Theory of Planned Behavior and Adherence in Chronic Illness: A Meta-Analysis

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Abstract

Social-cognitive models such as the theory of planned behavior have demonstrated efficacy in predicting behavior, but few studies have examined the theory as a predictor of treatment adherence in chronic illness. We tested the efficacy of the theory for predicting adherence to treatment in chronic illness across multiple studies. A database search identified 27 studies, meeting inclusion criteria. Averaged intercorrelations among theory variables were computed corrected for sampling error using random-effects meta-analysis. Path-analysis using the meta-analytically derived correlations was used to test theory hypotheses and effects of moderators. The theory explained 33% and 9% of the variance in intention and adherence behavior respectively. Theoretically consistent patterns of effects among the attitude, subjective norm, perceived behavioral control, intention and behavior constructs were found with small-to-medium effect sizes. Effect sizes were invariant across behavior and measurement type. Although results support theory predictions, effect sizes were small, particularly for the intention-behavior relationship.

Keywords: Adherence, compliance, meta-analysis, chronic illness, theory of planned behavior

Theory of Planned Behavior and Adherence in Chronic Illness: a Meta-Analysis

Adherence is defined by the World Health Organization as "the extent to which a person's behavior – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider" (Sabaté, 2003, p. 3). Poor adherence to treatment regimens requiring changes to behaviors including physical activity, diet, and adherence to pharmacotherapy is well-documented (Ockene et al., 2002). Non-adherence can result in significant mortality, morbidity and financial cost (Kohler & Baghdadi-Sabeti, 2011). Despite these risks, 50% of patients with a chronic condition do not adhere to their treatment recommendations (Sabaté, 2003).

To improve patient adherence, utilization of an appropriate theoretical framework has been recommended both to understand the predictors of non-adherence and guide intervention development (Campbell et al., 2007; Wallace et al., 2014). Knowledge of which theories can be successfully applied to adherence is necessary to inform interventions and, consequently, to enhance adherence in chronically ill patients (Brandes & Mullan, 2014; DiMatteo et al., 2012; Jones et al., 2013; Peters et al., 2013). One of the models used to predict adherence behaviors in chronically ill patients is the theory of planned behavior (Ajzen, 1991). The theory of planned behavior is one of the most widely applied theoretical models and has been found to be effective in predicting a range of health intentions and behaviors, including dietary behaviors, physical activity, condom use, drug use, and health screening behaviors (Armitage & Conner, 2001; Conner & Sparks, 2005; Hagger & Chatzisarantis, 2009; Hagger et al., 2002; McEachan et al., 2011). It has been beneficial in understanding a range of adherence behaviors including dietary adherence (e.g., Sainsbury & Mullan, 2011), exercise adherence (e.g., Courneya et al., 2008), and medication adherence in a variety of conditions, including both acute illnesses such as urinary tract infections (Ried &

Christensen, 1988) and chronic illnesses, such as HIV (Vissman et al., 2013). While a number of meta-analyses of the theory of planned behavior have been conducted (Albarracin et al., 2001; Armitage & Conner, 2001; Cooke & French, 2008; Hagger & Chatzisarantis, 2009; Hagger et al., 2002; Hausenblas et al., 1997; McEachan et al., 2011; Sheeran & Taylor, 1999; Topa & Moriano, 2010), the current study is warranted for several reasons. Importantly, none of the existing reviews distinguish adherence behavior from other health behaviors nor specifically identify adults with chronic illness.

While the pattern of effects in the theory of planned behavior may be inferred from previous meta-analyses, (and from the hypotheses of the theory itself), because it outlines factors related to the generalized prediction of intention and behavior, there is considerable variation in the magnitude of the effects across different behaviors, as outlined in previous research (McEachan et al., 2011). The previous findings indicate that behavior type is a pervasive moderator of theory of planned behavior effects. This may signal the need to examine theory effects for the long-term prediction of behavioral adherence in chronic illness in order to identify the most salient predictors. This is important when it comes to using the theory as a basis for interventions to change behavior as it will help identify the most viable target constructs for interventions to promote behavioral adherence. Adherence in chronic illness entails a specific pattern of behavior, i.e. performing a behavior or behaviors over a long period of time to manage the disease as recommended by a health care professional (Sabaté, 2003). For example, exercise undertaken for a leisure activity or to benefit health in a healthy population would not be considered an adherence behavioral pattern, unlike prescribed exercise following a cardiac event. Further, the consequences of non-adherence when diagnosed with a chronic condition are typically more serious than not undertaking a health behavior for the benefit of overall health, as the disease or symptoms may deteriorate rapidly if an individual does not adhere to the treatment or medication.

In addition to the differences in the type of behavior in question, there are also differences in terms of the population type between the current review and previous reviews. Typically theory of planned behavior studies comprise young, healthy undergraduates (McEachan et al., 2011), whereas this review will include only adults with a chronic illness. Given the unique characteristics of adherence behaviors and the population to which they apply (i.e., people with a chronic illness), it is therefore possible that the relations between the determinants of the theory of planned behavior and adherence will differ from health behaviors in general. The current meta-analysis will contribute to knowledge by providing an evidence base as to whether the theory of planned behavior is appropriate for guiding adherence to treatment regimes. In addition, while interventions in chronic illness contexts based on the theory may have some primary evidence on which to place their confidence in the predicted effects, and effect sizes from individual studies on which to base their statistical power analysis, a synthesis effect sizes across studies will provide a cumulative evidence base across studies. We anticipate that the current analysis will, therefore, provide more robust evidence on which to base interventions guided by the theory in chronic illness contexts.

Further many previous meta-analyses report the efficacy of the theory of planned behavior solely in terms of the effect sizes of individual relationships specified by the model rather than simultaneously examining the pattern of hypothesized relations among the theory of planned behavior variables and their fit with the meta-analytically derived correlations among the study variables. This will provide support for the nomological validity of the theory for adherence behavior, that is, testing whether a hypothesized network of relations including a construct or set of constructs is empirically supported. Nomological validity has been strongly advocated to provide robust evidence to support theories and models (Bagozzi, 1981; Bagozzi et al., 1992; Hagger & Chatzisarantis, in press; McLachlan et al., 2011), but is

seldom tested. The current review will address this limitation by conducting a path analysis based on the meta-analysis results to examine the direct and indirect effects of the relationships proposed by the theory, permitting a simultaneous test of the network of relations among the theory of planned behavior's variables for adherence in chronic illness.

A key tenet of the theory of planned behavior is that the most proximal predictor of behavior is a person's intention to perform that behavior (Ajzen, 1991). Intention is influenced by attitudes (i.e., positive or negative evaluation of the behavior), subjective norm (i.e., perceived social pressure to perform the behavior), and perceived behavioral control (i.e., perception of control over performing the behavior), which also has a direct influence on behavior. Meta-analyses have found support for the theory of planned behavior across a number of health behaviors, explaining 19–36% of the variance in behavior, and 40–49% of the variance in intention (Ajzen, 1991; Armitage & Conner, 2001; Godin & Kok, 1996; Hagger et al., 2002; McEachan et al., 2011; Schulze & Wittmann, 2003; Sniehotta et al., in press; Trafimow et al., 2002). Reviews have also supported the role of intention as a mediator of the effect of attitudes and subjective norms on behavior, and perceived behavioral control as a predictor of both intention and behavior, thus confirming the hypotheses proposed by the model (e.g., Armitage & Conner, 2001).

Despite its widespread application and support, the theory of planned behavior is not short of criticism. There is considerable debate surrounding the adequacy of the theory in the prediction of health-related behaviors (see Ajzen, 2014; Armitage, 2014; Conner, 2014; Hall, 2014; Ogden, 2014; Rhodes, 2014; Sniehotta et al., 2014; Trafimow, 2014). Criticisms include the theory of planned behavior being a static model, not accounting for the effects of behavior on cognitions and future behavior (Sniehotta et al., 2014); its focus on rational processes, thereby excluding emotional and non-conscious or implicit influences (Conner & Sparks, 2005; Sheeran et al., 2013); and the 'intention-behavior gap' (i.e., the discrepancy

arising when a person fails to act in line with their intentions), with the model being superior in predicting intention compared to actual behavior (Sheeran, 2002; Sniehotta et al., 2005; Webb & Sheeran, 2006).

Ajzen argues the model is dynamic, not static, pointing to feedback loops between behavior and cognitions (Ajzen, 2014; Fishbein & Ajzen, 1975, 2010), and does take into account irrational and unconscious thought via their influence on beliefs, which can likely reflect underlying as well as consciously held beliefs (Ajzen, 2014). It is proposed that the inability of the theory of planned behavior to fully account for the variance in intentions and behavior can, in part, be explained by challenges in measurement (for a detailed discussion see Fishbein & Ajzen, 2010). Further, the prediction of intention from behavior is beset with difficulties, such as the likely changing circumstances between intention formation and actual behavior. The temporal delay between measurement of behavior following prior assessment of intention will necessarily lead to weaker predictions and intention-behavior relations, as the passing of time increases the probability of other factors influencing intentions from initial measurement to the time behavior is actually assessed. Thus, when the follow-up period is increased, it is expected that the strength of the intention-behavior relationship will be reduced (Ajzen, 1985). McEachen et al.'s (2011) meta-analysis of the prospective prediction of health-related behaviors confirmed time as a moderator of the intention-behavior relationship, with behaviors measured over the shorter term (less than five weeks) being better predicted than those over the longer term (more than five weeks). These results suggest that as adherence to chronic illness is a behavior which is necessarily carried out over a prolonged period of time, the theory of planned behavior may have less predictive power.

In terms of evidence as to whether the theory of planned behavior is an appropriate model on which to base interventions to change health behaviors, studies have predominantly been correlational, with a prior systematic review of experimental studies where the theory

had been applied, unable to draw conclusions due to a lack of suitable studies (Hardeman et al., 2002). It has been argued that the theory of planned behavior has limited utility in informing intervention design for behavior change (see Sniehotta, 2009a) and while interventions based on the theory of planned behavior seem to be reasonably effective in changing intentions, there are far less efficacious in changing behavior (Webb & Sheeran, 2006).

However, others have argued there is simply a shortage of quality, experimental studies (Ajzen, 2014; Armitage, 2014). Proponents have stated that the available evidence does not provide unequivocal support for the premise that the theory of planned behavior has limited utility for intervention design, and pointed to studies of better quality that demonstrate support for the theory (Ajzen, 2014; Armitage, 2014). It has been suggested that increasing the effectiveness of adherence interventions may have a greater impact on health than improvements in medical treatments (Sabaté, 2003). Thus, determining whether the theory of planned behavior has utility for developing effective adherence interventions, particularly for changing behavior, requires further high-powered experimental replications, similar to those reported by Sniehotta (2009a). The current meta-analysis may provide some cumulative evidence in this regard to test the extent to which study design moderates the prediction of treatment adherence. This may shed light on whether experimental manipulations or interventions based on the theory will lead to substantive changes in behavioral outcomes for adherence behaviors. Specifically, we will seek to identify groups of studies that adopt intervention and correlational designs and examine this classification as a moderator of the effects of the theory of planned behavior constructs on behavioral outcomes.

Summary and Hypothesis

In summary, the strength of the theory of planned behavior has been its efficacy in explaining substantial amounts of variance in both intentions and behavior in health domains

from a relatively parsimonious set of predictors. Alternative models to the theory of planned behavior have been proposed (Hagger & Chatzisarantis, 2014a; Hall & Fong, 2010; Schwarzer, 2008; Sniehotta et al., 2014; Todd et al., 2014; West & Brown, 2013); however, evidence has yet to demonstrate whether they account for a substantive amount of additional variance in intention and behavioral outcomes. The theory has notable limitations that have been the subject of considerable debate in the literature, including whether manipulations based on the theory lead to substantial changes in behavior (Hardeman et al., 2002; Webb & Sheeran, 2006) and the 'gap' between intentions and behavior (Sniehotta et al., 2014; Sniehotta et al., 2005).

The aim of the current meta-analysis is to examine whether the theory of planned behavior can predict adherence in people diagnosed with a chronic condition. Given the existing evidence for the efficacy of the theory of planned behavior in predicting a number of health behaviors, it is hypothesized that the model will have utility in predicting adherence to a treatment regime in chronic illness. Based on the observation that the theory of planned behavior demonstrates better prediction with shorter time intervals, while adherence in chronic illness, by definition, implies a long-term prediction, it is hypothesized that the predictive power of the model will be reduced in comparison to existing theory of planned behavior reviews, with a smaller effect size between intention and behavior.

The effectiveness of the theory of planned behavior in predicting behavior varies depending on the type of behavior and the population under investigation (Armitage & Conner, 2001; Conner & Sparks, 2005; McEachan et al., 2011). As a previous meta-analysis noted that the efficacy of the theory of planned behavior was dependent on the type of behavior (McEachan et al., 2011), with physical activity and diet being better predicted than risk, detection, safer sex and drug abstinence behaviors, the review will examine whether the relationships specified by the model vary across different adherence behaviors. In light of

research showing adherence rates vary depending on the disease (DiMatteo, 2004), type of illness will also be examined as a potential moderator. In terms of sample characteristics, age has been shown to be a significant moderator in previous meta-analytic reviews of the theory of planned behavior (Hagger et al., 2002; McEachan et al., 2011; Sheeran & Orbell, 1998) and thus will also be investigated. Reviews have suggested that the theory of planned behavior may be better able to explain self-reported as opposed to objective measures of behavior (Armitage & Conner, 2001; McEachan et al., 2011), thus type of adherence measure (self-report vs. objective) will also be examined as a moderator, in addition to gender and study design (experimental/intervention vs. correlational).

Method

Search Strategy

The systematic literature search and data extraction phases were performed in April 2013 using electronic databases PsycINFO, MEDLINE, CINAHL and ISI Web of Science. The search strategy was modeled on recent theory of planned behavior meta-analyses of health-related behaviors (Cooke & French, 2008; Hagger & Chatzisarantis, 2009; Hagger et al., 2002; Manning, 2009; McEachan et al., 2011; Topa & Moriano, 2010). We sought to also identify studies of the Theory of Reasoned Action (Ajzen & Fishbein, 1980) since the theory of planned behavior extends on the theory of reasoned action by incorporating perceived behavioral control. Search terms were: adherence or compliance or concordance, attitud* and norm* and control and intention*; theory of planned behavi*; planned behavi*; theory of reasoned action; and Ajzen. The full search strategy can be viewed in the Electronic Supplementary Material 1. In addition, a citation search of Ajzen's original article (1991) proposing the theory of planned behavior was conducted on ISI Web of Science. Within the citation search, relevant articles were sought with the addition of the following terms: adherence or compliance or concordance. Reference lists of all included articles, key reviews

and meta-analyses, and Ajzen's website (http://people.umass.edu/aizen/tpbrefs.html) were manually searched to identity any additional articles.

Inclusion Criteria

Papers were eligible for inclusion if they were studies measuring the theory of reasoned action or theory of planned behavior constructs with participants suffering from a chronic disease. Articles had to examine adherence to treatment and/or health behaviors as recommended by a health care provider (e.g., exercise as part of cardiac rehabilitation) and have adherence as an outcome measure, either self-reported (e.g., a questionnaire, such as "what percentage of the time do you take your medication?") or objective (e.g., attendance at cardiac rehabilitation class). Studies had to explicitly reference the theory of planned behavior or theory of reasoned action, include a measure of at least one of the constructs from the theory of planned behavior or theory of reasoned action (i.e., attitude, subjective norm, perceived behavioral control or intention), be peer-reviewed and published in English. Studies of adherence to preventative community-based programs (e.g., screening, vaccination), those with populations considered to be at risk of chronic disease (e.g., sedentary adults) and guideline adherence (e.g., adherence of health care professionals to guidelines or protocols) were excluded.

Study Selection

All abstracts were screened by two authors familiar with social-cognitive models applied to health (k = 680), and subsequent full-text articles were reviewed separately by two authors for inclusion (k = 76). Disagreements were subject to independent review by a third author and resolved through discussion. Reasons for exclusion were: adherence was not an outcome measure, none of the variables from the theory of planned behavior or theory of reasoned action were measured, patients were not chronic illness sufferers, the study was not empirical, or correlations were not available following a data request. A total of 27 studies

met the inclusion criteria. The study selection process can be seen in Figure 1 (Moher et al., 2009). The PRISMA checklist can be located in the Electronic Supplementary Material 2.

Data Extraction

The following characteristics of the included studies were documented: type of chronic condition, sample characteristics, study design, type of adherence behavior, theory of planned behavior / theory of reasoned action constructs measured, and adherence outcomes measured. The data extraction table can be found in the Electronic Supplementary Material 3.

Analytic Strategy

The zero-order correlation coefficient (*r*) was identified as the appropriate effect size metric in the current analysis. The selection was based on an examination of the types of data and analytic procedures adopted in the current sample of studies– the majority adopted correlational designs. Further, *r* was selected as the metric for the current analysis because it was necessary to adopt a metric that was not previously corrected for artifacts of bias within a particular study such as sampling bias (e.g., use of latent variables) or the effect of other variables within the study (e.g., beta weights from regressions). The effect size was weighted by sample size. Authors who did not report the full correlation matrix were contacted with a data request. With studies that reported correlations at multiple time points, examined several types of adherence behavior, and had more than one adherence measure, the average correlation was calculated. Where different sample sizes were reported within the same study, the smaller sample size was used. The analysis includes data from both predictive and intervention studies ($k = 4$). None of the intervention studies explicitly targeted the theory of planned behavior variables and/or identified the relevant behavior change techniques so were classified as correlational for the purpose of the current analysis.

Moderator Coding

To assess the moderating impact of behavior type, adherence behaviors were coded into four groups: medication (k = 11), exercise (k = 8), diet (k = 5) and self-care (k = 6). This classification was agreed by two authors, who coded and verified independently. Studies were also classified according to use of a self-report (k = 22) or an objective measure (k = 8) of adherence behavior (three studies had both a self-report and objective measure).

Moderation by age was not possible as all the included studies were of adult populations and not classifiable into older/younger samples. Possible effect of study design could not be examined, as while four studies had an experimental design, they were classified as correlational because the intervention was not aimed at changing the theory of planned behavior variables. There was an insufficient number of studies for moderation by gender (four studies had an exclusively male (k = 1) or female (k = 3) samples) and for illness group, with only one condition (diabetes; k = 6) having greater than five studies.

Separate meta-analyses were conducted for behavior type and method of adherence measurement to examine the effect on the relationships between the constructs of the theory of planned behavior. The moderator was taken to be valid if the average corrected effect sizes calculated in each moderator group were significantly different as evidenced by the 95% confidence interval (CI^{95}).

Meta-analysis

Meta-analyses were undertaken using R Studio with metafor package (Viechtbauer, 2010). Fixed-effects models should be used for homogenous samples and random effect-size models for heterogeneous samples (Viechtbauer, 2010). As the samples in the included studies were heterogeneous, a random-effects model was used.

The effect size metric was the average correlation ($r+$), weighted by the observed sample size. Effect sizes were then calculated using Fisher's Z transformations. The strength of the effect sizes were interpreted in accordance with Cohen's (1992) guidelines ($r+$ = 0.10

is small, $r+ = 0.30$ is medium, $r+ = 0.50$ is large). A 95% CI was calculated for each effect size. Statistical heterogeneity was assessed using Q and I^2 statistics. A statistically significant Q suggests the presence of heterogeneity. I^2 measures heterogeneity in terms of a percentage of the total variation across the studies due to heterogeneity as opposed to chance, with 25% indicating low heterogeneity; over 50% indicating moderate heterogeneity; and over 75% indicating high heterogeneity (Higgins et al., 2003).

This meta-analytic strategy was used to examine both the overall utility of the model and the moderators. Not all of the included studies examined all the relationships specified by the theory of planned behavior, and some studies reported multiple adherence behaviors. Therefore, the sample sizes varied per analysis.

Path Analysis

Path analysis was conducted to test the hypothesized relations among the theory of planned behavior variables using the corrected correlations from the meta-analysis. Specifically, the hypothesis tests included the direct effect of intentions on treatment adherence behavior, the direct effects of attitudes, subjective norms, and perceived behavioral control on intentions, and the effect of these social-cognitive variables on behavior mediated by intentions. To reduce bias caused by the variation in the sample sizes across studies as a result of the corrected average correlations being derived from different subsets of studies, we opted for the most conservative strategy advocated by other researchers (Carr et al., 2003; Viswesvaran & Ones, 1995) and used the smallest sample size ($N = 3305$). Goodness-of-fit was established using multiple criteria and evaluated relative to the totally 'free' model in which all the parameters were freely estimated. The Comparative Fit Index (CFI) and Normed Fit Index (NFI) should meet or exceed 0.95 for an adequate model fit (Hu & Bentler, 1999). The Root Mean Square Error of Approximation (RMSEA) and the 90% Confidence Interval (CI^{90}) of RMSEA should be close to 0.08 with narrow confidence intervals, and the

Standardized Root Mean Squared Residuals (SRMSR) should be close to 0.05 for an acceptable model (Hu & Bentler, 1999).

Results

Study Characteristics

Twenty-seven studies met the inclusion criteria. Twelve chronic illnesses were reported and included diabetes (k = 6), heart disease (k = 4), hypertension (k = 3), HIV (k = 2), coeliac disease (k = 2), psychiatric illnesses (k = 2), breast cancer (k = 2), organ transplantation resulting from a number of different chronic conditions (e.g., chronic obstructive pulmonary disease, kidney disease) (k = 2), epilepsy (k = 1), lymphoma (k = 1), obesity (k = 1) and insomnia (k = 1).

Adherence Behaviors

The most commonly reported adherence behaviors were medication (k = 11), exercise (k = 8) and diet (k = 5). Six studies (Costa et al., 2012; Didarloo et al., 2012; Gatt & Sammut, 2008; Hebert et al., 2010; Miller et al., 1992; Syrjala et al., 2002) reported behaviors that were classified as ‘self-care activities’. These consisted of glucose monitoring (Didarloo et al., 2012); tooth brushing (Syrjala et al., 2002); multiple behaviors relevant to diabetes self-care (e.g., diet, exercise, foot care) (Didarloo et al., 2012; Gatt & Sammut, 2008); adherence to multiple behaviors relevant to management of chronic insomnia, such as implementing sleep hygiene practices at home (Hebert et al., 2010); and behaviors relevant to the management of hypertension, such as stress management (Miller et al., 1992).

Adherence Measures

The majority of studies used self-reported adherence (k = 22), rather than objective measures (k = 8). Three studies used both a self-report and an objective measure. Medication adherence was assessed predominantly by self-report (nine out of 11 studies), with little consistency in the measures used, although the Morisky Medication Adherence Scale

(Morisky et al., 1986) was used twice. The objective measures were a Medication Electronic Monitoring System and pharmacy refill data. Adherence to exercise was most commonly measured objectively, via class attendance (five out of nine studies). Dietary adherence was measured by self-report in all studies.

Effects of Theory of Planned Behavior Variables on Adherence Behavior

The average sample-corrected zero-order correlations ($r+$) among the theory of planned behavior variables were statistically significant ($p < 0.05$), ranging from 0.22 to 0.51 (Table 1). The variables hypothesized by the theory of planned behavior to be predictive of intention all had medium to large effect sizes. Perceived behavioral control had the strongest relationship with intention ($r+ = 0.51$), followed by attitude ($r+ = 0.41$) and subjective norm ($r+ = 0.32$). The 95% confidence intervals overlapped, indicating differences in the strengths of these relationships were not statistically significant. The heterogeneity of all weighted average correlations in the meta-analysis was high (Table 1). All calculations revealed an I^2 of 69% or greater, indicating substantive heterogeneity (Higgins et al., 2003).

Moderation Analyses

Moderator analyses were conducted when there were more than five studies in a moderator group. Table 2 shows the averaged sample-corrected correlations for analysis with type of adherence behaviors as moderators. Heterogeneity varied for most adherence behaviors (i.e., diet, exercise and self-care activities) and was high for medication adherence. There was considerable consistency in the relations across behavior type with no significant differences. Thus, type of adherence behavior did not influence the strength of the relationships between the theory of planned behavior variables and adherence to a recommended treatment regime.

Table 3 shows the averaged sample-corrected correlations for type of adherence measure as the moderator. The heterogeneity across the weighted correlations of self-report

386 measures was high and varied for objective measures. Results indicated that type of
387 adherence measure did not moderate the relations between theory of planned behavior
388 variables and adherence to a prescribed treatment regime.

389 Meta-regression was conducted to examine the unique effects of key demographic
390 variables from the sample of studies on the meta-analysed correlations among the theory of
391 planned behaviour constructs. Specifically, we regressed the averaged corrected effect size
392 for each of the theory relationships on the following moderators; mean age of the study
393 sample, time between initial administration of theory measure and follow-up prospective
394 behavioural measure, and proportion of males and females in the sample (expressed as a
395 percentage of males in the sample). Results revealed no statistically significant final models
396 ($Fs < 2.83$, $ps < .109$) with few statistically significant regression coefficients. Age was a
397 significant predictor of the subjective norm-perceived behavioral control relationship (t =
398 .831, $p = .025$). There were no other statistically significant effects indicating that the meta-
399 analysed effects were largely unaffected by variations in these demographic variables.

400 **Path Analysis**

401 The meta-analytically derived corrected correlation matrix was used to test the pattern
402 of relationships stipulated by the theory of planned behavior. The matrix was used as input
403 data for a path analytic model that stipulated the proposed pattern of relationships of the
404 theory of planned behavior. The model was estimated using the EQS structural-equation
405 modeling computer software using the maximum likelihood method (Fan et al., 1999). The
406 path model exhibited acceptable goodness-of-fit according to the multiple criteria adopted (χ^2
407 = 87.09, df = 2, $p < 0.001$; CFI = 0.97; GFI = 0.99; SRMSR = 0.04; RMSEA = 0.11; CI^{90} =
408 0.09 – 0.13). Beta coefficients from the meta-analytic path analysis are provided in Figure 2.
409 Overall, the model accounted for 32.92% and 9.18% of the variance in intentions and
410 behavior respectively.

Consistent with the theory of planned behavior, attitudes ($\beta = 0.20$, $p < 0.001$), subjective norm ($\beta = 0.16$, $p < 0.001$) and perceived behavioral control ($\beta = 0.39$, $p < 0.001$) were statistically significant predictors of intentions, and intentions was a statistically significant predictor of behavior ($\beta = 0.21$, $p < 0.001$). Interestingly, perceived behavioral control had the strongest effect size in its prediction of intentions, which is consistent with the zero-order corrected correlations. Analysis also revealed small, but statistically significant indirect effects for attitude ($\beta = 0.04$, $p < 0.001$), subjective norm ($\beta = 0.03$, $p < 0.001$) and perceived behavioral control ($\beta = 0.08$, $p < 0.001$) on intention, confirming intention was a mediator between the attitudes, subjective norm, and perceived behavioral control variables and behavior, consistent with the original hypotheses of the theory of planned behavior. There was a statistically significant direct effect of perceived behavioral control on behavior ($\beta = 0.13$, $p < 0.001$), which taken with the indirect effect, resulted in a statistically significant total effect of perceived behavioral control on behavior ($\beta = 0.21$, $p < 0.001$).

Funnel Plots

Funnel plots were generated to examine small-study bias that might indicate potential publication bias (see Figure 3). We also used Duval and Tweedie's (2000) method based on the funnel plots to correct the effect size for asymmetry and provide an adjustment of the effect size in the absence of bias. For the majority of effect sizes (8/10), funnel plots were generally symmetrical, with zero estimated number of missing studies. However, for the intention-behavior relationship, there were an estimated six studies missing and an estimated eight missing from the subjective norm-intention relationship, indicating possible small-study bias in the effect size, i.e., a tendency for smaller studies to report an inflated effect size. This may be an indicator of publication bias, but such interpretations cannot be definitively made based on these data alone (Hagger & Chatzisarantis, 2014b). Furthermore, given the significant heterogeneity for all relationships, the plots must be interpreted with caution.

Heterogeneity can be the reasons for funnel asymmetry, with the trim and fill method underestimating the true positive effect even when there is no publication bias (Hagger & Chatzisarantis, 2014b; Peters et al., 2007; Sterne et al., 2011; Terrin et al., 2005).

Discussion

We conducted the first meta-analysis of studies applying the theory of planned behavior to adherence behaviors in individuals suffering from chronic conditions. Relations among the theory constructs from twenty-seven studies were subjected to a random-effects meta-analysis, correcting for sampling error. Analysis found the theory of planned behavior accounted for 33% and 9% of the variance in intentions and behavior in treatment adherence, respectively. Consistent with the theory, attitudes, subjective norm and perceived behavioral control were statistically significant predictors of adherence intention and intention was a statistically significant predictor of treatment adherence behavior. Perceived behavioral control was also the strongest predictor of intention with an effect that was significantly larger than the effects for attitude and subjective norm. Further, analysis supported the role of intention as a mediator of the variables of attitudes, subjective norm, and perceived behavioral control and behavior, as proposed by the model.

The effect sizes between the theory of planned behavior components and adherence ranged from 0.22 to 0.51. Thus while the effect sizes in some studies in the current sample would be classified small-to-medium, others are in the medium-to-large range (see Cohen, 1992). This is generally lower than the effect sizes observed in other meta-analyses of the theory of planned behavior which show effect sizes tend to be medium in size or in the medium-to-large range (see Armitage & Conner, 2001; McEachan et al., 2011). For example, McEachan et al., found intention had the strongest relationship with prospective behavior (0.43) and attitude and perceived behavioural control had medium-sized relationships with behavior (both 0.31). However when considering whether an effect size is large, medium, or

small in the current meta-analysis of the theory of planned behavior, and indeed in other meta-analyses, results are confounded by the considerable degree of heterogeneity observed in the effects across studies, making it difficult to unequivocally conclude that the effect sizes are substantially different from other meta-analyses.

It is important to note that the identification of considerable heterogeneity in the theory effect sizes across studies is an important finding in its own right. Unresolved heterogeneity suggests that there may be a problem with the theory or its tests if tests of the theory across the literature do not give an accurate picture of the true effect. Of course, moderators are an issue that may help resolve these problems and identifying moderators is a necessity given that too few studies in the current sample measured or reported including them. But if zero, or a value close to zero, is one probable value of the effects in the model, then it does raise the question whether it should be concluded that the theory is effective in explaining adherence. Alongside this, it is important that the specific criteria against which the theory is accepted i.e., the proposed pattern of effects of Ajzen's original model are supported. If one of the effects is highly variable and zero (or a value close to zero) is one probable effect based on the confidence intervals of the effect size, does it mean the theory should be accepted or rejected? This is a problem that can be levelled at many social cognitive theories in health psychology. What constitutes a null or failed replication? Do all the theory relations have to be supported for the theory to stand? If so, what happens when the strength of the effect approaches (but perhaps does not quite include) zero, to all intents and purposes, the effect could be very small and, therefore, of little relevant theoretically. These are key questions that have been proposed elsewhere (e.g., (Hagger & Chatzisarantis, in press; Ogden, 2014) and that the current analyses raises but cannot resolve due to the lack of data to test a group of candidate moderators of its effects.

The small-sized notwithstanding, the effect sizes between the theory of planned behavior components and adherence are stronger than some of the widely accepted factors identified as predictors of adherence, including depression (Grenard et al., 2011) and communication skill of the physician (Haskard-Zolnierek & DiMatteo, 2009). The effect sizes also show the theory of planned behavior compares favorably when considering meta-analyses of social-cognitive models that have been applied to adherence, such as the health belief model and common sense model (Brandes & Mullan, 2014; DiMatteo et al., 2007; Leventhal et al., 1980; Rosenstock, 1974).

As hypothesized, the levels of prediction for both intention and behavior were lower than found in previous theory of planned behavior meta-analyses. The theory of planned behavior has been found to predict 39%–44% of the variance in intention and 19%–27% of the variance in health behaviors (Conner & Sparks, 2005; McEachan et al., 2011) in prior reviews. Several considerations may account for the differences in findings. Patients with chronic illness are required to adhere to an array of treatments, which may include a number of medications, with different and challenging dosing schedules, in addition to performing various health behaviors. For example, treatment for chronic kidney disease would typically involve dialysis, medications (such as iron supplements, phosphate binders and antihypertensive medicine), and self-monitoring of blood pressure in addition to dietary and fluid restriction (Loghman-Adham, 2003). This should be contrasted with the majority of theory of planned behavior studies, which have largely consisted of healthy student populations involving singular health-promoting behaviors, such as predicting dietary intake, physical activity or drinking alcohol (McEachan et al., 2011). Student populations are commonly younger, better educated and from a higher socio-economic group than the general adult population (Hooghe et al., 2010). In comparison, chronic disease is greater in older populations who are more socially disadvantaged (Alwan, 2011). Thus, differences both in

the sample characteristics and health behaviors of the studies comprising the current review as compared to previous theory of planned behavior meta-analyses may partly account for the lower variance explained for intention and behavior, and demonstrates the importance of this review.

Identifying which other factors may account for the unexplained variance in treatment adherence is complex. A recent systematic review tried to identify all the possible factors that may influence non-adherence in chronic treatment regimens and identified 771 individual factors (Kardas et al., 2013), making it a considerable challenge to develop a theoretical model that can fully explain adherence. In terms of medication adherence, there is a growing body of literature that supports the predictive power of patients' beliefs regarding the necessity of their treatment (i.e., patients have the perception that they are in need of the prescribed treatment) and patients' concerns about their treatment regime (e.g., patients might be concerned that they will experience unwanted side-effects) (Horne et al., 2013; Horne & Weinman, 1999; Langebeek et al., 2014). Recent meta-analyses have shown that beliefs about necessity of treatment and concerns are significantly related to chronically patients' levels of adherence (Horne et al., 2013; Langebeek et al., 2014). Adding these factors to the theory of planned behavior as possible predictors of patients' intention or behavior may increase the explained variance of the model on adherence. A further consideration is the prolonged duration of adherence behaviors. Given the enduring nature of chronic conditions, adherence is a behavior that needs to be carried out over the long-term. Length of follow-up has been found to moderate relations among the theory of planned behavior variables, with the intention-behavior relationship being weaker in studies with longer follow-up periods (McEachan et al., 2011). Thus, as hypothesized, it was found that the prediction of behavior would be impaired given the long-term nature of the behavior.

The effect size between intention-behavior was small-to-medium in the current analysis ($r+ = 0.28$) demonstrating the frequently observed intention-behavior 'gap'. The 'gap' has been identified as a threat to the validity of the theory of planned behavior as a basis for interventions to promote behavioral engagement and adherence, as it implies that interventions targeting the key factors do not always result in behavior change (Webb & Sheeran, 2006). Various strategies have been proposed to narrow the gap, including action planning and self-regulation (Gollwitzer & Sheeran, 2006; Hagger & Luszczynska, 2014; Mullan et al., 2011; Sniehotta, 2009b; Sniehotta et al., 2005). For example, self-regulatory skills have been shown to mediate the intention-behavior relationship in medication adherence with HIV patients (de Bruin et al., 2012). Others factors explored to bridge the intention-behavior gap in adherence are psychological symptoms, such as depression. It is suggested that interventions to treat patients for symptoms such as depression should assist with the translation of positive intention into improved adherence (Sainsbury et al., 2013). With regard to adherence, research into the intention-behavior gap is scarce and would be worthy of further investigation.

Moderation analysis for behavior type revealed considerable consistency in the relations among the theory of planned behavior constructs for diet, exercise, medication and self-care adherence behaviors. Previous research suggests behavior type moderates the theory of planned behavior (McEachan et al., 2011), with the theory having greater success at predicting certain health behaviors than others, such as *engaging* in physical activity or dietary changes as opposed to *abstaining* from drugs (e.g., quitting smoking) (McEachan et al., 2011). However, it is important to note that these variations tend to be in the order of magnitude rather than whether the effect is present or absent. In other words, the pattern of the proposed effects in the theory does not differ across behaviors only the size. This is consistent with the notion that theory of planned behavior is a generalized theory of

behavioural prediction and, as such, the hypothesized pattern of effects should hold across multiple behaviors and multiple contexts (Hagger & Chatzisarantis, 2014a; Hagger & Chatzisarantis, in press). The consistency between the types of adherence behaviors in the current study may be due to the fact that, generally speaking they are *active*, requiring engagement with a behavior, e.g., taking a pill or undertaking regular exercise, as opposed to passive or cessation behaviors.

It was also hypothesized that effect sizes would be greater for self-reported than objective measures of behavior, as has been the case in previous meta-analyses of the theory of planned behavior (Armitage & Conner, 2001; McEachan et al., 2011), however no differences were identified. This may be due to the small number of studies employing objective measures. Adherence was predominantly measured by self-report, which can be subject to self-presentation bias and result in an overestimation of adherence (Horne et al., 2005). While there is no 'gold standard' for measuring adherence (Osterberg & Blaschke, 2005), triangulation of measures to include objective markers is recommended (Horne et al., 2005); only three of the included studies utilized both self-report and objective measures.

Indeed, for all moderator analyses, the number of studies was small, resulting in lower power to detect differences. Further, it is perhaps unsurprising that few moderation effects were apparent given the considerable heterogeneity present. A number of the relationships had wide CIs, indicating variability in the studies and uncertainty of the true effect size. This limits the ability to determine any influence of moderation, and results therefore need to be interpreted with caution. Further primary studies are required to address the possible role of these dimensions in shaping relationships between the components of the theory of planned behavior.

The findings of the meta-regression investigating the unique effects of age, gender, and time interval between initial and follow-up behavioral outcome on the effect sizes for the

relations among the theory of planned behavior constructs revealed that the only statistically significant effect that for age on the subjective norm-perceived behavioral control effect. This analysis indicated that these moderators were unable to account for substantially meaningful proportion of the variance in the theory effect sizes. These findings provide a multivariate corroboration of the moderator analysis.

Limitations

While the analysis was carried out using a random effects model corrected for sampling error, which is appropriate for situations where heterogeneity is identified, high variability remained. A number of factors are likely to contribute to this heterogeneity. Studies were diverse on a number of key characteristics, including study size and design, type of adherence behavior, definition of adherence, time points of data collection, patient characteristics, disease states, and measures of both the theory of planned behavior constructs and adherence. It is likely that measurement error could account for some of the variation. The substantial heterogeneity reduces the precision of the meta-analytic effect sizes, and results should be regarded in context of this limitation.

It is possible that the strength of the adherence behavior relationships for medication adherence may have been attenuated by ceiling effects, which, if present, would limit the scope for variance to be explained by additional factors, resulting in lower relations among study variables as a consequence. Other researchers have commented that ceiling effects may account for the apparent lack of effect in adherence intervention studies (e.g., Shet et al., 2014). Unfortunately the small number of studies that reported the actual adherence rates precluded the conduct of a meta-regression analysis to investigate whether ceiling effects predicted the effect size in the present study.

We did not include unpublished literature in our analysis, thus there is potential for publication bias because studies with positive results may be more likely to be published

(Dickersin, 1990; Easterbrook et al., 1991), although it has been argued that in reality the practice of trying to identify and include unpublished studies would not solve this (e.g., most unpublished studies are not indexed) and could actually increase bias (Ferguson & Heene, 2012). Funnel plot analysis indicated possible small study bias for two of the relationships; however, the considerable heterogeneity in effects render definitive conclusions on bias on the basis of these tests challenging (Hagger & Chatzisarantis, 2014b).

Conclusion and Implications

The findings of this review in addition to the known limitations of the theory (Sniehotta et al., 2014) suggest that while the theory of planned behavior makes a useful contribution to our understanding of adherence in chronic illness, focusing solely on the theory of planned behavior variables to predict and develop interventions to alter adherence may be insufficient. While the theory of planned behavior is open to additional predictors (Ajzen, 1991), and could be enhanced by other variables known to be important in adherence, it has been suggested that extended theory of planned behavior models limit advancement in theory development (Sniehotta et al., 2014). The solution may lie in the development of clearly defined and articulated theories that can be experimentally tested and formally falsified (Hagger & Chatzisarantis, 2015; Ogden, 2015; Sniehotta et al., 2015).

Adherence to a prescribed treatment regime is influenced at multiple levels beyond patient-related factors, including social and economic, therapy related and health system factors (Sabaté, 2003), and thus a theory must be able to accommodate these multifaceted components. For example, the capability, opportunity, motivation and behavior (COM-B model of behavior (Michie et al., 2011) has recently been proposed as having promise in understanding adherence (Jackson et al., 2014), as accounts for a broad spectrum of factors influencing adherence, including the wider determinants such as the healthcare system (Jackson et al., 2014; Michie et al., 2011). However, it is worth noting that neither the COM-

B model of behavior nor the theory of planned behavior were designed specifically to understand and predict adherence to a treatment regime. Models dedicated to understanding adherence are few in number and have been developed solely for medication adherence. These include the necessity-concerns framework (Horne & Weinman, 1999), shown in a recent meta-analysis to have efficacy in understanding adherence for long-term conditions (Horne et al., 2013), and more recently the proximal-distal continuum of adherence drivers (McHorney, 2008). Developing effective adherence interventions is a priority (Haynes et al., 2008). The recently updated Cochrane systematic review of interventions for enhancing medication adherence illustrates the difficulties in improving adherence (Nieuwlaat et al., 2014). The review included an additional 109 new randomised controlled trials, resulting in the inclusion of 182 studies in total. Disappointingly, the authors found inconsistent results, with only a small number of the highest quality studies demonstrating improvements in both adherence and clinical outcomes. Interventions were so varied determining the common characteristics in effective interventions was not possible, although, as found previously, commonalities were their frequent interaction with patients and complexity. The review concluded developments in terms of the design of practicable interventions which can be applied in the healthcare system are urgently required.

The theory of planned behavior has been shown to be applicable to a range of health behaviors, but the current review suggests its validity for predicting adherence behavior in people with chronic illness is limited. Further research is needed to examine the utility of other theories both in predicting adherence as well as the development and evaluation of adherence interventions.

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