and repeated use; thus, we also expect the confidence in that response to be high and intervention potential to be low. Between these extremes, as learning occurs, we expect the intervention potential for a type 2 response to decline as one moves away from the novel IT extreme. Type 2 responses are similar in nature to type 1 responses (e.g., they include decisions to use (or not use) the target IT).

The use of limited information in generating a type 1 default response suggests that bounded rationality

[2] Type 1 processes (above the dotted line) and type 2 processes (below the dotted line) are subject to bounded rationality; unconscious selective attention to cognitions determines type 1 response; cognitions that lead to type 2 response may be few with short casual paths. See Figures 2 and 3 for additional perspectives; this snapshot of type 1 and type 2 processes does not show learning or other influences on these processes.

constraints apply to type 1 processes. Shleifer (2012) views the version of bounded rationality that leads to type 1 choices as different from Simon's (1976) version, which leads to satisficing choices. For example, as a result of bounded rationality, type 1 processes may ignore more critical information and focus on less relevant information that stands out and, thus, result in a type 1 response that may be overridden by intervening type 2 processes; in contrast, Simon's (1976) bounded rationality focuses on a few most relevant and crucial factors that result in an acceptable choice. Nevertheless, both type 1 and satisficing processes use limited information or cognitions and are completed in a limited time. In the context of the cognitive control problem, overriding a type 1 response requires additional cognitive processing, takes additional time, and competes with other tasks that put demands on a constrained working memory. Thus, intervention by type 2 processes requires extra effort beyond type 1 processing regardless of where the individual is along the continuum of IT use from initial use to automatic use.

Given the reliance of type 2 processes on working memory, with its limited capacity, bounded rationality constraints apply even more to type 2 processes than type 1 processes, which do not rely on working memory. Limited cognitive resources constrain the information or cognitions considered in the decision to use IT. Type 2 processes and associated resources compete with other task demands for working memory. They are also time constrained. We expect that, together, these constraints typically lead to cognitively simplified, acceptable decisions rather than cognitively complex, optimal decisions. Cognitions used to guide decisions to use IT may be few with short causal paths. For example, the experienced sales associate might think: "It will take me too long to learn to use the greater IT inventory functionality. It's not worth it now.". The new sales associate might think: "I'm going to have enough of these unusual orders in the future that I need to learn more about that part of the IT".

Even though we illustrate the influence of type 1 processes in Figure 2 as progressing linearly, this increasing influence may not follow a linear progression. Indeed, future research needs to investigate how this increasing influence does progress. Researchers who conduct such work may find interest in Benlian's (2015) research, which found a non-linear pattern of IT feature use over time. Example questions research could investigate include: "What causes the confidence in default type 1 responses to increase rapidly (or slowly) and, thereby, affect intervention potential?", "Does increasing skill in using the IT increase the perceived time and working memory available and, thereby, affect intervention by slower type 2 processes?", "What kinds of instructional cues lead to greater intervention potential?", and "Is the intervention threshold fixed, or what factors lead to changes in it?".

Our explanations of type 1 and type 2 processes and the cognitive control problem that we present above, all of which Figures 2 to 4 graphically represent, contain several essential elements and related insights. Besides those that we summarize above, they include:

- Slow, controlled, conscious (type 2) cognitive processes are more likely to intervene to reinforce or override the default fast, automatic, unconscious (type 1) cognitive response when there is little or no learning from prior use of the target IT (which includes similar IT) or related instruction. Thus, type 2 processes are dominant over type 1 processes when there is little or no prior use of the target IT.
- Type 2 processes are less likely to intervene to reinforce or override the default type 1 response as learning occurs. Thus, the influence of type 2 processes decreases as learning occurs via prior decisions to use IT and via actual use of the IT.
- Type 2 processes are unlikely to intervene to reinforce or override the default type 1 response when high learning has occurred from prior use of IT. Thus, type 1 processes dominate type 2 processes when there is extensive learning.
- In the cognitive control problem, intervention potential represents the likelihood of intervention. When the intervention potential is high enough (i.e., exceeds the intervention threshold), type 2 processes intervene. The relationship between extent of learning (or prior use) and intervention potential may not be linear.
- Both type 1 and type 2 processes are subject to bounded rationality.

3.3 Comparison with Elaboration Likelihood Model and Self-regulation

Another dual-process theory that could potentially provide insights for the cognitive control problem is the elaboration likelihood model (ELM) that Bhattacherjee and Sanford (2006) introduced to the IS literature. It includes type 1 processes, referred to as the peripheral route, which involve little cognitive effort (i.e., low elaboration) and type 2 processes, referred to as the central route, which involve thoughtful information processing (i.e., high elaboration). Bhattacherjee and Sanford's (2006) explanation of ELM does not include a default response by the peripheral route (type 1 processes) with potential intervention by the central route (type 2 processes). Instead, ELM suggests that those who receive information about an IT are more likely to engage type 2 processes if the information is personally relevant and they have the expertise or ability to evaluate it; otherwise, they will rely on peripheral cues, such as source credibility, via type 1 processes. Thus, the theoretical foundation for this version of ELM and our explanation of underlying processes differ on the role of type 1 and type 2 processes in the cognitive control problem. Kitchen, Kerr, Schultz, McColl, and Pals (2014) provide a broad review of ELM that should be useful for future researchers who wish to more thoroughly compare ELM and our explanation.

The IS literature also has references to self-regulation, which involves reasoning processes (i.e., type 2 processes) that could confirm or override a type 1 response (Soror, Hammer, Steelman, Davis, & Moez, 2015). Given the potential relevance of self-regulation in addressing the cognitive control problem, we briefly discuss the implications of self-regulation for our explanation of fast, automatic, unconscious (type 1) and slow, controlled, conscious (type 2) processes in determining use of IT. Soror et al. (2015) discuss self-regulation in conjunction with type 1 processes, which they refer to as the reflexive or automatic system, and type 2 processes, which they refer to as the reflective system. In our explanation of underlying processes, the cognitive control problem occurs when an individual is anywhere on the continuum of IT use from initial use to continuing use and to automatic use. Soror et al.'s (2015) discussion of self-regulation places the individual at only automatic (or habitual) use; thus, self-regulation involves the reflective system's intervening only at the point of automatic use rather than along the continuum of use prior to that. Self-regulation overrides the reflexive system response of habitual behavior (e.g., reading a text when notified of an incoming message) that conflicts with an established goal (e.g., driving safely). In Soror et al.'s (2015) discussion, self-regulation is more limited in scope than the cognitive control problem. Future researchers interested in more thoroughly comparing self-regulation with our explanation of type 1 and type 2 processes may find it useful to review Lord, Diefendorff, Schmidt, and Hall (2010).

4 Discussion

Traditionally, a linear model of the moderating effects of past behavior with an interaction term (e.g., see Figure 1 and Equation 1) has been used in empirical investigations of theories of IT use that include previous interaction with a target IT. This traditional approach to testing theories of IT use has several limitations. We identify these limitations here and provide a broad set of suggestions for future researchers to consider as they investigate our explanation of the processes underlying theories of IT use.

Consider the portion of Figure 1 represented in Equation 1 along with Figures 2 to 4. The traditional approach to empirically testing theories of IT use reflected in Figure 1 and Equation 1 includes the following representations or assumptions:

- Type 2 processes (as Figures 2 and 3 show) are represented by cognitions typically found in theories of IT use. (Beyond intention to use target IT (INT), which is the only cognition used for illustrative purposes in Equation 1, many cognitions are used in testing theories of IT use.)
- Learning (or the repetitive effects of 1) decisions to use target IT and 2) use of target IT) is reflected in prior behavior with target IT (PAST in Equation 1).
- Learning is also reflected in a decline in the influence of type 2 processes (and the concomitant increase in influence of type 1 processes as represented in Figure 2). Figure 1 represents this changing influence as moderating effects of prior behavior with target IT. Equation 1 illustrates a traditional moderating effect with the influence of intention to use target IT (INT) on use of target IT (USE) declining as past behavior with target IT (PAST) increases. This moderating effect would be empirically confirmed if b3 (the coefficient of the interaction (INT*PAST) in Equation 1) were negative. With this traditional conceptual and corresponding statistical model of the moderating effect of past behavior, the decline in influence is linearly related to the increase in learning.

Given our EUP, however, the traditional approach to empirically testing theories of IT use reflected in Figure 1 and Equation 1 includes the following limitations:

- It does not include type 1 processes except as a complement to type 2 processes (see the last bullet above), and that form of inclusion does not specify a default type 1 response (or how it would be generated). Related to this basic omission, the traditional approach does not take into account the potential intervention of type 2 processes. It also does not take into account the insight from our EUP that cognitions that lead to a default type 1 response are not necessarily the cognitions found in cognitive theories of IT use. Thus, if cognitions that lead to a default type 1 response are not the relevant cognitions that traditional theories such as TAM, TPB, or UTAUT identify but instead are "less relevant" information that "receives undue attention because it stands out", traditional theories of IT use and approaches to investigating them are unlikely to discover or confirm those type 1 cognitions.
- Using the traditional moderating effect approach to take into account learning (or the shifting influence of type 1 and type 2 processes along the continuum of IT use) does not take into account the insight

from our EUP that the declining influence of type 2 processes as learning increases is not necessarily linear.

- The traditional approach does not take into account the insight from our EUP that type 1 and type 2 processes are subject to bounded rationality. In a traditional theory of IT use, the cognitions associated with that theory are presumably all the relevant cognitive influences on a decision to use a target IT. One implication of bounded rationality, however, would be that cognitive resources (e.g., time and working memory) are constrained and so are the cognitions. Only a few cognitions, rather than all of those in the theory, are likely to be considered. In addition, other aspects of bounded rationality (e.g., selective perception or biases) may result in an individual's considering cognitions that are less relevant or otherwise differing from those in extant theories.

Given the limitations above, the traditional approach to testing theories of IT use does not provide an appropriate empirical test of our explanation of processes that underlie a decision to use IT. Building on the essential elements of our EUP and related insights, future researchers could develop and test new variance models that address the limitations of the traditional models to explain initial, continued, and automatic use of targeted IT, which would result in substantially new research. For example, researchers need to explore how to incorporate type 1 and type 2 processes into new variance models together with their shifting influence on use of IT as learning from repetitive use occurs. Researchers could consider including learning explicitly in new variance models rather than inferring it from the moderating effect of past behavior as has been done traditionally. The relationship between learning and use of IT could be modeled to reflect the insight that it may not be linear.

Beyond research on variance explained, researchers could develop new avenues of research by investigating processes. For example, they could explore the generation of type 1 responses. That includes investigations related to two insights from our EUP; namely, investigations of how cognitions leading to a default type 1 response differ from cognitions found in current cognitive theories of IT use and the effects of bounded rationality on generation of a type 1 response. Research on the process of generating type 1 responses could also explore the effectiveness of various decision-making heuristics that those facing decisions to use IT use—especially those who are underutilizing it. The work of Tversky and Kahneman (1974) could be one model for inspiring a program of research in this area. Another avenue for developing process research would be to examine the intervention of type 2 processes (i.e., the cognitive control problem). As part of that examination, researchers could investigate the effects of bounded rationality on type 2 processes. Beyond being guided by Figure 4 and our related discussion, future researchers could also find guidance in Evans' (2011) discussion about "the intervention model".

4.1 Implication for Separate Theories of Initial, Continuing, and Automatic Use of IT

Our theoretical explanation provides a simpler, more parsimonious explanation of IT use than multiple theories. Ortiz de Guinea and Markus (2009, p. 441) argue that continuing IT use may be "far less intentional and far more automatic than the IS literature would lead one to presume". They claim that future research should not focus on intentions or decisions but rather on behavior and that reason-based models, including TAM and the theory of planned behavior (TPB), "are probably not the most useful theoretical foundations for studies of continuing IT use, however valuable they may be for understanding initial IT adoption decisions and technology replacement decisions". This position echoes that of other researchers (e.g., Jasperson et al., 2005; Karahanna et al., 1999). These authors are basically arguing for two different theories of use: one for initial or novel use that includes intentions with its cognitive antecedents and one for continuing and automatic use that omits such constructs. Our explanation with two types of cognitive processes that shift in influence as an individual moves from initial to automatic use provides a single explanation of IT use that applies to initial use and to continuing and automatic use.

4.2 Addressing the Underutilization of IT Assets

In this paper, we explain default type 1 cognitive processes (fast, automatic, unconscious) and potentially intervening type 2 cognitive processes (slow, controlled, conscious) that are engaged as individuals along the continuum of IT use determine their next use of a specific IT. This explanation has implications for organizations that seek to better use their IT assets. These implications include directions for future research that would provide answers to questions these organizations would like answered and practical advice these organizations can implement now. We discuss these implications next.

4.2.1 Research Implications

Relevant questions for guiding future research include how to facilitate an intervention of type 2 processes when the type 1 response is not to use the IT and how to facilitate a type 2 response to use the IT. Shleifer (2012) notes that a common tactic is to provide education. Making information available to guide decision making behavior (Ölander & Thøgersen,

2014) is a similar tactic. However, Shleifer (2012) suggests that, to be most effective, education should focus on affecting type 1 processes since they provide the initial response regarding use. Similarly, Ölander and Thøgersen (2014) suggest paying attention to the heuristics (i.e., type 1 processing) people use when processing information. Thus, another relevant research question would be how to facilitate a type 1 response to use the IT. In other words, what cognitions of the potential IT user should one target and how can one selectively evoke them?

Previous research on type 1 processes, which has been conducted outside the context of the decision to use IT, suggests that structuring the context leading to a type 1 response (i.e., designing the choice architecture (Thaler & Sunstein, 2008)) can influence the response. Ölander and Thøgersen (2014, p. 344) note that nudging (Thaler & Sunstein, 2008) "has become an umbrella term" for "many heuristics, often taking the form of biases, which we seem to apply in much decision-making and which make us susceptible to the influence of contextual cues". They note several heuristics, such as anchoring, availability, representativeness, framing, priming, loss aversion, follow the herd, status quo, and path of least resistance. Thaler and Sunstein (2008) recommend designing a choice architecture that includes a default choice. For example, a default choice could nudge the decision maker to select the status quo or the path of least resistance. Ölander and Thøgersen (2014) note that the "status quo bias and the related 'path of least resistance'…is one of the most utilized heuristics in the choice architecture associated with nudging". Organizations that desire to increase IT use would prefer to nudge decision makers to use or at least learn to use the IT, but that may not be the status quo or path of least resistance. Future researchers could explore the applicability and effectiveness of various heuristics and nudges in the context of organizations that seek to better use their IT assets. Beyond the earlier suggestion for researchers to find inspiration from Tversky and Kahneman's (1974) work, we also suggest that bounded rationality constraints will limit education, provision of information, or default choices that involve increasing awareness of biases or taking time to address such biases; thus, we encourage researchers to conduct research that carefully evaluates the effectiveness of such interventions.

Most previous cognitive-based research on technology acceptance and use has focused on type 2 processes. Although that research has led to recommendations such as to design systems to be easy to use, enjoyable, and useful, to deliver education or information to encourage learning and use of the IT, and to provide task and social support for learning and using the IT, that research has not recognized limited cognitive resources (i.e., bounded rationality). Future researchers could explore how bounded rationality modifies such recommendations, particularly for organizations that seek to better utilize their IT assets.

As Sun et al. (2016) note, choosing to adopt IT that is not relevant for a task (i.e., choosing an IT that is a poor fit) could result in a substantial waste of time and resources. Thus, a decision not to use an irrelevant IT could be a worthwhile outcome of the choice process for individuals who are underutilizing IT. As we note above, future research could examine how to facilitate a response to use a target IT; moreover, valuable future research could examine how to avoid adopting IT with a poor fit.

4.2.2 Practical Implications

Although our theory has implications for designing systems, providing task and social support, and delivering education or information, we limit our suggestions here to the common tactic of delivering education or information. More specifically, we suggest that organizations with underutilized IT assets consider education or provision of information directed at not only type 2 processes but also type 1 processes. By directing efforts at type 1 processes, organizations would ideally facilitate a default type 1 response to use or, at minimum, learn to use the IT. Given that type 1 and type 2 processes are evoked differently and involve different elements, the education or provision of information would be designed differently to reach these different processes.

Consider a context in which individuals encountered a decision to use an underutilized IT. For example, assume the experienced sales associate in the fourth scenario had to take physical inventory and could decide to use the basic IT or the IT with greater functionality. Rather than a type 1 response to use the basic IT, the organization would prefer a type 1 response to use the IT with greater functionality. To evoke the latter response, we suggest regularly providing a message, or nudge, in the decision context that encouraged the associate to use or learn to use the IT with greater functionality. This message could be randomly selected from an array of brief, simple, subliminal messages that are cognitively unconscious (Hassin, 2013) and that a variety of credible sources such as individuals' peers or superiors could deliver. The suggestion for brief, simple, and cognitively unconscious messages is based on needing to reach fast, automatic, unconscious processes that bounded rationality tightly constrains. For example, one could display a picture of the experienced sales associate and the boss high-fiving while the sales associate uses the IT with greater functionality. The suggestion for an array of different messages is based on the likelihood that the context for the decision to use or learn to use an underutilized IT will occur frequently rather than once or just a few times, so many different messages provide fresh stimuli. One could use one or more of the heuristics or biases that we note above to craft message content that encourages individuals to use a target IT and stands out and that individuals selectively perceive when deciding to use the target IT. Such messages ideally would lead to a type 1 response to use the target IT.

Providing education or information to reach type 2 processes could occur in or beyond the context of a decision to use an underutilized IT. Suggestions in the context of such a decision would be similar to those above for reaching type 1 processes since similar constraints apply. Beyond that context, one could design interventions to 1) raise the potential for type 2 processes to intervene when a type 1 response not to use the IT occurs and 2) increase the likelihood that the intervening type 2 processes will lead to a decision to use the IT or at least learn to use the IT. Our theoretical clarification implies that one should recognize bounded rationality when designing education or information for either of these purposes. For example, given an individual's time constraints, one could design interventions to provide more time for education (e.g., by setting aside time for those who underutilize the IT to participate in formal learning of high-priority functionality that is a component of the underutilized IT). In addition, one could design the education, whether formal or informal, to deliver on demand the essentials, organized in brief segments, for using the functionality of the IT (van Dam, 2012; Mayer, 2008). Delivering essentials on demand in brief segments recognizes that time is limited and allows individuals to learn when they have limited time available or when they could pursue learning to help them complete a task with the IT's functionality when performing a task. To take advantage of potential support from social networks, one could pair or group individuals in a cooperative learning design (Johnson, Johnson, & Smith, 2007).

From investigating the research agenda above or the effectiveness of interventions that we suggest in the practical implications above, researchers could develop findings that supplement or modify the suggestions that we present here. In the meantime, implications from both our theoretical clarification and findings from related research provide initial guidance for organizations that seek to better utilize their IT assets. Further, we limit the scope of our suggestions to the common tactic of delivering education or information. Others could develop additional suggestions beyond this scope.

5 Conclusion

Theories of information technology (IT) use have helped explain the factors that affect individual decisions to use IT; however, organizations need a novel perspective to address the continuing underutilization of IT assets. In this paper, we provide such a perspective. In particular, we explain two cognitive processes—type 1 (fast, automatic, unconscious) and type 2 (slow, controlled, conscious)—that underlie the decision to use IT and the shifting influence of those processes as learning increases from both repeated decisions to use a target IT and repeated use of that IT. All decisions to use IT first generate a fast type 1 response, but slow type 2 processes intervene if the intervention potential is high enough.

An essential element of our explanation of underlying processes (EUP) is the relationship between learning and the intervention potential (i.e., the likelihood that type 2 processes will intervene). We summarize specific elements of our EUP that illuminate this relationship here. As learning occurs, type 1 and type 2 processes and related cognitions incorporate the effects of that learning. At the left end of the continuum of IT use where there is little or no learning from prior use of the target (or similar) IT or related instruction, slow, controlled, conscious (type 2) cognitive processes are more likely to intervene to reinforce or override the default fast, automatic, unconscious (type 1) cognitive response. Thus, slow (type 2) processes are dominant at initial use of a target IT. Between the extremes of the continuum, as learning increases, the likelihood of intervention by slow processes declines. At the right end of the continuum where learning is high such that a fast (type 1) response is automatic, the likelihood of intervention by type 2 processes is essentially nil. Thus, fast processes dominate at automatic use of a target IT. Although increased learning is related to a decline in the intervention potential, the relationship between extent of learning (or position on the continuum of IT use) and likelihood of intervention is not necessarily linear. Future research needs to develop and empirically investigate new variance and process models of IT use based on these essential elements of our EUP.

Further, we develop two additional insights from our EUP. First, type 1 responses are not necessarily based on the cognitions found in extant theories of IT use; instead, they could be based on less relevant cognitions such as those that are selectively evoked because they stand out or reflect biases. Second, cognitive constraints on type 1 and type 2 processes mean that both processes operate under bounded rationality. We propose new directions for future research, which includes developing and empirically investigating new variance and process models that incorporate essential elements of our EUP and related insights. We also offer practical guidance for organizations that seek to better utilize their IT assets. For example, we suggest that organizations with underutilized IT assets focus on providing education or information to those who face decisions concerning their use of underutilized IT;

more specifically, we recommend that they develop brief, simple, cognitively unconscious messages directed at nudging those decision makers toward a default response to use the target IT.

An important contribution that also emerges from our EUP is a unifying foundation for previously separate theoretical explanations of initial, continuing, and automatic use. Overall, our contributions significantly advance the field's conceptual understanding of the underlying processes determining use of IT. They also open fertile new ground for research in an area that needs it. Furthermore, for organizations that seek to better utilize IT assets, we provide immediate suggestions and hope for future research-based recommendations.

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About the Authors

Thomas W. Ferratt, PhD, is Professor Emeritus at the University of Dayton. His research has primarily focused on the management of information systems professionals. His 2016 paper with Fred Niederman and Eileen Trauth in *The DATA BASE for Advances in Information Systems* received an AIS Best Information Systems Publications Award. He has been on the editorial boards of *Information Systems Research*, *MIS Quarterly*, *Journal of the Association for Information Systems*, and *The DATA* BASE for *Advances in Information Systems*. In addition, he has served in leadership roles with the Special Interest Group on Computer Personnel Research (SIGCPR) and, subsequent to its merger, the Special Interest Group on Management Information Systems (SIGMIS) of the Association for Computing Machinery (ACM).

Jayesh Prasad is a Professor of MIS in the School of Business Administration at the University of Dayton. He earned his PhD in MIS at the Katz Graduate School of Business at the University of Pittsburgh. His current research interests focus on the adoption, implementation, and use of information technologies by individuals and organizations as well as on the management of information systems personnel and projects. His research results have been published in a variety of journals including the *MIS Quarterly*, *Information Systems Research*, *Communications of the ACM*, *Decision Sciences*, and *IEEE Transactions on Software Engineering*.

James Dunne, PhD, University of Illinois, is a Professor in the Department of MIS, Operations Management, and Decision Sciences at the University of Dayton. His research has focused on network theory, statistical methodologies, and management of technology including project management. His work has been published in leading academic journals *IIE Transactions*, *Academy of Management Journal*, and *Operations Research*, among others. In addition, he has had a long career in academic administration having served as department chair for 10 years, two terms as associate dean, and recently as interim dean, School of Business Administration.