The unappreciated relevance of auxiliary assumptions for evaluating theory-based interventions in health psychology

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Abstract
The use of theory in health behavior change interventions has been recently questioned with mixed results found for theory-based intervention effectiveness. But theory testing in intervention depends on not only theoretical assumptions, but on auxiliary assumptions too. Specifically, auxiliary assumptions are required to traverse the distance from nonobservational terms in theories and observational terms at the level of the empirical hypotheses in interventions. We believe intervention failures are often due to flaws in auxiliary assumptions rather than assumptions at the theoretical level. We use the theory of planned behavior to illustrate how the consideration of these auxiliary assumptions is important to appraise the effectiveness of interventions informed by theory. We hope that bringing attention to the importance of auxiliary assumptions provides a more nuanced and accurate appraisal of theory utility.

Keywords
auxiliary assumptions, health behavior change, intervention effectiveness, theory of planned behavior, theory-based interventions

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Participation in health risk (e.g., smoking, alcohol consumption, sedentary behavior) and health enhancing (e.g., physical activity, fruit and vegetable consumption) behaviors can have significant effects on health outcomes (Bauer et al., 2014; Go et al., 2014; Rhodes et al., 2017; Ronksley et al., 2011). Behavioral interventions developed to either promote health enhancing behavior or reduce excessive health risk behavior can positively influence such outcomes. To facilitate intervention development, health psychological theories can be used to underpin interventions. These theories specify the key modifiable determinants underlying health behavior and outline the mechanisms through which interventions exert influence on behavior (Hagger et al., 2020; Hardeman et al., 2005). Recent work has questioned the utility of underpinning interventions with theory. Indeed, some primary and meta-analytic studies have demonstrated no advantage of theory-based interventions when compared to interventions lacking a theoretical base (Prestwich et al., 2014; Rhodes et al., 2017). This led to some questions regarding the effectiveness and use of theory in intervention development: if theory-based interventions do not lead to successful health behavior change, why should such theory be used?

We believe that such conclusions are, at best, premature. Interventions based on theory depend not only on the theoretical assumptions but also on the auxiliary assumptions (St Quinton et al., 2021; Trafimow, 2015). Not considering auxiliary assumptions can have important implications for theory effectiveness. The purpose of this article is to highlight the importance of auxiliary assumptions in theory testing in intervention. To do this, we first introduce theory-based interventions and the concern over effectiveness. We then introduce auxiliary assumptions in the context of theory falsification and outline how these assumptions are important in theory testing. Following this, we introduce the theory of planned behavior (TPB; Ajzen, 1991) and use the theory to demonstrate how auxiliary assumptions play an important role in appraising intervention effectiveness. We hope the article identifies important issues and prevents researchers from prematurely reaching potentially inaccurate conclusions about the utility of theory in health interventions. Only when strong auxiliary assumptions are attached to theoretical propositions can accumulated evidence falsify theory.

**Does theory influence intervention effectiveness?**

Interventions designed to change health behaviors can have important consequences for health and well-being. For example, successful interventions can reduce mortality rates and prevent the onset of chronic conditions (Michie et al., 2011). To supplement the development of interventions, the use of theory is included in several intervention frameworks and planning models such as the Medical Research Council (Craig et al., 2008) and intervention mapping (Bartholomew et al., 2006). The inclusion of theory is based on the premise that success is more likely in interventions based on theory than in interventions lacking a theoretical base. Behavior change theories can predict and explain why an individual engages or does not engage in a health behavior (Conner & Norman, 2005). These theories can provide the basis from which interventions aimed at changing behavior can be developed (Noar & Zimmerman, 2005). More specifically, theory enables the understanding of the causal mechanisms of behavior and informs...
how intervention development should be approached (Michie et al., 2008). If specific theoretical determinants exert influence on a particular health behavior, interventions should target such determinants to promote behavior change. This, in turn, should increase the effectiveness of interventions, as key determinants will be targeted (Glanz & Bishop, 2010; Hardeman et al., 2005). The inclusion of theory also enables an understanding of what works, what does not work, and why this may be so (Michie et al., 2008).

Many interventions have been adopted to change health behavior. Meta-analytical reviews synthesizing the evidence of theory-based interventions have found mixed results. Some interventions based on theory have demonstrated greater effectiveness than interventions not adopting a theoretical base (e.g., Bluethmann et al., 2017; Taylor et al., 2012; Webb et al., 2010). For example, Taylor et al. (2012) reported an effect size of $d = 0.34$ when theory was used to develop interventions compared to an effect size of $d = 0.21$ when theory was not adopted. However, others have found little or no effect from theory-based interventions (e.g., Ayling et al., 2015; Dalgetty et al., 2019; Diep et al., 2014; Prestwich et al., 2014; Rhodes et al., 2017). Perhaps more worryingly, some research has shown atheoretical interventions to be more successful than theoretically informed ones (Gardner et al., 2011; Mehtälä et al., 2014). Due to these inconsistent findings, the importance of psychological theory in informing health behavior change interventions has been questioned (Hagger & Weed, 2019).

There are two main reasons why theory-based interventions may not work. First, the theory guiding the intervention may be incorrect. That is, the theorized psychological determinants do not determine the behavior. Interventions modifying such determinants would therefore fail to cause behavioral change. Second, the theory may not be applied correctly. The application of theory is, of course, important when appraising how accurate the theory is. We can see this when considering Newton’s theory in the development of a rocket ship; if the rocket does not reach escape velocity, we may be inclined to blame the theory, that is, believe that Newton’s laws are false. Alternatively, we could blame how the theory was applied. For example, an unbalanced force may not be exerted to the rocket, thereby disregarding Newton’s first law of motion. The same logic applies to the role of psychological theory in intervention. That is, we need to look at the application of the theory rather than the theory itself when examining effectiveness. To do so, one needs to consider not only the theoretical assumptions but also assumptions that are auxiliary to the theory. Auxiliary assumptions are usefully understood in the context of theory falsification (Trafimow, 2009), and so we introduce this first.

**Theory falsification**

Falsification has a long history in science but was brought to attention in the 20th century by Popper (1959). He emphasized the asymmetry between the informativeness of confirmatory and falsifying evidence in theory testing. No amount of confirmatory evidence implies that the theory under test is true. Inferring the truth of a theory from confirmatory evidence is committing the fallacy of affirming the consequent. This can be demonstrated by considering the following: (a) premise 1: if the theory is true, the observation should be true; (b) premise 2: the observation is true; (c) premise 3: therefore, the theory is true.
An obvious problem with this proposition is that a successful prediction may have nothing to do with the theory. For example, we may predict that excessive alcohol consumption contributes to higher income and, upon seeing a wealthy person, conclude that they are an excessive drinker. Repeated empirical successes therefore do not necessarily provide support for the theory. In contrast, it is possible to falsify a theory by denying the consequent. We can see this by considering the following: (a) premise 1: if the theory is true, the observation should be true; (b) premise 2: the observation is not true; (c) premise 3: therefore, the theory is not true.

We can see denying the consequent alters the second premise by focusing on theory falsification rather than theory confirmation. Unlike theory confirmation, a single piece of evidence can result in falsification (Popper, 1959). Accordingly, the proposition is that scientists should focus on disconfirming theories, and scientific progress is made when better theories replace falsified theories. However, Duhem (1954) and Lakatos (1976) identified a complication to this assumption. They pointed out that predictions not only come from the theory, but also require auxiliary assumptions. Thus, any failed prediction can be blamed on either the theory or on at least one auxiliary assumption, and if an auxiliary assumption is at fault, the theory has not been falsified. We will now discuss auxiliary assumptions in greater detail.

**Auxiliary assumptions**

Theory-based predictions in any area of science rely on two levels of inferences. The first is the theoretical level, where theories contain nonobservational terms. The second is the empirical hypotheses, which contain observational terms. But we need a way to get from the nonobservational theoretical terms to the observational terms in empirical hypotheses. Enter auxiliary assumptions. Auxiliary assumptions are needed to bridge the gap between the nonobservational terms at the theoretical level, and the observational terms at the level of the empirical hypotheses. These assumptions are distinct from theoretical assumptions but are nevertheless important external conditions required for the theory to make empirical predictions and assumptions to be tested. When appraising the utility of a theory, one must therefore consider both theoretical assumptions and auxiliary assumptions; it does not suffice to consider only the theoretical assumptions. In doing so, an empirical failure can be blamed on either the theory or at least one auxiliary assumption (Duhem, 1954; Lakatos, 1976; Meehl, 1978; Quine, 1951; Trafimow, 2009, 2017; Tunç & Tunç, 2020). Thus, a failed prediction does not necessarily mean the theory is poor (Earp & Trafimow, 2015). Similarly, an empirical victory can be credited to theory or auxiliary assumptions (Trafimow, 2017).

The role of auxiliary assumptions is important in psychological research. Let’s take a look at the predictive utility of theories concerning behavior change. These theories suggest the causal mechanisms through which determinants influence behavior. A theoretical assumption may be that a person’s attitude and intention influences behavior. The theory therefore includes nonobservational terms, for example, attitude and intention. There are also observational terms required to test these hypotheses. For example, observable check marks are alleged to measure, say, attitude and intention. But to test the theoretical assumptions, in this case that behavior is influenced by attitude and intention, it is
important that, amongst other things, attitude and intention scales accurately represent an individual’s attitude and intention. Now, no theory would explain whether check marks on the scales accurately indicate people’s standings on attitude and intention; rather, the validity of the scales depends on auxiliary assumptions linking theoretical terms to how they are measured or manipulated (Trafimow, 2012). Without a way to enable the linking, that is, without auxiliary assumptions, there would be no way to traverse the gap between nonobservational terms in theories and observational terms in empirical hypotheses.

Consider another example in the attitude research. The importance of attitude on behavior was questioned by Wicker (1969). At the time, the literature was replete with low attitude–behavior correlations. However, Fishbein and Ajzen (1975) identified an important auxiliary assumption attached to this prediction; attitude must be measured with the same target, action, context, and time as behavior. Now, this auxiliary assumption said nothing about the importance of attitude at the theoretical level (attitude was always an important construct). Rather, this specification provided important information required to test the hypothesis at the empirical level. The introduction of this auxiliary assumption opened the door for researchers to confirm the relationship between attitude and behavior and obtain much more impressive attitude–behavior correlations than was hitherto possible. The reinstation of the attitude construct would not have been possible without the inclusion of the auxiliary assumption.

To summarize, theoretical predictions derive not only from a given theory, but from a combination of theoretical assumptions and auxiliary assumptions. Specifically, auxiliary assumptions traverse the distance from nonobservational terms in theories to observational terms in empirical hypotheses. Failed empirical predictions can be blamed on either the theory (e.g., poor theoretical assumptions) or one of the auxiliary assumptions (e.g., poor measurement). It is therefore important to consider not only theoretical assumptions but auxiliary assumptions, too.

Applicability to interventions

We have highlighted the role that auxiliary assumptions play in theory prediction. But the application of auxiliary assumptions is not only relevant for theory prediction; it is important that interventions developed using theory also consider auxiliary assumptions (St Quinton et al., 2021). To see why, consider that interventions involve something observable, whether it is a marketing campaign, policy change, or other kind of treatment designed to induce behavior change. Therefore, just as it is necessary to conjunct theory with auxiliary assumptions to traverse the gap between nonobservational terms in theories and observational terms in empirical hypotheses, it is similarly necessary to conjunct theory with auxiliary assumptions to traverse the gap between nonobservational terms in theories and observables pertaining to interventions.

In turn, if an intervention fails, there are two plausible places to put the blame. First, the theory might be wrong, thereby causing the intervention to fail. Second, at least one auxiliary assumption may be wrong, thereby causing the intervention to fail through no fault of the theory. Therefore, effective theory-based interventions depend not only on the quality of the theory, but on the quality of the auxiliary assumptions too. In the subsequent section, we consider the TPB as an illustration.
The theory of planned behavior

The TPB is a popular social cognition theory that has been widely used in health behavior change research. The theory suggests the causal pathway from psychological determinants to behavior. The theory assumes behavior to be influenced proximally by intention, which represents the extent to which a person is motivated to engage in the behavior. The theory suggests intention has three underlying determinants in attitude, subjective norm, and perceived behavioral control. Attitude refers to a person’s evaluation of the behavior, subjective norm concerns the perceived influences of other people, and perceived behavioral control relates to the perceived ease or difficulty of undertaking the behavior. Attitude, subjective norm, and perceived behavioral control are underpinned by behavioral, normative, and control beliefs, respectively. Perceived behavioral control also moderates the influence of intention on behavior; intention is more likely to be carried out if a person perceives having greater control over the behavior.

The theory has fared well in meta-analytic studies assessing its predictive validity in the health domain (e.g., Armitage & Conner, 2001; McEachan et al., 2011; Rich et al., 2015). However, the theory has demonstrated mixed success in terms of change. Some interventions adopting the theory have demonstrated change (e.g., Anderson et al., 2005; Armitage & Talibudeen, 2010; Norman et al., 2018; White et al., 2010) whereas others have not (e.g., Sniehotta, 2009; St-Pierre et al., 2017; Williams et al., 2015). A meta-analytic synthesis conducted by Steinmetz et al. (2016) found effect sizes of 0.34 and 0.50 for interventions in changing intention and behavior, respectively. Similarly, Webb and Sheeran (2006) showed medium-to-large changes in intention ($d = 0.66$) are associated with small-to-medium changes in behavior ($d = 0.36$). As such, some have not only questioned the utility of the theory but have suggested it should be retired (Sniehotta et al., 2014). We believe such conclusions cannot be made without considering the auxiliary assumptions attached to the theory in intervention. We will now outline some of these assumptions.

Theory of planned behavior intervention auxiliary assumptions

A significant issue in assessing the usefulness of the TPB in intervention is how the theory was used. Interventions must target a relevant determinant (or combination of determinants) specified in the theory. That is because the importance of the underlying determinants need not be equal in all behaviors, persons, or populations (Trafimow & Finlay, 1996). For example, intention to engage in one behavior may be influenced by attitude whereas subjective norm could be the main driver of another behavior. Fishbein and Ajzen (2010) provide detailed guidelines on the formative work required to understand the contribution of determinants. Following this work, an intervention designer would understand which determinant(s) should be the focus of intervention.

Despite the importance of this formative work, it is surprising how infrequently this is undertaken, especially when compared to the number of studies that have adopted the theory. This may lead to interventions targeting psychological determinants irrelevant to the target behavior or population. For example, change is unlikely if an intervention addresses normative factors, but intentions are influenced more strongly by attitude. To
illustrate this, Stasson and Fishbein (1990) had shown seat belt use in safe driving situations to be influenced by attitude and seat belt use in risky driving situations to be influenced by normative factors. To confirm these predictions, Trafimow and Fishbein (1994) manipulated attitude towards seat belt use in both situations and, in accordance with the initial predictions, found these manipulations had a greater impact on intentions to wear a seat belt in safe than in risky driving situations. Undertaking formative work to understand what to change ensures the intervention provides relevant psychological treatment. An intervention not applying the theory correctly has clear implications for theory effectiveness. It is therefore important to consider how theory was used in the intervention.

Despite this importance, one cannot establish effectiveness if a relevant determinant is not targeted or if the theory is not applied correctly. Yet, despite such importance, these issues are not part of the theoretical propositions outlined by the TPB; they constitute auxiliary assumptions. To be clear, the TPB outlines the causal influence of attitude, subjective norm, and perceived behavioral control to behavior through intention. Whether the theory is applied correctly at the empirical level, although needed to test these hypotheses, is nevertheless auxiliary to the theory itself. Failure to implement these is no fault of the theory and cannot provide a valid assessment of its utility. It is therefore important to consider such auxiliary assumptions to appraise theory effectiveness. We will now consider some auxiliary assumptions attached to intervention delivery.

A significant challenge for intervention designers in promoting health behavior change is modifying the theorized determinants. This is important if the theoretical propositions are correct, that is, that changing specific psychological determinants will lead to behavior change. This is also key if the theory is going to be put to the test. Clearly, it is not possible to test whether intention results in behavior change without first changing intention. And to change intention, we need to modify at least one of the underlying determinants. The designer must therefore select an appropriate strategy (or strategies) to include in the intervention. The taxonomy of behavior change techniques developed by Michie et al. (2013) provides a toolbox of strategies. The decision as to which of the 93 strategies to select could be facilitated by drawing on recent work attempting to map techniques onto psychological determinants (Carey et al., 2018; Connell et al., 2018). The assumption of this work is that an intervention designed to modify a specific determinant would fare better if one of the recommended strategies is used. For example, Carey et al. (2018) identified eight techniques that could effectively modify a person’s attitude, such as providing health consequences or incentivizing behavioral participation. Selecting an appropriate strategy (or strategies) is especially important given its influence on intervention effectiveness (McEwan et al., 2019). An intervention targeting a theoretical determinant, such as attitude, but adopting a poor strategy, is unlikely to demonstrate positive outcomes. But this failure is not a theoretical issue. To be clear, the TPB posits change will occur if specific determinants are altered. Now, failure to change these determinants is not a fault of the theory but rather indicts a poor auxiliary assumption attached to the theory in relation to intervention (Trafimow, 2015). Failure to change attitude, for example, might not say anything about the effectiveness of the TPB in behavior change; it might say more about the intervention applied to engender change. That the treatment successfully influences the crucial determinant is another auxiliary
assumption needed to traverse the distance from the nonobservational theoretical terms to the observational terms in intervention hypotheses.

Other auxiliary issues concerning intervention delivery also exist. There are many ways to communicate an intervention, and each delivery mode has potential pros and cons. Face-to-face delivery requires participants to be present during the intervention, but personalized treatment can be provided using this modality. Online modalities are convenient and have widespread reach, but this delivery mode is reliant on technological availability and competence (Erbe et al., 2017). Other factors requiring consideration are intervention dose and frequency. Modifying attitude towards one health behavior may take a single session over a couple of weeks whereas changing attitude towards another health behavior could require many sessions over several months. These issues are, of course, important in influencing intervention effectiveness, though the theory says nothing about them. Interventions delivered using a website could prove unsuccessful if the sample have limited access to the internet. Similarly, attempting to modify erroneous deep-seated attitudes may fail to cause change if delivered on only a single occasion. But hopefully it is clear that despite influencing effectiveness, these are auxiliary assumptions attached to intervention. Instead of providing a test of the theoretical assumptions, such as whether perceived behavioral control changes intention or whether positive intentions translate into behavior, intervention effectiveness may be strongly influenced by auxiliary assumption quality. Appraising the effectiveness of the TPB within intervention therefore requires consideration of these auxiliary assumptions. It is unsound to draw conclusions about the theory without proper consideration of auxiliary assumption quality.

An intervention designer may carefully consider all of the above, yet behavior change is still lacking. The degree to which an intervention is delivered as intended by the designers is another important issue (Dusenbury et al., 2003). The deliverer may not implement the intervention correctly in practice and therefore experience challenges to fidelity. It is also important that participants respond to and engage with intervention material (Hasson et al., 2012). The intervention may be delivered accordingly, but the information may not be acknowledged, or relevant activities part of the strategy may not be undertaken. Consider the strategy of self-monitoring, which requires participants to monitor how often they engage in the behavior. Now, this strategy can alter a person’s perception of control; successful behavioral accomplishments increase the amount of control one perceives to have. But participants may not actually record their behavior, or the intervention deliverer may not correctly instruct participants on the self-monitoring requirements. On these occasions, intervention effectiveness can be influenced, but this is not necessarily a consequence of the underlying theory. Instead, fault lies with the way the intervention was delivered. This therefore represents auxiliary assumptions attached to intervention delivery when testing the theory. The designers need to make auxiliary assumptions that traverse the gap from what they intend to theoretically manipulate (e.g., perceived behavioral control) to whether the implemented delivery actually accomplishes that. Of course, it is important to also consider the auxiliary assumptions previously outlined: that perceived behavioral control is a relevant determinant underlying the behavior; that self-monitoring is an appropriate strategy; and that a relevant mode and frequency is adopted. Only when such auxiliary assumptions are considered can assumptions at the theoretical level be tested.
We have suggested auxiliary assumptions need to be considered when testing theory in intervention, and that one of the main issues is the inability to change psychological determinants. To demonstrate this point, Trafimow (2015) provides an example relating to increasing broccoli consumption through attitude change. He suggests that if we can somehow manage to make everyone like eating broccoli through making attitude towards consuming it more positive, then behavior change is likely to occur (assuming relevant control and normative influences). This may prove to be a difficult undertaking given the (potential) unpleasant taste of broccoli. But this problem is not with the theory; it is with knowing how to make people like eating broccoli. It is much easier to speculate that broccoli eating would increase if people’s attitudes towards eating broccoli could be made positive than it is to figure out how to make people like eating broccoli. But we can only test the theoretical assumption by modifying attitude in intervention. The problem, therefore, is not with the theory, but the auxiliary assumptions attached to the theory in intervention.

We can see how the TPB’s utility can be misrepresented by examining an intervention conducted by Sniehotta (2009). The intervention was developed to change university students’ attendance at sports facilities. The intervention successfully managed to change intention, but behavior change was not seen in recorded attendance. It was therefore concluded that the TPB did not suffice in guiding behavior change interventions. However, as Ajzen (2015) pointed out, closer inspection of the formative data suggested that, despite being motivated to attend the facilities, perceptions of control were weak. Focus should therefore have been on ensuring intention translation was possible by attending to issues of control. Additionally, the information provided in the intervention to modify cognitions was relatively poor (Ajzen, 2015). Intervention failure was therefore more a consequence of poor auxiliary assumptions than of poor theory.

To recap, many important considerations are required in the development and implementation of interventions adopting the TPB. However, such considerations do not provide tests of effectiveness at the theoretical level. These are intervention auxiliary assumptions required to bridge the gap between nonobservational theoretical terms and hypotheses about interventions. The TPB provides a causal role of psychological determinants to behavior; however, because intervention failure can be blamed on theory or on auxiliary assumptions, it is unsound to jump to the conclusion that theory is at fault. It would take substantial empirical investigation of the quality of the auxiliary assumptions, with strong data upholding that quality, before it would be sensible to blame theory for intervention failures. Though we have adopted the TPB to demonstrate our points, it is important to note the suggestions made are applicable to the many other psychological theories used to develop intervention, such as social cognitive theory (Bandura, 1986), health belief model (Rosenstock, 1974), COM-B model (Michie et al., 2014), and self-determination theory (Deci & Ryan, 1985). To do so, one would obviously need to consider the specific psychological content outlined in the theory. But given the limited support for theoretically informed interventions (Dalgetty et al., 2019; Prestwich et al., 2014; Rhodes et al., 2017), and the subsequent questions regarding the utility of behavioral theories (Hagger & Weed, 2019), we recommend increased appreciation of the role of auxiliary assumptions in traversing the distance between psychological theory and theory-based interventions.
It is also important to note we are not suggesting these issues are not considered by researchers. Indeed, studies often report, for example, the strategies used to change psychological determinants, and it is often acknowledged that intervention effectiveness depends on such strategies. However, what has not been made explicit is how these represent auxiliary assumptions and how their careful consideration is crucial for drawing sound conclusions about the worth of the theory. Again, an ineffective intervention could mean that the theory is at fault, or it could mean that there is one or more faulty auxiliary assumptions. Given that the failures of theory-based interventions can be due to poor theory or to poor auxiliary assumptions, it is worthwhile to consider how to distinguish the two possibilities. This is a complex issue that deserves its own article, but we can recommend a few items to consider. First, there are psychometric issues, such as the reliability and validity of the measures. Many researchers seem to think that obtaining a nice factor structure establishes construct validity, but more is needed. Construct validity involves a matching of empirical with theoretical relations (Cronbach & Meehl, 1955), and if this has not been accomplished, and it rarely has been in our opinion, then construct validity has not been accomplished either (Trafimow & Osman, 2022). In that case, intervention failure can plausibly, though not definitively, be attributed to a failure in the auxiliary assumption of construct-valid measures. Another item, to which we alluded earlier, is whether the intervention influenced the theoretical constructs it was supposed to influence. One way to determine this is to measure the theoretical constructs of interest. For example, if an intervention is designed to increase exercise behavior through influencing underlying attitudes, the researchers could measure attitudes in the experimental and control conditions. If there is no difference in attitudes in the two conditions, then the intervention may not have influenced them, and the failure to increase exercise behavior might reasonably be blamed on the failure to influence attitudes rather than on the theory. That said, however, even if an effect on attitudes is obtained, the intervention may have unintentionally influenced another relevant construct in the opposite direction. If the intervention increased attitudes, but at the cost, unbeknownst to the researcher, of decreasing perceived behavioral control, the intervention can scarcely be expected to succeed even if the theory is correct. In general, when there is a lack of measures of relevant theoretical constructs, that may shift the weight of suspicion in the direction of auxiliary assumptions as opposed to theory. A third item is whether the researchers have made important auxiliary assumptions explicit (Trafimow, 2012). If not, that would be a reason to suspect that the researchers have not carefully considered these auxiliary assumptions, and that lack of consideration might be a reason to similarly suspect that an intervention failure should be blamed on auxiliary assumptions. Finally, the track record of the theory’s degree of corroboration in previous tests is an important factor to consider. When a theory has survived a set of severe tests but an intervention based on it nevertheless fails, the theory may still be wrong (Popper, 1963), but more likely, the problem would lie with the auxiliary assumptions. In this case, the initial search for the reason for failure might best focus on auxiliary assumptions.

Although we have provided examples of auxiliary assumptions, many more require attention when testing theory in intervention. For example, when participants provide psychological assessments, it is not explicitly assumed that participants can read
questionnaires, that participants understand what is asked of them, or that participants are honest in their responses. Yet theory effectiveness depends on these assumptions. We acknowledge there are many auxiliary assumptions to consider, and some are more difficult to accommodate than others. However, behavior change is, after all, difficult, and successfully influencing health behavior is crucial for health and wellbeing. We hope that bringing attention to the cruciality of auxiliary assumptions aids researchers in more accurately evaluating the worth of theories. This would provide a significant contribution to the field through improving the soundness of theory evaluation in the field of health behaviors.

**Concluding remarks**

Two conditions must be satisfied for theory to result in effective interventions. First, the theory must provide an accurate account of human behavior. Second, however, even if the first condition is met, the auxiliary assumptions used to traverse the gap between theory and intervention must be of high quality. We have outlined some applicable to the TPB. But when these auxiliary assumptions are not considered, an accurate appraisal of theory effectiveness is compromised. Evaluating the use of theory in behavior change interventions in this manner may lead to premature conclusions about the effectiveness of theory. Therefore, it may not be the case that psychological theory is limited in its ability to inform the development of effective interventions, something which would be catastrophic for theorizing. Rather, intervention failure could be a consequence of one or more auxiliary assumptions. Researchers should be aware of the many auxiliary assumptions attached to theory when making decisions regarding utility. Better auxiliary assumptions may dramatically improve the extent to which theory benefits intervention.

**Funding**

The authors received no financial support for the research, authorship, and/or publication of this article.

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