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Procedural Information and Behavioral Control: Longitudinal Analysis of the Intention-Behavior Gap in the Context of Recycling

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Abstract: The theory of planned behavior states that individuals act on their intentions, especially when they have behavioral control. The current study examines how seeking recycling-related procedural information—i.e., information about how and where to recycle—is related to behavioral control. Hypothesis testing used hierarchical ordinary least squares regression analysis of longitudinal data from 553 survey respondents. Results supported seven hypotheses. Most notably, procedural information seeking both mediated and moderated the relationship between intention and behavior. Further, the moderation effect was itself mediated by behavioral control. The argument for this mediated moderation is that information seeking enhances behavioral control, and it is primarily behavioral control that moderates the relationship between intention and behavior. These results have implications for the theory of planned behavior and, more generally, for how individuals use information to support their behaviors.

Keywords: planned behavior; reasoned action; recycling; information seeking; behavioral control; mediation; moderation; mediated moderation

1. Introduction

There are a number of procedural steps involved in household recycling, such as identifying recyclable items, separating them from non-recyclables, rinsing away food residue, and placing them in appropriate receptacles. Whereas uncertainty about the procedure is a common barrier to recycling behavior [1,2], individuals are more likely to recycle when they understand how to do it [3,4]. Essentially, information and practical knowledge build competencies to perform certain behaviors, such as recycling.

The theory of planned behavior [5,6] supports the linkage between procedural competence and recycling behavior. According to that theory, individuals have stronger intention to perform a behavior when they have a positive attitude toward it, believe that it is socially acceptable or encouraged, and feel they have control over engaging in it [7]. Further, intention is more likely to translate to actual behavior when individuals have actual behavioral control [8]. This intuitive linkage between competence and performance of a behavior appears in myriad contexts, including environmental behaviors.

Other research accounts more directly for process-related concepts to explain why people engage in behaviors. For example, the concept of implementation intention captures different aspects of performing behaviors, including how and where to perform them [9,10]. Implementation intention concerns volitional aspects of behavior, and helps link the motivation to engage in behavior with actual behavioral performance [11].

Those lines of scholarship suggest that individuals are more likely to engage in certain behaviors when they understand the behavioral procedures. This study is interested in clarifying the basis of such understanding. As individuals may gain understanding by acquiring relevant information, it is

worthwhile to examine the role of information seeking in supporting procedural behaviors, such as recycling. In particular, it is interesting to study the relationship between information seeking and behavioral control. Such an examination can clarify the linkage between intention and behavior.

Building on prior research, this study proposes that individuals have greater behavioral control and are more likely to engage in recycling when they seek information about how and where to recycle. This study labels such information as procedural information. The theory of planned behavior provides a useful framework to study relationships among procedural information seeking, individual control over the behavior, and self-reported recycling. Path analysis of longitudinal survey data tests novel hypotheses, which the following sections develop.

1.1. The Theory of Planned Behavior

Individuals often use information to formulate plans; thus, information is useful when individuals engage in planned behaviors [12]. Planned behaviors involve forethought, and often arise after individuals have formed behavioral intentions. The theory of planned behavior [5,6] gives a parsimonious explanation of why individuals form intentions and engage in behaviors.

An important basis of a behavioral intention is motivation to perform it. Two prominent beliefs that influence this motivation are that the behavior supports desired outcomes and is socially accepted or encouraged [5]. The former kind of belief is related to attitudes because individuals may express their thoughts about a behavior in terms of how they feel about it. Feeling that a behavior is useful, beneficial, or enjoyable reveals a positive attitude toward the behavior. The latter kind of belief is related to social norms because individuals consider how others regard the behavior. Perceiving that others engage in or approve of the behavior reveals a subjective norm in favor of the behavior. These two factors provide a good explanation of behavioral intention and actual behavior when the behavior is easy to perform [7].

However, not all behaviors are easy to perform. Individuals might prefer to engage in certain behaviors, but feel they lack the ability to do so. Thus, perceived behavioral control also affects behavioral intention [5,7]. Behavioral control plays a second role in the model by explaining the relationship between intention and behavior. This role is important because individuals can misperceive their behavioral control, and a behavioral intention built on a false sense of control is unlikely to translate into actual behavior [13,14]. Even when individuals hold accurate beliefs about their behavioral control, it is theoretically meaningful to separate their perceptions from their actual ability.

The linkage between intention and action may also strengthen when individuals form implementation intentions [15–17]. Implementation intentions are similar to behavioral intention, but they refer more specifically to the procedure of performing the behavior. For example, when individuals state how and where they will perform the behavior, they have implementation intentions. Those intentions help individuals specifically plan their intended behavior.

Taken together, behavioral intention may reflect attitude toward the behavior, behavior-related subjective norm, and perceived behavioral control. These linkages define the motivational basis of behavioral intention. There is empirical support for these linkages across many behavioral contexts [14]. Finally, individuals who have behavioral intention are more likely to actually engage in the behavior when they have actual behavioral control. Although the theory of planned behavior omits several important behavioral determinants, such as self-determination, self-identity, and choice architecture [18], it is a good baseline for examining behaviors that involve forethought. Figure 1 is a conceptual diagram of the theory of planned behavior, differentiating between its motivational and action-related components.

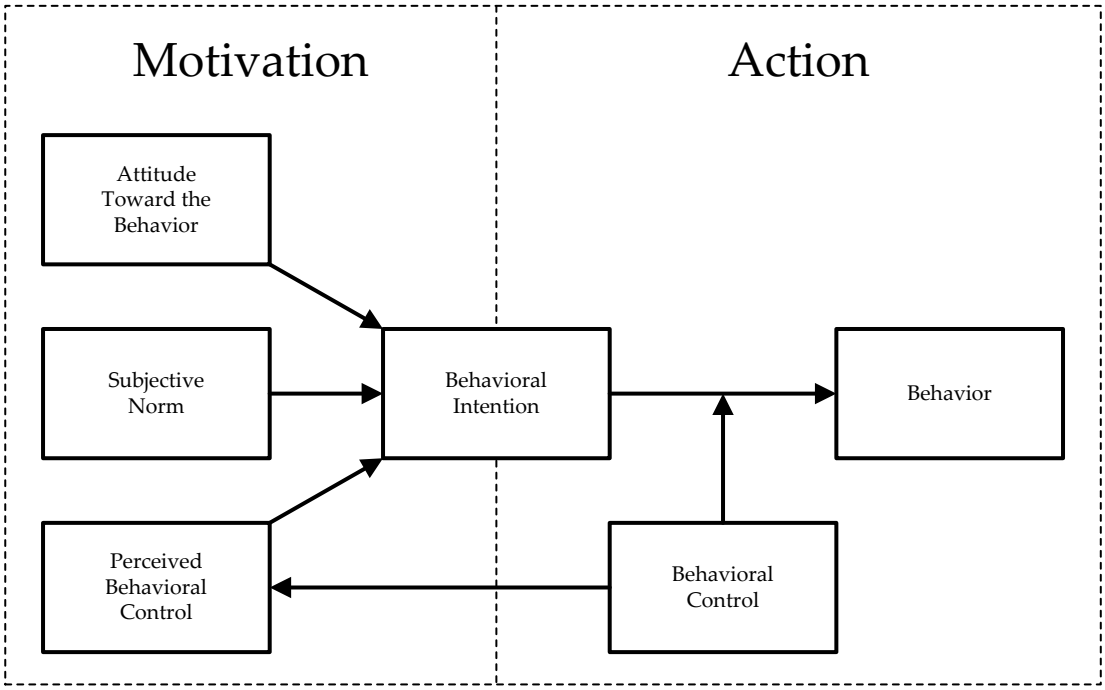

Figure 1. Theory of planned behavior. Motivational components affect behavioral intention. Behavioral control moderates the linkage between intention and behavior.

1.2. Recycling as Planned Behavior

The theory of planned behavior is useful to explain recycling because recycling involves a number of procedural steps. Research that accounts for attitude toward recycling, recycling-related subjective norm, and perceived recycling control can help explain why individuals recycle [19]. Other scholars have explained recycling behavior in terms of implementation intention. Individuals are more likely to recycle when they have intentions about how and where they will do it [16].

Studying behavioral control is important in the context of recycling because perceived behavioral control can be an important determinant of behavioral intention [20,21], and individuals are less likely to act on their intentions when infrastructure is lacking or they are unsure how to use it [1,19,22]. It follows that individuals will have stronger intentions to recycle and be more likely to actually recycle if they have good understanding of how and where to recycle. This focus on procedure can help clarify why individuals have or lack behavioral control.

Consistent with that prior research, I expect to find that (a) recycling intention is positively related to recycling behavior, (b) actual recycling control is positively related to recycling behavior, and (c) the greater the actual recycling control, the more positive the relationship between recycling intention and recycling behavior. These relationships are well established and do not warrant new hypotheses.

1.3. Procedural Information

One way individuals can enhance their behavioral control is to learn more about how to perform the behavior. Specifically, individuals can gain procedural competence by seeking information about how and where to perform a behavior. Such procedural information conveys practical knowledge about the behavior, and may enhance behavioral control by supporting the formation of implementation intentions.

Prior work suggests some factors that motivate the seeking of procedural information. Atkin [23] proposed that individuals selectively seek information that has instrumental utility. Such information can serve different needs, one of which relates to the performance of behaviors. Building on that perspective, the model of informational utility states that individuals selectively seek information that

satisfies functional information needs [24]. According to that model, information selection is a function of the magnitude, likelihood, and immediacy of the issue that the information concerns [24,25]. In other words, individuals actively seek out information that helps them respond to important issues that are likely to affect them in the short term. Empirical tests of that model generally concern selective exposure to risk information that supports surveillance motives and may support risk avoidance behavior. However, the model should also be useful to explain information seeking that supports the performance of instrumental tasks, including recycling. The central idea is that individuals are motivated to seek information that helps them behave in a desirable way. In the current context, individuals may seek procedural recycling information in support of their intended recycling behavior.

Hypothesis 1 (H1). *The greater the recycling intention, the greater the procedural information seeking.*

Consequently, procedural information can support the performance of instrumental tasks, including recycling. Most research on the linkage between information and behavior has focused on the effects of information provision. Tsagarakis [26] argued that providing information about the household waste separation procedure is crucial for effective waste management. This is consistent with research showing that targeted information campaigns can encourage reuse and recycling [27].

At least two studies provide more direct empirical support of the linkage between procedural information and the performance of pro-environmental behaviors. Wei, Chiang, Kou, and Lee [28] found that individuals have a more positive attitude toward green products when they regard green product advertising as useful for guiding purchase decisions. Although attitude is not the same as intention or behavior, it is an important antecedent of both, and that finding suggests that useful information may indirectly facilitate behavior. Another study found that individuals who report using the media in order to better understand how to deal with environmental issues have stronger pro-environmental behavioral intention [29]. In other words, individuals who seek useful action-related information have stronger motivation to engage in related behaviors.

Hypothesis 2 (H2). *The greater the procedural information seeking, the greater the recycling behavior.*

Hypothesis 3 (H3). *Procedural information seeking mediates the relationship between recycling intention and recycling behavior.*

This kind of information seeking may especially facilitate procedural behaviors because it can support behavioral control. Specifically, procedural recycling information can support the formation of implementation intentions. This argument presumes an indirect linkage, where implementation intention mediates the relationship between information seeking and behavioral control. This study focuses instead on the direct linkage between information seeking and behavioral control:

Hypothesis 4 (H4). *The greater the procedural information seeking, the greater the recycling-related behavioral control.*

The second hypothesis of this study asserted a linkage between procedural information seeking and recycling behavior. Part of that effect may be due to a shift in attitude toward recycling, and another part of it may be due to a shift in behavioral control. This study is interested in the latter explanation, which suggests a mediated relationship.

Hypothesis 5 (H5). *Behavioral control mediates the relationship between procedural information seeking and recycling behavior.*

Finally, procedural information seeking should moderate the relationship between recycling intention and recycling behavior. This is because learning about the recycling procedure can help

individuals actually recycle when it is their intention. This moderation is ultimately an effect of behavioral control, which suggests mediated moderation.

Hypothesis 6 (H6). *The greater the procedural information seeking, the more positive the relationship between recycling intention and recycling behavior.*

Hypothesis 7 (H7). *Behavioral control mediates this moderation effect.*

Figure 2 summarizes the predicted effects in a path diagram. In order to test these predicted effects, I conducted a regression analysis of survey data from a two-wave longitudinal study. The following sections describe this study: Section 2 presents the sampling procedure and measurement of variables; Section 3 covers the statistical analyses and results of hypothesis testing; and Section 4 interprets the results, considers their theoretical implications, and addresses some conceptual and methodological limitations before concluding.

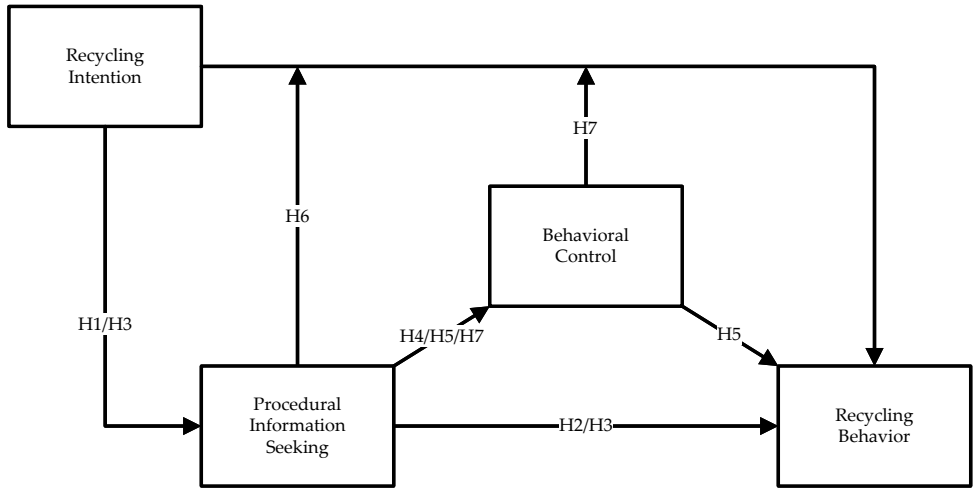

Figure 2. Diagram of predicted effects. Procedural information seeking mediates and moderates the relationship between recycling intention and behavior. The moderation effect is mediated by behavioral control, as is the effect of procedural information seeking on recycling behavior.

2. Method

2.1. Sample

Members of a Singapore-based online research panel constituted the sampling frame. The panel comprises a non-probability opt-in sample of adult residents of Singapore. Invitations to participate in this study used simple random sampling from among the panel members. The initial survey had a sample size of 1468 and a response rate of 19%. Respondents answered various questions about recycling, including their recycling intention. After one month, 553 of those respondents participated in a follow-up survey. Those respondents answered questions about information seeking, behavioral control, and recycling behavior. Analyses concern the longitudinal data of only those participants. Participants were 54% female and 46% male. The median age was 36 years (M = 37.29, SD = 11.43).

2.2. Measurement

Items measuring recycling intention appeared in the initial survey. Those items had a common stem, "During the next month." Measurement of procedural information seeking, behavioral control, and recycling behavior appeared in the follow-up survey. Those items had the common stem, "During the previous month." Table 1 contains descriptive summaries of the composite variables and

measurement items, including mean (*M*) and standard deviation (*SD*). In addition, Table 1 includes Cronbach's α to indicate the reliability of composites of three or more items and the Spearman-Brown coefficient (r_{sb}) for composites of two items.

Table 1. Descriptive summary of variables and items.

Variable/Item	*M*	*SD*	
Recycling intention: During the next month,	3.74	0.62	r_{sb} = 0.71
I will do more to recycle.	3.90	0.65	
I plan to increase the amount of waste I recycle.	3.59	0.76	
Information seeking: During the previous month,	3.14	0.80	α = 0.86
I learned more about what kinds of waste can be recycled.	3.12	0.89	
I learned more about the locations of recycling bins.	3.17	0.92	
I learned more about how to properly sort recyclables.	3.12	0.89	
Behavioral control: During the previous month,	3.20	0.76	α = 0.82
It was easy for me to recycle.	3.34	0.85	
I found that recycling was difficult.	3.19	0.92	
I was often unable to recycle.	3.08	0.89	
I was able to recycle whenever I wanted.	3.24	0.89	
I had difficulty finding recycling bins.	3.13	1.04	
I was unsure about what items I could recycle.	3.17	0.88	
Recycling behavior: During the previous month,	3.12	0.71	r_{sb} = 0.76
I did more to recycle than I usually do.	3.15	0.80	
I increased the amount of waste I recycle.	3.10	0.78	

3. Results

Some of the analyses tested for interaction effects. Interaction effects are simpler to interpret when the independent variables are mean-centered [30]. In order to have consistency across all hypothesis testing, I analyzed z-scores of all variables, including the dependent variable. By analyzing z-scores of all variables, the unstandardized (B) and standardized (β) regression estimates are identical and the model y-intercept is zero. Some of the results refer to regression models (Model 1 through Model 5), which appear in Table 2. The first model predicts recycling behavior with only recycling intention. Each subsequent model adds a single independent variable in a sequence that clarifies the predicted effects. Table 2 includes the 95% confidence intervals (95% CI) of the estimates, change in explained variance (ΔR^2), and total explained variance (R^2).

In support of H1, simple ordinary least squares (OLS) regression showed that recycling intention positively predicted procedural information seeking (β = 0.25, 95% CI (0.16, 0.33), $p < 0.001$).

The test of H2 used multiple OLS regression. The dependent variable was recycling behavior. The independent variables were recycling intention, procedural information seeking, and behavioral control (Model 3). Results showed that procedural information seeking positively predicted recycling behavior (β = 0.30, 95% CI (0.22, 0.38), $p < 0.001$). That finding supports H2.

Table 2. Hierarchical OLS regression of recycling behavior.

Predictor	Model 1		Model 2		Model 3		Model 4		Model 5	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
RI	0.33 ***	0.25, 0.41	0.23 ***	0.16, 0.31	0.20 ***	0.13, 0.28	0.21 ***	0.13, 0.28	0.22 ***	0.14, 0.29
IS			0.41 ***	0.33, 0.48	0.30 ***	0.22, 0.38	0.30 ***	0.22, 0.37	0.30 ***	0.22, 0.38
BC					0.24 ***	0.16, 0.32	0.24 ***	0.16, 0.32	0.22 ***	0.14, 0.30
RI × IS							0.10 **	0.03, 0.17	0.02	-0.05, 0.10
RI × BC									0.15 ***	0.07, 0.23
ΔR^2	0.11 ***		0.16 ***		0.05 ***		0.01 **		0.02 ***	
R^2	0.11		0.27		0.31		0.32		0.34	

Note: RI = recycling intention. IS = procedural information seeking. BC = behavioral control. ** $p < 0.01$. *** $p < 0.01$.

The test of H3 used the PROCESS macro for SPSS [31]. The mediation analysis used the Sobel test and 5000 bias-corrected bootstrap samples to estimate 95% confidence intervals. Recycling behavior was the dependent variable (Y), recycling intention was the independent variable (X), and procedural information seeking was the mediator (M). Results showed a significant indirect effect of recycling intention on recycling behavior via procedural information seeking (β = 0.10, 95% CI (0.06, 0.15), $p < 0.001$). Another view of this mediation is that the effect of recycling intention on recycling behavior (Model 1) decreased by 0.10 after controlling for procedural information seeking (Model 2).

In support of H4, simple OLS regression showed that procedural information seeking positively predicted behavioral control (β = 0.48, 95% CI (0.40, 0.55), $p < 0.001$).

The test of H5 used the PROCESS macro as previously described. In this model, recycling behavior was the dependent variable (Y), procedural information seeking was the independent variable (X), behavioral control was the mediator (M), and recycling intention was a covariate. Results showed a significant indirect effect of procedural information seeking on recycling behavior via behavioral control (β = 0.11, 95% CI (0.07, 0.16), $p < 0.001$). Another view of this mediation is that the effect of procedural information seeking (Model 2) decreased by 0.11 after controlling for the effect of behavioral control (Model 3).

The test of H6 used multiple OLS regression. The model was the same as that used to test H2, but it added the interaction of procedural information seeking and recycling intention as a predictor (Model 4). The interaction effect was significant (β = 0.10, 95% CI (0.03, 0.17), $p = 0.005$). Specifically, the greater the procedural information seeking, the more positive the relationship between recycling intention and recycling behavior. This finding supports H6.

Finally, the test of H7 used the PROCESS macro as previously described. In this model, recycling behavior was the dependent variable (Y); the interaction of procedural information seeking and recycling intention was the independent variable (X); the interaction of behavioral control and recycling intention was the mediator (M); and procedural information seeking, behavioral control, and recycling intention were covariates. Results showed that the interaction of procedural information seeking and recycling intention had an indirect effect on recycling intention, where the mediator was the interaction of behavioral control and recycling intention (β = 0.08, 95% CI (0.03, 0.13), $p < 0.001$). Another view of this mediation is that the former interaction effect (Model 4) decreased by 0.08 after controlling for the latter interaction effect (Model 5). Figure 3 depicts this mediated moderation using the pick-a-point method to plot interaction effects. The pick-a-point method uses the unstandardized regression slopes of the full model to estimate marginal means at combinations of low and high values of the interacting variables [32,33]. Figure 4 is a path diagram of the observed effects.

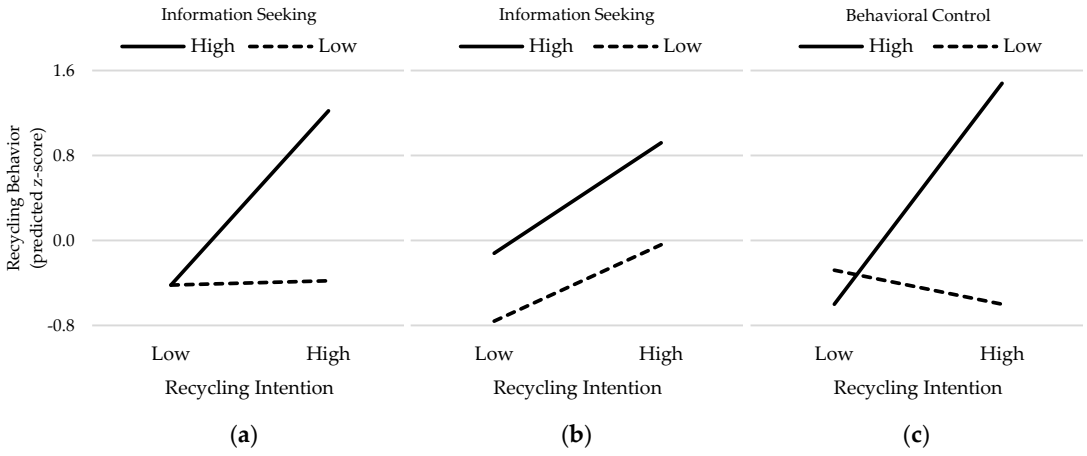

Figure 3. (**a**) The interaction of recycling intention and information seeking has a significant effect on recycling behavior. (**b**) That effect diminishes after modeling (**c**) the interaction of recycling intention and behavioral control. The high and low values of interacting variables are $M \pm 2\ SD$.

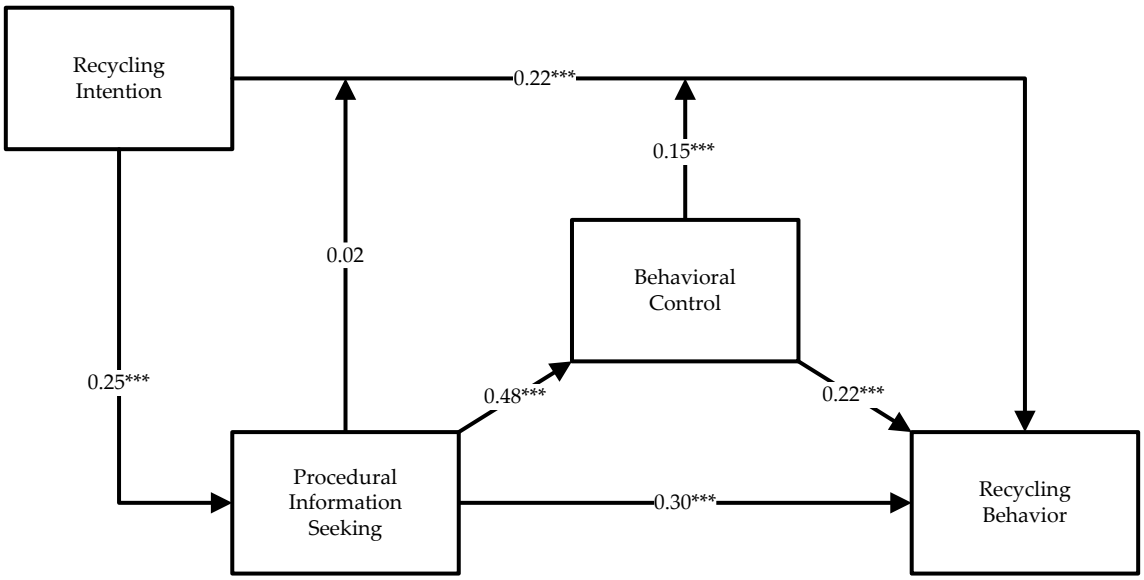

Figure 4. Diagram of observed effects. Note. *** $p < 0.001$.

4. Discussion

This study incorporated procedural information seeking into the theory of planned behavior in order to predict recycling behavior. The argument for this research approach is that certain behaviors, such as recycling, are easier to perform when individuals understand how and where to perform them. Individuals can gain that kind of understanding by seeking procedural recycling information. That kind of information is instructive about the recycling process. In this study, procedural information concerned what items are recyclable, the locations of recycling bins, and how to properly sort recyclables. This discussion interprets the current findings, considers their theoretical implications, and addresses some conceptual and methodological limitations before concluding.

4.1. Interpretation of Findings

Prior research consistently shows a positive relationship between intention and behavior [14]. Current results suggest that procedural information seeking partly explains and also strengthens that relationship in the context of recycling. These pathways of mediation and moderation have distinct implications for the role of procedural recycling information as a correlate of recycling behavior.

According to the mediation effect, individuals who have strong recycling intention are also more inclined to seek recycling information. This suggests that individuals consider their informational needs as a part of their behavioral planning. When individuals are motivated to engage in a behavior, they may seek information to support its performance. Subsequently, information seeking is positively related to actual recycling behavior.

The second part of this mediation path—the linkage between information seeking and recycling behavior—is itself mediated by behavioral control. This finding makes sense given the nature of procedural information. To the extent that procedural information helps individuals to perform procedural behaviors, it should enhance their behavioral control.

In addition to those mediated pathways, procedural information seeking moderated the relationship between recycling intention and recycling behavior. The argument for this effect assumes that information seeking enhances behavioral control; thus, the moderation is actually due to behavioral control. An analysis of mediated moderation supported that argument. Specifically, information seeking had the predicted moderating effect, but the effect diminished when the regression model also included the moderating effect of behavioral control. This finding further supports the idea that procedural information is an important antecedent of recycling behavior.

The importance of procedural information seeking also appears in its relatively large main effect on recycling behavior. Although that effect was not statistically larger than the other two main effects (see the overlapping confidence intervals in Table 2) it is still a noteworthy finding. These results show, at the very least, that procedural information seeking is as important a factor in predicting behavior as are behavioral intention and behavioral control. This effect makes sense, given the procedural nature of recycling. It would be interesting to know if this effect generalizes to other procedural behaviors and if it weakens for less procedural behaviors. Behaviors that involve fewer or simpler steps, such as switching off unnecessary lights, may be less affected by information seeking than by other behavioral factors. It would also be interesting to examine this effect in the context of habitual or routine behaviors. Prior research has suggested that individuals with strong habits need less information because they feel sufficiently knowledgeable about the behavior and also because habitual behaviors involve less planning [34].

4.2. Theoretical Implications

The current findings are consistent with Funke's [12] argument that knowledge is a necessary antecedent of goal-oriented behaviors. He drew on the theory of planned behavior to support his argument, asserting that intention implies having knowledge about a behavior. Given that assumption, planned behaviors are inherently knowledge-based. That argument is consistent with previous findings that attention to pro-environmental media messages is positively related to pro-environmental behavioral intention [29]. Whereas previous research has associated perceived knowledge about a behavior with attitude toward the behavior [35], the current study suggests that an important component of behavior has to do with procedural knowledge and its relation to perceived behavioral control. It would also be interesting to know how attention to or seeking of social information may influence subjective norms.

Not only is knowledge a precursor of intention, but knowledge may also support the linkage between intention and action. To the extent that individuals have accurate knowledge about how to perform a behavior, their perceived and actual behavioral control will align and their intention will likely translate into action. For example, individuals are less likely to have healthy diets when they do not know how to prepare healthy meals [36]. Knowing how to perform a behavior can arise from information seeking, as the current results suggest. The more individuals understand the actions and objects that support a behavior, the easier it will be for them to engage in the behavior. Such understanding reflects procedural information and manifests as action knowledge, which can support the formation of routines that make behavioral control a more automatic process [37].

What remains unclear is the boundary conditions in which procedural information seeking affects recycling behavior. It makes sense that this effect would tend to arise only when individuals have access to recycling facilities. For instance, the effect of attitude and subjective norm on recycling behavior diminishes when individuals perceived recycling facilities to be lacking [19]. Certainly, procedural information seeking will be unrelated to recycling behaviors if there are no recycling facilities. What is the minimum provision of recycling facilities for procedural information seeking to matter? That would be an interesting question for future research to address.

4.3. Limitations

Despite the consistency of the current findings and their theoretical import, there are some limitations. First, this study somewhat implies that information provision can create change. However, information provision by itself has limited effects on behavior, notably in the context of environmental behaviors [38]. Other factors, such as values and personal norms, need to be addressed in order to understand how communication can effect positive change. Nonetheless, when behaviors involve following steps, access to easy-to-understand procedural information can help individuals know how to perform those behaviors.

Another limitation is that the online panel is not representative of the population. It excludes non Internet users and probably also light Internet users. The information seeking and processing strategies of the panel members may be different from the general public, which would limit the generalizability of the current findings. Although there is no specific reason to expect the current findings to be in error, the results would benefit from replication using a unique sampling frame.

5. Conclusions

In conclusion, this study showed that the linkage between recycling intention and behavior is stronger when individuals have sought information about how and where to recycle. Such procedural information can support the formation of implementation intention and action knowledge and, as a result, enhance behavioral control. These results are consistent with the theory of planned behavior and add a more informational aspect to it. Future research should examine this model in the contexts of other behaviors and include implementation intention as an outcome of information seeking. Such work would provide a more nuanced account of the effects of information seeking on behavioral control and performance.

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