Article

Causality in the Theory of Planned Behavior

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Reuven Sussman[1,2] and Robert Gifford[1]

Abstract

The theory of planned behavior proposes that behavior is predicted by behavioral intention which is, in turn, predicted by three base components: attitudes toward the behavior, subjective norms regarding the behavior, and perceived control over the behavior. Implied within this theory is that each of the three base components influence intentions, solely in that direction. However, despite being one of the most widely used theories in many areas of psychology and health sciences, few studies have tested this basic premise. Might causal influence also flow in a reverse-causal direction from intentions back to the base components? This causal sequence was tested and supported by a correlational study, a lab-based experiment, and a quasi-experimental field study. This demonstration of reverse-causal relations from intentions to the base components suggests that the theory of planned behavior should be modified to include reciprocal causal relations.

Keywords

theory of planned behavior, causality, cross-lagged correlation, quasi-experiment

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The theory of planned behavior (TPB) arguably is the most frequently cited explanation of human behavior. It proposes that three constructs (herein called *base components*) influence intentions (INT) and that intentions influence action. The three base components are as follows: Attitudes toward the behavior (ATT), subjective norms regarding the behavior (SN), and perceived control over the behavior (PBC). Although much research has established the connection between intentions and behavior (e.g., Armitage & Conner, 2001), comparatively little has examined the cause-effect relation between the base components and intentions.

Since its refinement in the late 1980s (e.g., Ajzen, 1985), hundreds of studies have investigated or applied the TPB to predict behavior in the fields of health, environmental sustainability, and others. In the health and environment domains, researchers typically measure ATT, SN, PBC, and INT as predictors of a particular self-reported behavior simultaneously and then use regressions or structural equation models to fit the theory to the data they have collected. For example, studies of physical activity that use this method find that ATT, SN, and PBC predict the intention to engage in active behavior (e.g., Gretebeck et al., 2007).

The purpose of the current series of studies was to assess the underlying assumption of causal influence among the original base components of the TPB.[1] Specifically, our objective was to learn whether base components influence intentions unidirectionally (as currently implied), or whether reverse-causal influences from intentions back to base components may also exist. The original TPB model and our proposed modification can be seen in Figure 1.

Fishbein and Ajzen (1975) proposed the theory of reasoned action (TRA; the precursor to the TPB) to describe the process by which internal mental processes can lead to action. Their unique contribution was distinguishing the concepts of beliefs, attitudes, subjective norms, and intentions from one another, and proposing a sequence in which they occur. Throughout their book, Belief, attitude, intention, and behavior: An introduction to theory and research, Fishbein and Ajzen (1975) frequently explain the relationship between factors using language such as "this attitude leads to a set of intentions . . ." (p. 15). This continues in 1991 with the assertion that "the theory of planned behavior postulates three conceptually independent determinants of intention. The first is the attitude toward the behavior . . . The second predictor is a social factor termed subjective norm . . . The third antecedent of intention is the degree of perceived behavioral control" (Ajzen, 1991, p. 188). Their

[1]University of Victoria, British Columbia, Canada, USA
[2]American Council for an Energy-Efficient Economy, Washington, DC, USA

Corresponding Author:
Reuven Sussman, American Council for an Energy-Efficient Economy, 529 14th Street N.W., Suite 600, Washington, DC 20045, USA.
Email: reuven.sussman@utoronto.ca

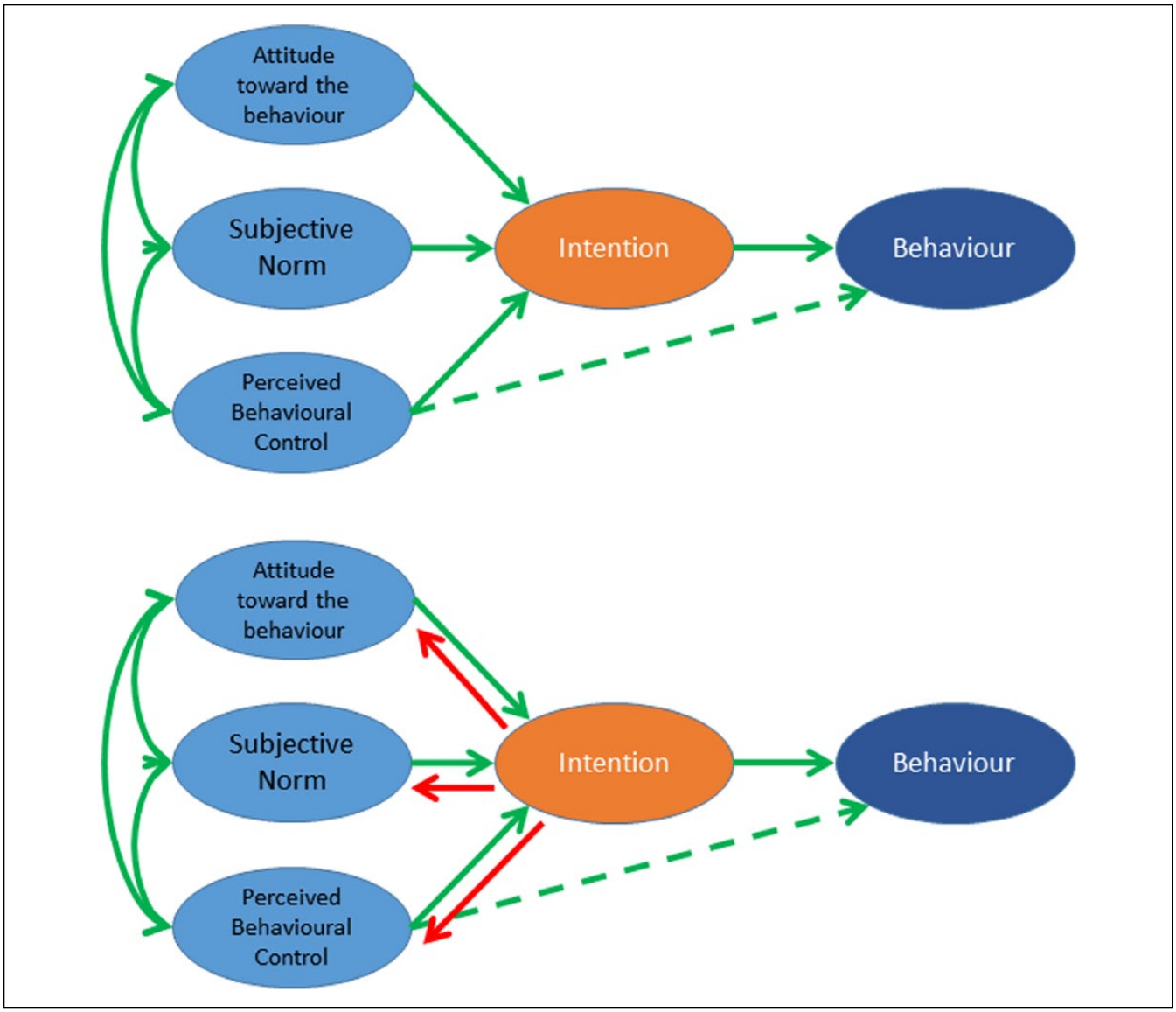

Figure 1. Modified (below) and traditional (above) theory of planned behavior (TPB).

suggestion that base components determine intentions has been subsequently echoed, tested, and supported with numerous structural equation models and correlational studies (e.g., Bentler & Speckart, 1981; Gretebeck et al., 2007; Kahle & Berman, 1979).

In arguing for their specific order of mental constructs in the TPB, Fishbein and Ajzen presented a handful of studies which suggested that changes in ATT or SN may cause a change in INT, but none that investigated a potential reverse-causal link.[2] For example, they note that manipulating perceptions of subjective norms can affect intentions (Mezei, 1971), and changing attitudes about a behavior can lead to more instances of that behavior (Ajzen & Fishbein, 1972). In the decades since the TRA and TPB were proposed, however, the issue of causality seems to have been assumed to be "solved," and most researchers have gone about conducting research using correlational designs, assuming they indicated that base components influence intentions which, in turn, influence behavior.

However, before the TRA and TPB became the dominant models they are today, several researchers criticized the way that Fishbein and Ajzen separated the concepts of ATT, SN, and INT and put them in a specific sequence. Liska (1984) cites evidence demonstrating that ATT, SN, and INT may not be unique constructs, that beliefs may not cause attitudes, that beliefs may directly influence behavior, and that the sequence postulated by the TRA may not be accurate.

Furthermore, the assumption that base components determine intentions has been primarily demonstrated statistically (not experimentally) in past research, and the statistical evidence is equivocal. Several studies have calculated

cross-lagged regression coefficients between all elements of the TRA and the TPB, but the direction of causality was generally ambiguous (e.g., Hagger, Chatzisarantis, Biddle, & Orbell, 2001; Kahle & Beatty, 1987). Other studies report evidence for a forward-causal relation, but do not test for a possible reverse-causal relation (e.g., Armitage, Reid, & Spencer, 2013; Elliott, Thomson, Robertson, Stephenson, & Wicks, 2013), and one study found that intentions may be more likely to cause one base component, attitudes, than *vice versa* (Tyagi & Wotruba, 1993).

Most TPB studies that claim to find directional associations among ATT, SN, PBC, and INT use cross-sectional data investigated with regression or structural equation models. More than half of all published TPB studies use cross-sectional designs, which is problematic for several reasons (Elliott et al., 2013).

The first reason is that cross-sectional tests of the TPB demonstrate only that differences in the model's constructs are related to differences in intention and behavior between participants; it says nothing about how individuals change over time or how particular individuals' ATT, SN, or PBC affects their intentions. The second reason is that measuring all the TPB constructs simultaneously renders data vulnerable to consistency biases, which serve to artificially inflate relations (e.g., Budd, 1987). Finally, if self-reported behavior is measured at the same time as the other TPB constructs, then any model based on that information can only predict "past" behavior (not future behavior, as the model is meant to predict). Indeed, when data are measured simultaneously, only associations among them can be inferred—the directionality of influence is impossible to determine. Cross-lagged correlations can support a causal hypothesis, but a well-designed quasi-experimental or randomized controlled trial would offer stronger support.

Several lines of research offer plausible reasons for questioning the assumption that the TPB base components causally precede INT rather than solely following it. These include research on cognitive dissonance, public commitment, confirmation bias, implemental mind-set, and the false consensus effect. For example, research on implemental mind-set suggests that once an intention is set, perceived behavioral control increases such that games of skill seem easier than before (Armor & Taylor, 2003). Cognitive dissonance explains why the act of setting an intention to bet on a horse could change attitudes about that horse, even before actual betting has occurred (Brownstein, Read, & Simon, 2004). The false consensus effect predicts that people who choose to engage in certain actions, such as ignoring a "shower ban," perceive that others are more likely to do so as well (Monin & Norton, 2003).

Each of these areas of research demonstrates, in some way, that once a decision is made, attitudes, subjective norms, or perceived behavioral control regarding that behavior may subsequently change; in essence, that ATT, SN, and PBC may follow (rather than only precede) behavioral intentions. Importantly, however, these assumptions have not yet been applied to SN, ATT, and PBC simultaneously within the framework of TPB, particularly using experimental research designs.

Therefore, the primary objective of the present series of studies was to investigate whether reverse-causal relations exist between intentions and the base components of the TPB. The first study used a cross-lagged design. The second was a laboratory-based free-choice experiment, and the third was a field experiment in which intentions were targeted in an attempt to change ATT, SN, and PBC, along with behavior. Our overarching hypothesis across these three studies is that INT will influence some or all of the TPB base components in a reverse-causal manner.

Study 1

Study 1 was a nonexperimental demonstration that base components can plausibly follow intentions, and that intentions predict action.

Method

Participants

In total, 361 undergraduate students from a mid-sized Canadian university were recruited to participate in exchange for course credit. Overall, 25% were males, with an average age of 20 years ($SD = 3.67$ years, *range* = 17-51 years).[3]

Procedure

The participants were informed that the study would include three parts and that, after the third part, they could choose to take action to support a local environmental organization. They were therefore aware that, after the end of the study, they would be provided with the materials needed to engage in up to seven potential support actions: sign a petition, sign a pre-written letter, read more information, write a letter, donate money, purchase merchandise, or register to receive a newsletter.

At Time 1 (T1), participants provided written consent to participate and then read the section of the environmental organization's website that described its goals, approach, values, and current activities. They then completed an online TPB questionnaire about supporting that organization by engaging in one or more of the seven support actions. The questionnaire measured (a) the base components of the TPB model about supporting the organization and (b) intentions to actually adopt any of the seven support actions at the end of the study.[4] The complete list of items is available in Online Appendix 1. The base components and intentions were presented in a random order.

At Time 2 (T2), 11 to 31 days later ($M_{days} = 23.23$ days, $SD = 2.65$ days), the participants ($n = 310$) completed the same questionnaire again. At Time 3 (T3), 0 to 8 days after

T2 (M_{days} = 4.13 days, SD = 2.33 days), participants (n = 280) came to the lab to complete an unrelated distracter questionnaire. Along with the distracter questionnaire, the participants received a folder with materials for supporting the environmental organization in up to the seven ways described above. They were told that the reason they were asked to come to the lab was to complete the distracter questionnaire but, after they finished, they could also choose to use any of the materials in the folder to support the environmental organization described in T1 and T2 of the study. Overall, 58% of participants who completed T3 chose to engage in at least one support action (n = 162 of 280).

Results

Participants

Of the 361 participants who enrolled in the study, 279 completed all three parts (T1, T2, and T3), 31 only completed T1 and T2, 50 only completed T1, and one only completed T1 and T3. In addition, 14 were excluded because they were already involved with the environmental organization or because they provided answers indicative of not paying attention (i.e., they failed at least two attention items embedded within either questionnaire or they provided extreme answers, above z = 3.0, on measures of ATT, SN, PBC, or INT).[5] Within the final sample, responses to items were normally distributed with no outliers.

Reliability

The reliability of the ATT, SN, PBC, and INT factors were calculated using all participants at each time point. Cronbach's alpha was acceptable for each factor at each time point ($\alpha > .70$), six composite variables were created (Time 1 and Time 2 attitudes = ATT_{T1} and ATT_{T2}; Time 1 and Time 2 subjective norms = SN_{T1} and SN_{T2}; Time 1 and Time 2 perceived behavioral control = PBC_{T1} and PBC_{T2}). The composite variables were created by obtaining the means of items within each factor. Details of the reliability of each factor can be seen in Table 1.

Predicting Intentions and Base Components

For each base component (ATT, SN, PBC), a cross-lagged correlation analysis was conducted with intentions. The autocorrelations and synchronous correlations were checked for stability and stationarity. As Figure 2 shows, the autocorrelations for ATT, SN, PBC, and INT were all strong and significant. The synchronous correlations were strong and significant for ATT, SN, and INT, but not for PBC. In the case of PBC, the relation between PBC and INT was weak but became stronger over time. This may indicate the influence of one or more extraneous variables. Nevertheless, this did not appear to influence the cross-lagged correlations.

Table 1. Reliability of TPB Components.

Factor	Cronbach's alpha	N of Items	N	M[a]	SD[a]
Time 1 ATT	.76	5	361	68.86	15.13
Time 2 ATT	.80	5	309	70.46	15.41
Time 1 SN	.86	4	361	63.19	21.55
Time 2 SN	.86	4	309	64.56	21.32
Time 1 PBC	.72	4	361	70.6	17.43
Time 2 PBC	.71	4	309	70.27	16.04
Time 1 INT	.77	7	361	36.0	17.82
Time 2 INT	.77	7	309	36.56	17.63

Note. TPB = theory of planned behavior; ATT = attitudes; SN = subjective norms; PBC = perceived behavioral control; INT = Intentions.
[a]*M* and *SD* are calculated without the 14 excluded participants described in the text.

As may be seen in Figure 2, the individual cross-lagged correlations were moderately strong and significant for SN–INT and ATT–INT. The PBC–INT relation was borderline significant in both the forward and reverse directions. Using Kenny's (1975) method for comparing cross-lagged correlations, the forward-causal relations were not significantly stronger than the reverse-causal relations for any of the variables. The cross-lagged correlations between SN and INT indicated that a reverse-causal sequence was more likely, although the difference was not significant (z = –.81). These findings suggest reciprocal relations between ATT and INT, SN and INT, and PBC and INT, such that, within each pair, each influences the other, indicating that reverse causation was distinctly possible. A graphical version of these relations is shown in Figure 2.

Notably, the relationship between INT and PBC was not stable over time (it was initially weak but became stronger). This may indicate the influence of one or more extraneous variables. Although this did not appear to influence the cross-lagged correlations, these results should be interpreted with caution, particularly given the borderline significant result.

Behavior

Although the primary objective of Study 1 was to determine whether intentions influence attitudes toward the behavior, subjective norms, and perceived behavioral control, an interesting additional objective was to determine which of these factors predicted behavior.

A regression model was constructed with number of support actions as the dependent variable, predicted by: INT_{T2}, INT_{T1}, ATT_{T2}, ATT_{T1}, SN_{T2}, SN_{T1}, PBC_{T2}, and PBC_{T1}. The model was significant, R^2 = .28, $F(8, 261)$ = 12.97, $p < .001$, and, as suggested by the TPB, the best predictors of behavior were $INT_{T2,}$ β = .25, $t(261)$ = 3.06, $p < .01$, and INT_{T1}, β = .29, $t(261)$ = 3.36, $p < .01$.[6]

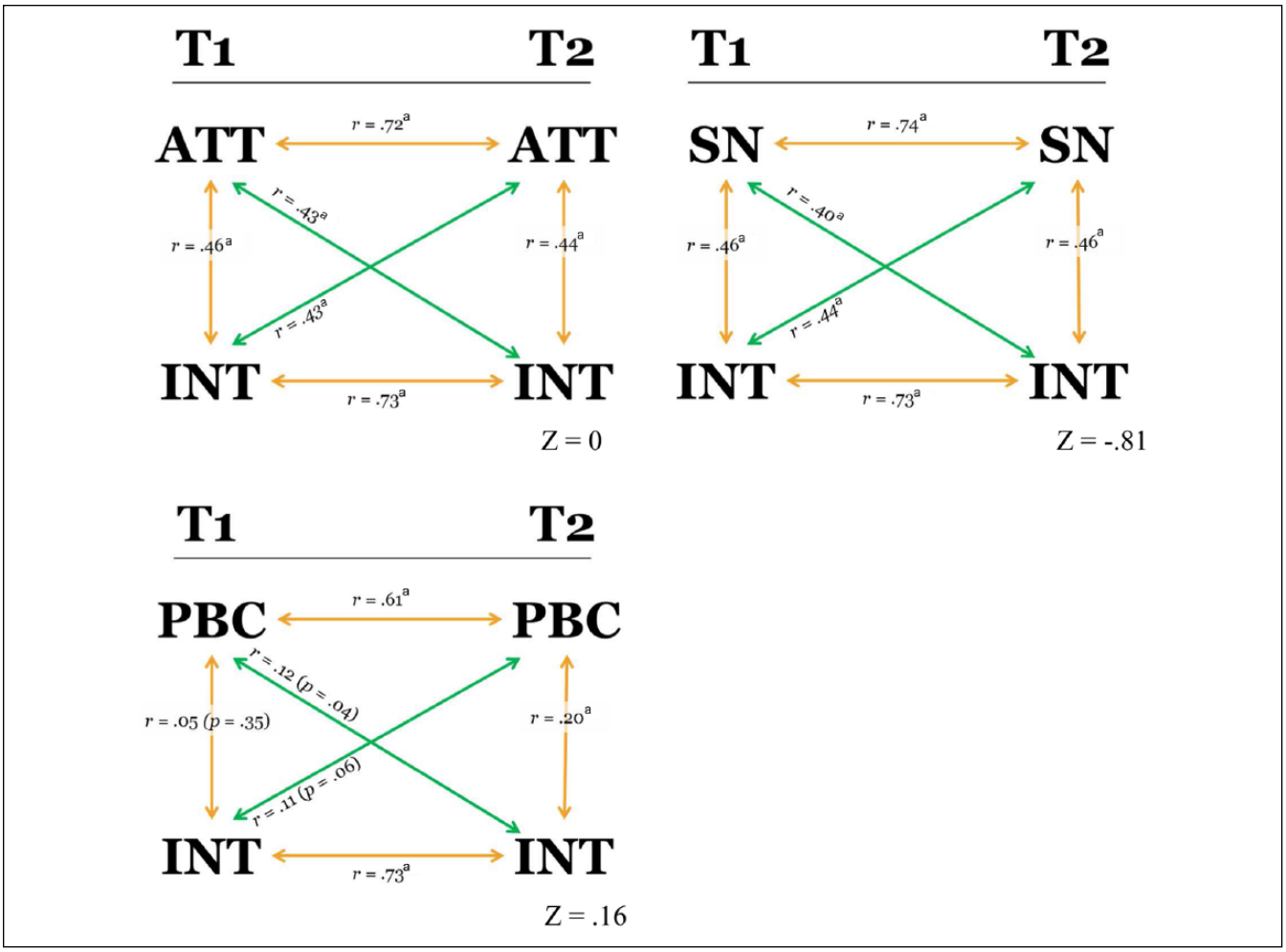

Figure 2. Cross-lagged correlations for ATT (attitudes), SN (subjective norms), PBC (perceived behavioural control) and INT (intentions).
Note. Z-scores were calculated using Kenny's (1975) method; negative values suggest reverse-causality. T1 = Time 1; T2 = Time 2.
[a]All correlations were significant at the $p < .001$ level, unless otherwise indicated.

Discussion

The original formulation of the TPB proposed that base components precede and influence intentions, but we found that forward-causal relations were only part of the story; a moderately strong and significant reverse-causal relation was also discovered for ATT and SN. When both forward and reverse-causal relations are statistically significant, but not significantly different from one another, the relation may be interpreted as reciprocal (e.g., Marsh, Papaioannou, & Theodorakis, 2006). Therefore, a reciprocal relation between two base components (ATT and SN) and INT is one reasonable explanation of the data.

The relationship between INT and PBC was less clear than expected. A few contributing factors may have led to these results. First, the behavior itself was perceived as "easy" by most participants because they knew they would be provided materials to engage in the behaviors immediately following the study. This was reflected in mean PBC scores ($M_{PBC\ T1\ and\ T2} > 70$ out of 100). Therefore, a possible ceiling effect and reduction in variability within the measure could have made finding a significant effect more difficult.

Second, considerable variability existed in the ease or difficulty of potential support actions. Although all the behaviors together were labeled "support actions," participants' perceptions of the difficulty of "engaging in a support action" varied greatly because the actions themselves varied in difficulty (e.g., signing a petition to writing a letter).

Third, the measure composed items that each measured PBC in different ways—for example, although questions about "personal control" over the behavior received high scores, the question about "expensive or cheap" received a range of answers. Finally, PBC became a better predictor of intentions and actions as they came closer (in time) to the opportunity to actually act. This was possibly because the idea of actually taking action became more salient closer to

the time of acting. For these reasons, the relation between intentions and PBC was considered tenuous or nonexistent.

In Study 2, many of the PBC measurement issues were addressed; behaviors were more specifically defined, they varied in difficulty, and they were measured with reliable items that correlated better with one another. We built upon Study 1's cross-lagged correlational findings by conducting a second, experimental study.

Study 2

Study 2 used an experimental design to test the hypothesis that intentions can cause a change in attitudes, subjective norms, and perceived behavioral control.

Method

Participants

In total, 295 undergraduate students from a Western Canadian university were recruited to participate in exchange for course credit.[7] Of these, 149 were assigned to the control group, and 146 were assigned to the intervention group. Overall, 19% ($n = 55$) were males, and the median age was 21 years (*range* = 18-60 years).[8]

Procedure

The free-choice paradigm (Brehm, 1956) was adapted for this experiment. Research based on this paradigm suggests that the act of selecting one alternative and rejecting another causes subsequent attitudes toward each alternative to change. We attempted to extend this finding to SN and PBC. We hypothesized that if individuals are forced to choose between forming an intention to support one of two organizations, they will subsequently display more positive ATT, SN, and PBC toward that organization and more negative ATT, SN, and PBC toward the rejected organization, thus demonstrating that intentions may influence TPB base components in a reverse-causal sequence.

Time 1. The study took place in two parts, each occurring between 1 and 14 days apart ($M_{delay} = 3.34$ days, $SD = 2.39$ days). At Time 1 (T1), the participants came to a computer lab on campus, provided their consent to participate and completed an online base components questionnaire about supporting each of four organizations (similar to the base components questionnaire used in Study 1).[9] The questionnaire for each organization was preceded by a brief video about that organization taken from the organization's website or YouTube channel.

Each 22-item questionnaire asked participants about their attitudes, perceptions of social norms, and perceptions of behavioral control for supporting each of the four organizations, in specific ways (signing a petition for one, volunteering for another, donating money to a third, or signing a letter on behalf of the fourth). The specificity of behaviors was increased in Study 2 (as compared with Study 1) to improve the reliability of the PBC subscale. The organizations were presented in a random sequence (with a 45-s break after the second organization), and the order of questions within each questionnaire were randomized.

Forming an intention. Following the four questionnaires, participants were asked to rank order each of the four organizations in terms of which they were most likely to take action to support after the end of the study. As is typical of studies that employ a free-choice paradigm, participants in the intervention group were asked to choose between two of the four alternatives. They were advised that the research team had partnered with two of the four organizations and they must choose which of the two they would prefer to form an intention to support. The two organizations were those ranked second and third (of four) because choosing between similarly ranked options in the middle range of preference can maximize the process of cognitive dissonance, while avoiding a ceiling or floor effect (cf. Shultz, Léveillé, & Lepper, 1999).

Through this process, a spreading of alternatives was expected for the intervention group, such that base components for the chosen option would become more supportive at Time 2 and base components for the rejected option would become less supportive at Time 2. Control group participants were not asked to choose between two organizations and so, for them, the alternatives were expected to remain the same or come together as a result of a natural regression to the mean.

Most participants (80%) chose the organization that they ranked second rather than their third choice. However, 20% of participants unexpectedly did the opposite. To avoid a sampling bias in the intervention group caused by excluding participants who chose the third-ranked option rather than the second-ranked option, we employed a method described by Risen and Chen (2010). One solution they recommended was to subtly encourage participants to choose their higher-ranked option, or to force them to do so.[10]

Participants in the intervention group were asked to explain (in a few sentences) why the higher-ranked organization should be supported. This step was included to maximize self-perception and cognitive dissonance.

Ensuring a genuine intention. Prior to beginning the questionnaires, the participants were told the names of the four environmental organizations and the specific means by which each could be supported. Before watching any videos or reading descriptions of the organizations, they were asked whether they would be "willing to commit to supporting one of the environmental organizations" after the second part of the study was completed. This was done because we anticipated that cognitive dissonance would not occur if the intention to

act was not genuine. Participants who were not willing to commit to supporting one of the organizations before beginning the study were asked to complete the questionnaire "hypothetically." Each participant (regardless of commitment) was randomly assigned to the control or intervention condition. Basic demographic information was requested at the end of T1.

Time 2. At Time 2 (T2), the participants were asked to complete the same base components questionnaires again for each organization, in random order. Embedded within each group of questionnaires at T1 and T2 were nine "attention items" intended to assess whether participants were responding mindfully. Participants who answered at least four attention items (of nine) from T1 or T2 inappropriately were excluded from the analyses.

Behavior was measured at the end of T2. Participants in the intervention group were provided a web link that could be used to complete the action for which they had formed an intention to complete (i.e., supporting the organization they ranked second). Participants in the control group were provided web links for all four organizations. Immediately after presenting the web links to participants, they were asked to report whether they had clicked on the link and followed through with an action (or to explain why they did not).

Results

Participants

Of the 295 participants, 275 completed both T1 and T2. In total, 19 participants were excluded because of careless responding.[11] Overall, 23% of participants ($n = 69$) stated at the outset that they were not "willing to commit" to supporting one of the organizations before the study began and thus completed the questionnaires "hypothetically."

Reliability and Descriptive Statistics for Base Components

For each of the four organizations, reliability was assessed for each subscale (ATT, SN, and PBC) at both times (T1 and T2). In all cases, the subscales were quite reliable ($\alpha > .80$) and had high corrected inter-item correlations ($r > .40$). All ATT subscales had $\alpha > .90$, all SN subscales had $\alpha \geqslant .83$, and all PBC subscales had $\alpha \geqslant .89$. Composite variables were therefore created for ATT, SN, and PBC at each time point for each organization. The second- and third-ranked organizations at each time point were the primary organizations of interest.

Reverse-Causal Influence of Intentions on Base Components

The free-choice paradigm (Brehm, 1956) was designed to engage cognitive dissonance through decision-making and therefore to cause individuals to prefer a chosen alternative more often than a rejected alternative. Therefore, we examined the results for a spreading of alternatives in the intervention group, compared with the control group.

As shown in the analyses to follow, the expected pattern of results was clearly visible only for participants who were not "willing to commit" to supporting one of the four organizations prior to beginning the study. The participants who were "willing to commit" showed a more-or-less fixed pattern of preferences from T1 to T2.

Two-way repeated measures analysis of variance (ANOVA). The constructed models included two within-subject independent variables, *Time* (T1 to T2) and *Difference between ranks* (i.e., spread of difference between organizations ranked second and ranked third), and one between-subject variable: *Group* (intervention vs. control). The analyses were conducted independently for individuals who agreed to make a genuine commitment to supporting one of the organizations before beginning the study, and those who were not.

Individuals who were "willing to commit" ($n = 226$) displayed little change in their ratings of ATT, SN, or PBC for organizations they ranked second or third. An exception was a slight but significant spreading of alternatives for the attitudes of participants in the intervention group, but not for those in the control group, Time*Rank*Group: $F(1, 192) = 4.02$, $p = .05$, $\eta_p^2 = .02$. No significant spreading of alternatives or regression to the mean was observed for SN, $F(1, 192) = 0.36$, $p = .55$, $\eta_p^2 = .002$, or PBC, $F(1, 192) = 0.23$, $p = .63$, $\eta_p^2 = .001$.

Individuals who were not "willing to commit" ($n = 69$) displayed significant (or borderline significant) changes in ratings of all three base components (ATT, SN, and PBC). These changes were twofold: a spreading of alternatives in the intervention group, and a regression to the mean (compression of alternatives) in the control group. The three-way Time*Rank*Group interaction was significant for ATT, $F(1, 58) = 14.12$, $p < .001$, $\eta_p^2 = .2$, and SN, $F(1, 58) = 6.09$, $p = .02$, $\eta_p^2 = .1$, and borderline significant for PBC, $F(1, 58) = 2.99$, $p = .09$, $\eta_p^2 = .05$. These patterns can be seen in Figure 3. Table 2 shows the estimated marginal means, standard errors, and 95% confidence intervals of ATT, SN, and PBC for each group at T1 and T2.

Discussion

Study 2 demonstrated, using a controlled laboratory experiment, that attitudes, subjective norms, and (to a lesser degree) perceived behavioral control for supporting an environmental organization can be influenced by forming an intention to support that organization (and not supporting an alternative organization).

One particularly interesting finding was that participants who did not initially commit to supporting an

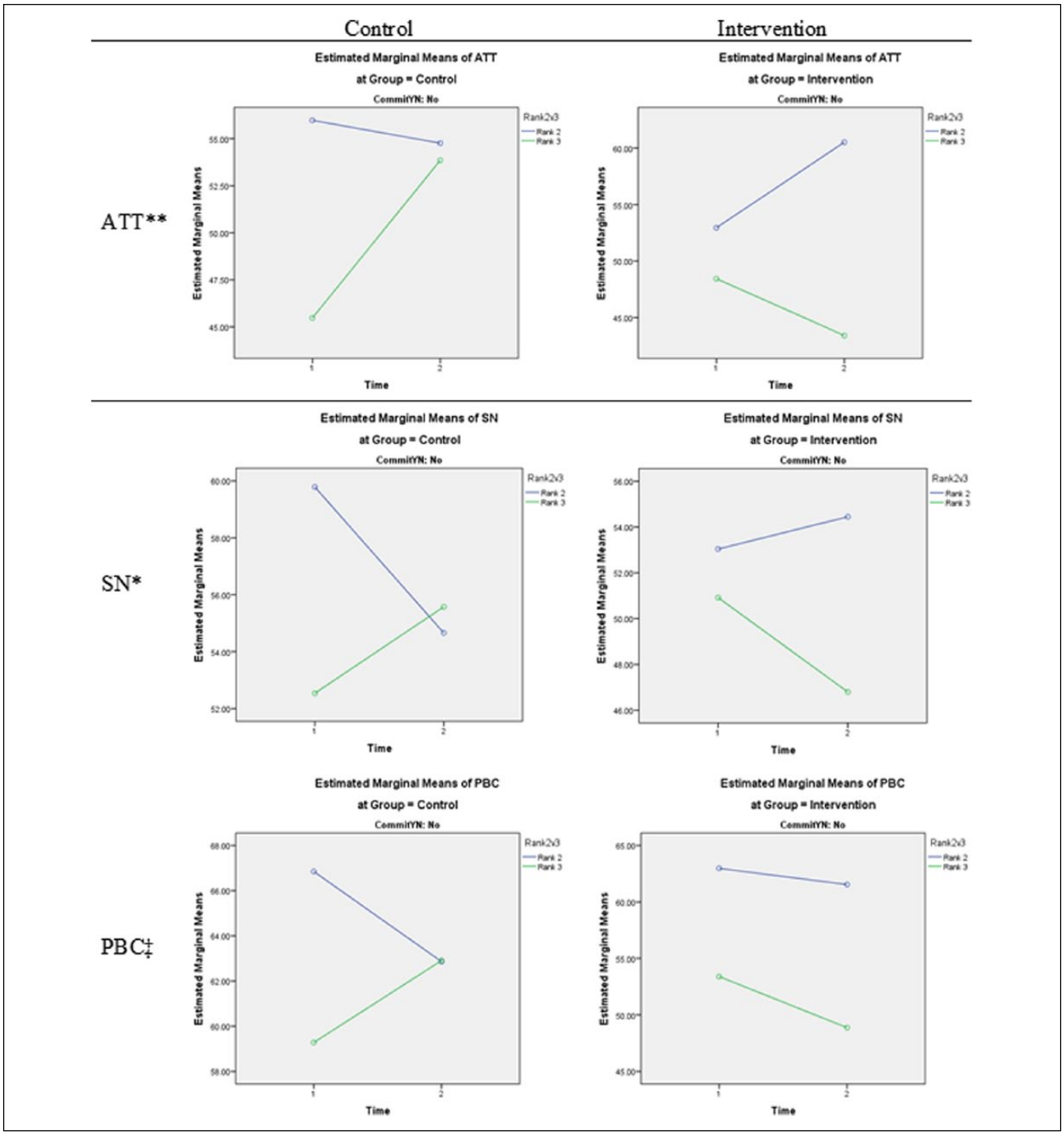

Figure 3. Participants who did not state "willing to commit" before the start of the study.
Note. ATT = attitudes; SN = subjective norms; PBC = perceived behavioral control.
†$p = .09$. *$p < .05$. **$p < .01$.

environmental organization were those who were most likely to modify their base component ratings from T1 to T2. Individuals who were "willing to commit" to supporting an organization before the study subsequently made more rigid ratings that were less susceptible to change from T1 to T2.

Study 3

Study 3 was a field experiment in which we attempted to strengthen participants' intentions to engage in a pro-environmental behavior and then assessed subsequent attitudes, subjective norms, and perceived behavioral control.

Table 2. Estimated Marginal Means, With 95% CIs.

Commitment to action	Measure	Group	*M*	*SE*	95% CI	
					Lower bound	Upper bound
Yes commitment	PBC	Control	67.316	1.607	64.146	70.487
		Intervention	64.481	1.675	61.177	67.785
	ATT	Control	63.743	1.652	60.484	67.001
		Intervention	64.780	1.722	61.385	68.176
	SN	Control	62.583	1.525	59.576	65.590
		Intervention	61.443	1.589	58.309	64.577
No commitment	PBC	Control	64.854	3.617	57.616	72.091
		Intervention	60.833	3.926	52.976	68.690
	ATT	Control	55.368	3.676	48.013	62.724
		Intervention	55.513	3.991	47.528	63.498
	SN	Control	57.221	3.391	50.436	64.006
		Intervention	53.130	3.681	45.765	60.496

Note. "Commitment to action" refers to whether participants agreed to follow-through with their intended action at the end of the study. CI = confidence interval; ATT = attitudes; SN = subjective norms; PBC = perceived behavioral control; INT = Intentions.

Method

Setting

The target behavior for Study 3 was the efficient use of "setback mode" for fume hoods in a chemistry research facility. Fume hoods are enclosed work tables that are approximately 5 ft wide and 2 ft deep in which chemistry experiments may be safely conducted. Fume hoods consume a great deal of energy because they require electricity to force air out through the roof of the building and energy to re-heat the room that houses the fume hoods. For safety reasons, fume hoods may not be turned off but, if their access windows are closed, fume hoods in this facility can be safely switched to setback mode overnight to reduce electricity use and heating.

Two areas of the facility house 32 fume hoods and were randomly assigned to the control condition. The remaining area houses 23 fume hoods and it was assigned to the intervention condition. Lab occupants rarely interact with lab users in other areas of the building.

Participants

After two preliminary drafts and pilot tests of the base components questionnaires, the final version was administered to 53 lab users during the baseline period. The follow-up questionnaire, immediately following the intervention, was completed by 41 lab users. In total, 26 lab users completed the questionnaire both at baseline and follow-up (Intervention: $n = 13$, Control: $n = 13$).[12]

Procedure

Study 3 took place in two parts: baseline and intervention. During the baseline phase, the base components questionnaire was administered to every available lab user (following written consent to participate). During the intervention phase, a researcher met with each chemistry lab research group and, after addressing a few common misconceptions about using setback mode, administered a short intention-strengthening exercise. The exercise involved two parts: asking lab users to publicly commit to using setback mode (sticking a sign to the fume hood stating "I use setback mode at night") and completing an intention-strengthening exercise.

The brief intention-strengthening exercise consisted of asking participants to (a) set a goal, (b) visualize the goal, and (c) make a plan for how to achieve the goal. The *mental contrasting with implementation intentions* method for encouraging behavior change was based the work of Gollwitzer and colleagues (e.g., Gollwitzer & Sheeran, 2006) and has been effective for changing behavior in other contexts (e.g., Stadler, Oettingen, & Gollwitzer, 2009; Stadler, Oettingen, & Gollwitzer, 2010).

Chemistry lab users in the control groups also met with the researcher but were not asked to engage in the motivational exercise or to publicly commit to using setback mode. Both groups then completed the standardized questionnaire at the end of the lab meeting.

Behavior. Before, during, and after the study, use of the setback switch for each fume hood was automatically logged in a central database. This automatically logged information was used as the measure of actual behavior of lab users during the baseline and intervention phases, as well as several months after the intervention. In particular, the dependent variable was the state of each fume hood's setback switch each night (i.e., at 3 a.m., when no one was in the lab).

Results

Base Components Questionnaire

Attitude (ATT) items, $n = 6$ (including one reverse-scored item), showed good reliability as a subscale (Cronbach's

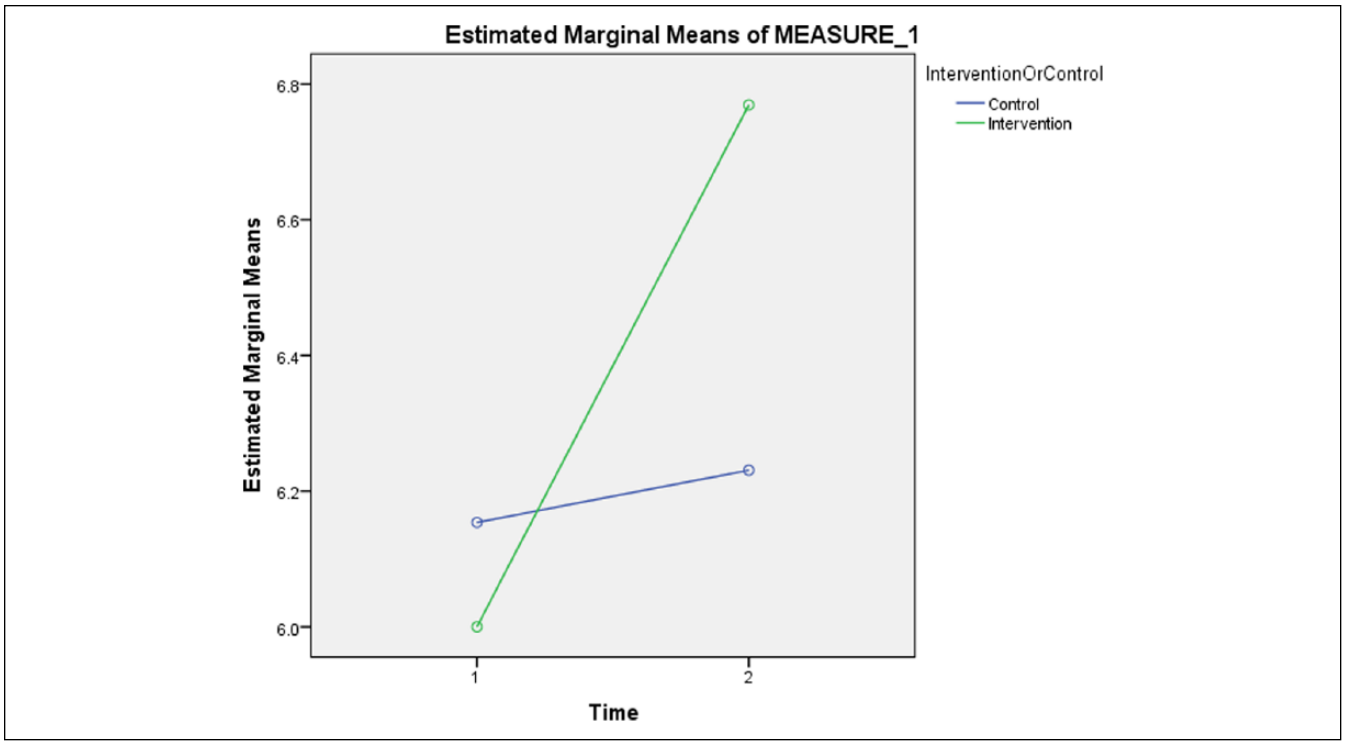

Figure 4. Perception that health and safety officer approves of using setback mode at night.
Note. Interaction between Time and Condition for the SN item "approval of behavior by health and safety officer." Participants who engaged in an intention-strengthening exercise to encourage use of the setback switch, subsequently displayed a larger shift toward endorsing this subjective norm item than participants in the control group. SN = subjective norms.

$\alpha_{T1} = .72$, $\alpha_{T2} = .82$). Therefore, a composite ATT variable was created (i.e., the mean of all six ATT items). Subjective norms were measured with three SN items: "Most graduate students use setback mode when they leave for the lab for the day . . . [7 = *agree*] to [1 = *disagree*]," "My direct supervisor in the lab would approve of me using setback mode when I leave the lab for the day . . . [7 = *agree*] to [1 = *disagree*]," and "[This university's] occupational health staff would approve of me using setback mode when I leave the lab for the day . . . [7 = *agree*] to [1 = *disagree*]." Perhaps because of the small number of items, the SN scale was not reliable at T1 (Cronbach's $\alpha = .56$) or T2 ($\alpha = .58$). Therefore, without combining the three items together, each item was examined individually, as a sub-measure of subjective norms (each covering a unique aspect of the construct).

PBC was not a useful measure for this particular behavior because of a strong ceiling effect (ratings were most commonly seven out of seven). Participants perceived the behavior as easy and completely "under their control" from the beginning of the study, therefore, there was little room for changes in this perception.

Repeated measures ANOVA. To determine whether participants in the intervention group developed more positive attitudes or perceptions of subjective norms than participants in the control group, a one-way repeated-measures ANOVA was conducted for each variable (ATT, Supervisor Approval, Health and Safety Approval, Graduate Student Behavior).

Ratings of one subjective norm (perceived approval of the behavior by the health and safety officer) increased significantly more in the intervention than control group. For this injunctive norm, the interaction between Time and Condition was significant, $F(1, 24) = 4.91$, $p = .04$, partial $\eta = .17$. A significant main effect of Time on its own was found, $F(1, 24) = 7.33$, $p = .012$, partial $\eta = .23$, but no significant main effect of Condition on its own occurred, $F(1, 24) = .43$, $p = .52$, partial $\eta = .02$. That is, participants in both groups increased their ratings of this injunctive norm, but the increase was significantly greater in the intervention group than the control group. This interaction is depicted in Figure 4. Repeated measures ANOVAs for attitudes and the other two SN items did not show significant main effects or interactions ($p > .05$). Estimated marginal means, standard errors, and 95% confidence intervals for all groups are presented in Table 3.

Behavior. During the baseline period, use of setback mode was significantly correlated with attitudes ($r = .55$, $p < .01$), perceived supervisor approval ($r = .43$, $p < .05$), and perceived use of the switch by other graduate students ($r = .44$, $p < .05$). During and after the intervention period, use of setback mode was borderline significantly correlated with

Table 3. Estimated Marginal Means With 95% Confidence Intervals for Each Measure.

Measure	Group	Time	*M*	*SE*	95% CI	
					Lower bound	Upper bound
ATT—composite measure	Control	1	5.28	.34	4.58	5.98
		2	5.37	.31	4.73	6.02
	Intervention	1	5.40	.34	4.66	6.06
		2	5.67	.31	5.02	6.31
SN—"Most graduate students use setback mode when they leave for the lab for the day"	Control	1	3.70	.60	2.45	4.93
		2	3.85	.46	2.91	4.79
	Intervention	1	4.00	.60	2.76	5.24
		2	3.62	.46	2.68	4.56
SN—"My direct supervisor in the lab would approve of me using setback mode when I leave the lab for the day"	Control	1	5.62	.32	4.96	6.27
		2	6.00	.40	5.18	6.82
	Intervention	1	6.23	.32	5.58	6.89
		2	6.39	.40	5.57	7.20
SN—"[This university's] occupational health staff would approve of me using setback mode when I leave the lab for the day"	Control	1	6.15	.26	5.61	6.70
		2	6.23	.20	5.82	6.65
	Intervention	1	6.00	.26	5.46	6.54
		2	6.80	.20	6.35	7.18

Note. CI = confidence interval; ATT = attitudes; SN = subjective norms.

attitudes ($r = .35$, $p = .07$) but not any of the three SN items (all $ps < .05$, $n_{hoods} = 28$, $n_{nights} = 89$).

Discussion

Lab users who set an intention to use setback mode on their fume hoods subsequently increased their perception that the university's occupational health and safety officer approved of the behavior (an important social referent, as determined by preliminary interview). During the intervention period, both the intervention and control groups were told that the occupational health and safety officer approved of using the setback switch overnight (even if a chemical reaction was happening in the fume hood). However, only participants who also engaged in the intention-strengthening exercise (including *public commitment* and *mental contrasting with implementation intentions*) significantly changed their perceptions. Those who were not instructed to set an intention did not change their perceptions about the health and safety officer's approval. This, once again, suggests that intentions affect some aspects of subjective norms in a reverse-causal manner.[13]

Although perceptions of approval by the university's health and safety officer may have increased significantly for the intervention group, this factor did not appear to play a role in the actual use of the setback switch. For the subsample of participants who chose to indicate which fume hood they used at baseline or post-intervention, other factors, such as attitudes toward using the switch, approval of the behavior by their direct supervisor, and the perceptions of other graduate students' use of the switch, were more strongly related to actual use of the setback switch.

Attitudes toward use of setback mode, in particular, were most strongly related to actual use of the switch during each time period. Perceived approval of the behavior by the health and safety officer was not correlated with behavior at any of the three time points. This could indicate that this idea was less important because it was not involved in the decision to act. As in Study 2, perceptions that were relevant to the behavior were less flexible and changeable than perceptions that were irrelevant to the behavior. Weakly held beliefs, and beliefs of people who are not highly involved in a behavior, tend to be more easily changed than strongly held beliefs (Petty, Haugtvedt, & Smith, 1995). Attitudes that are deemed important to an individual are more resistant to persuasion than unimportant attitudes (Jacks & Devine, 2000; Zuwerink & Devine, 1996).

Notably, this initial field test of the potential reverse-causal of effect of intentions on base components was limited due to the specific sample that was studied and the focus on a single easy behavior. Additional future testing should be conducted using a larger and more diverse sample performing a variety of behaviors, including some that may be influenced by PBC. This was a first attempt at conducting an experimental field study, but more research is needed to confirm our conclusions. Despite these limitations, we were encouraged to find partial support for our hypothesis in Study 3.

General Discussion

Taken together, results from Studies 1 to 3 generally support the hypothesis that one's formed intentions may affect the SN and ATT in a reverse-causal direction. Therefore, the TPB model of behavior should be updated to include a

reverse-causal relation between intentions and those two base components. We found weak evidence for a reverse-causal PBC–INT relation and, therefore, this piece should be studied further before conclusions can be drawn. Overall, however, a reciprocal TPB model is plausible.

This revision to the TPB could have profound impacts on how models of TPB constructs are analyzed. Endogeneity bias stemming from reverse causality has the potential to alter results of regression analyses. Indeed, multitudes of previous TPB studies may include ordinary least squares (OLS) regressions that are fundamentally misspecified due to an endogeneity bias. We suggest researchers take note of this possibility before analyzing future TPB-related data.

One particularly interesting addendum to the findings of Studies 2 and 3 is that the base components most likely to be influenced by intentions are those that are least likely to be relevant to actual behavior. Perhaps the best explanation for this is that important perceptions are least susceptible to change. In this case, justifying behavior using certain base components may raise the importance of those base components. If, for example, a person thinks (consciously or unconsciously) "I am doing this behavior primarily because everyone else is doing it," then the importance of subjective norms is mentally increased for this person and, thus, the perception of subjective norms will be less likely to change as a result of setting an intention. Attitudes (e.g., "this behavior is important") and perceived control (e.g., "this behavior is easy"), on the other hand, might be less important and, thus, potentially more likely to change. This idea stems from research on attitudes, in which stronger (and more central) attitudes are less likely to change than weaker (and more peripheral) attitudes (Jacks & Devine, 2000; Petty et al., 1995; Zuwerink & Devine, 1996).

One limitation of the present study was that a reverse-causal relation was not clear between PBC and INT in any of our three experiments. Although not all base components play a role in every behavior, we also found that PBC was an unreliable measure with a ceiling effect for Studies 1 and 3. Partially because of the nature of the construct (consisting of two quite different subparts—control and ease), and partially because of the nature of the behaviors being measured (objectively easy or consisting of several different options), PBC was not a useful measure for these two studies.

Although difficult to measure, PBC is a key aspect of the TPB. Studies 1 and 3 were, therefore, limited in what they could say about the relation between intentions and TPB base components. Study 2 of this dissertation, however, reformulated the PBC subscale and made use of specific behaviors that varied in difficulty, thus allowing a more reliable PBC measure. That study found a borderline significant influence of INT on PBC. Future research could build on the Study 2 strategy for measuring and testing PBC within the TPB. Based on the current series of studies, however, we cannot definitively conclude that intentions influence this base component in a reverse-causal manner.

Another limitation was that all three studies were constrained to specific behaviors within student populations. Although studies of the traditional TPB model show that it is similarly applicable for diverse groups of people performing wide ranges of behaviors, more research should be conducted on the reciprocal TPB model to validate the conclusions from the current series of studies. This is the first demonstration of a potential reciprocal model within the TPB, and results of Study 3 (which takes place outside the lab with graduate students rather than undergraduates) are potentially promising but nonetheless require further investigation.

The TPB is perhaps the most well-known and thoroughly investigated explanation for action (or inaction) in psychology. With well over 1,000 studies evaluating and applying the theory, its influence is far-reaching. Yet, alternatives to the basic premise of the theory and the implied causality among its constructs had not been well studied because the standard view of causality has generally been assumed.

Often, theories in psychology are presented and tested exclusively with cross-sectional self-report data. Many of them propose relations among constructs that are unidirectional or contain (implied or explicit) causal pathways. However, the "proof" for these pathways stems from survey data and statistical analyses rather than experimental manipulation of independent variables and observation of actual behavior. Experiments that assess actual behavior and employ systematic experimentation may be challenging to construct, and require considerable creativity, but ultimately offer the highest level of support for a psychological theory to explain human behavior. Future psychology theories should more often include directly observed behavior and controlled experiments (Baumeister, Vohs, & Funder, 2007).

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Notes

1. We recognize that several additional constructs have been proposed to increase the predictive power of the TPB (e.g., identity; Hagger, Anderson, Kyriakaki, & Darkings, 2007) and, although these are likely to be useful additions, the purpose of the present studies was to examine the causal links between the original base components.
2. In their original conception of the theory of reasoned action, Fishbein and Ajzen (1975) did propose a feedback loop in which actual behavior influences attitudes and subjective norms to change, but do not mention a possible reciprocal relationship between intentions and attitudes or subjective norms. Furthermore, this feedback loop was dropped from later conceptualizations of the TPB.
3. Based on correlation coefficients found in similar cross-lagged correlation studies (e.g., correlations varied around approximately $r = 0.3$ for Tyagi & Wotruba, 1993), our sample size surpassed the minimum required ($n = 111$) for a cross-lagged correlation analysis with power of 0.95, α of 0.05.
4. The questionnaire was based on the procedure suggested by Fishbein and Ajzen (2010) and underwent two preliminary drafts that were each pilot tested with small groups of participants drawn from the same participant pool as the final study ($n = 20$ and $n = 26$). The questionnaire was designed for brevity, reliability, and validity. Because of the skewness of some answers in the second draft of the questionnaire, the higher-range scores permitted in the final questionnaire was extended and the lower range was reduced. The final questionnaire is available in Online Appendix 1.
5. An extreme score ($z > 3.0$) indicated that participants provided extreme answers on each question within a scale. This likely occurred because the participant did not understand the question or simply wanted to complete the survey with as little effort as possible. Only eight participants were excluded for this reason (one had also failed an attention item and completed T1 in less than 7 min, and another also completed the survey in less than 7 min). Analyses conducted with and without extreme scorers did not differ significantly, with the possible exception of PBC. When extreme scorers were included, the PBC–INT cross-lagged correlations were nearly identical in strength as when they were excluded, but the reverse-causal correlation changed from borderline significant ($PBC_{T2}INT_{T1}$, $r = .11$, $p = .06$) to significant ($PBC_{T2}INT_{T1}$, $r = .12$, $p = .04$).
6. T1 = Time 1, T2 = Time 2. For example, INT_{T2} refers to *intentions at* Time 2.
7. Participants in Study 1 were excluded from taking part in Study 2.
8. Based on the medium-sized correlation coefficients found in Study 1, our sample size surpassed the minimum required ($n = 84$) for a repeated measures analysis of variance examining within-between interactions (two groups with two measurements each), with a power of 0.95, α of .05 and effect size of Cohen's $f = .20$.
9. The questionnaire for Study 2 underwent two drafts, each followed by pilot testing on an independent sample, drawn from the same population as the final study ($n = 90$ and $n = 94$). Pilot testing ensured sufficient reliability, particularly for the PBC subscale, and allowed for an assessment of the randomization and technical programming requirements of the study. The final questionnaire can be seen in Online Appendix 2.
10. Participants in the intervention group were guided to select the option which they ranked highest (i.e., number two). This was accomplished by presenting the higher-ranked option first and in a brighter font color. If participants in the intervention group nevertheless insisted on selecting the lower-ranked option, they received the message, "Error . . . Sorry, [organization ranked third] is no longer a partner for this study but we haven't had a chance to overhaul the questionnaire yet. Would you mind supporting the [organization ranked second] instead? . . . Thank you." Then, they were asked to click the box next to the statement "I will support [organization ranked second] at the end of the study by [doing the behavior associated with second-ranked organization]." In this way, we did not have to exclude participants for choosing the lower-ranked option, and all participants in the intervention group made identical choices (a requirement for a truly randomized controlled experiment). This potentially diluted our effect and reduced the power of our experiment to find a significant result but also ensured an unbiased sample of participants in the experimental condition.
11. Of the careless responders, $n = 13$ failed more than three attention items at T1 or T2, and $n = 6$ completed T2 extremely quickly (within the top 2% shortest times, less than 7.43 min).
12. Based on the medium effect size of significant results found in Study 2, we aimed to recruit at least 54 participants for our planned repeated measures ANOVA for Study 3 (to achieve power of 0.95 with $\alpha = .05$ and Cohen's $f = .25$). Although nearly the entire population of lab users participated in Study 3, we were unable to meet the minimum sample size required for a power of 0.95. The achieved power of Study 2 for comparison between groups over time was 0.69.
13. Participants' ATT, SN, and PBC about setback mode were assessed immediately after their lab meetings, before they could actually use setback mode. Therefore, the change in ratings for "Health and Safety Officer approval" could only be attributed to the intention-strengthening exercise, and not to behavior change.

Supplemental Material

Supplemental material is available online with this article.

ORCID iD

Reuven Sussman https://orcid.org/0000-0002-0466-4408

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