

**Explaining the intention-behaviour gap in gluten free diet adherence: The moderating roles of habit and perceived behavioural control**

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Adherence to a strict gluten free diet (GFD) is the only treatment for coeliac disease. Nonetheless, many individuals with the disease struggle to achieve and maintain strict adherence. While the theory of planned behaviour is useful for predicting GFD adherence, an intention-behaviour gap remains. The aim of this study was to investigate the roles of habit and perceived behavioural control in moderating the intention-behaviour relationship in GFD adherence. A significant three-way interaction was found such that the association between intention and adherence was dependent on both perceived behavioural control and habit. Implications for both theory and intervention design are discussed.

## **INTRODUCTION**

Coeliac disease is a chronic autoimmune disorder in which sufferers are unable to tolerate dietary gluten (Green and Cellier, 2007). Continued gluten consumption in coeliac disease sufferers leads to significant internal damage (villous atrophy) and consequently, a range of gastrointestinal and malabsorption symptoms (Green and Cellier, 2007). At present the only available treatment for coeliac disease is lifelong adherence to a strict gluten free diet (GFD; Green and Cellier, 2007). If left untreated, or for those not fully adherent to a GFD, coeliac disease has been linked to an increased risk of developing serious long-term health complications including intestinal and bowel cancers, osteoporosis, and infertility (Green and Jabri, 2003). The amount of gluten shown to prevent histological recovery has been reported to be as small as one milligram per day (Biagi et al., 2004), meaning that strict adherence in this population is of the utmost importance.

Despite this, in a systematic review, adherence to the GFD was found to be less than optimal; only 70% of participants (median; range: 36% to 90%) were classified as having strict adherence, although cross-study comparisons were limited by large variations in the measurement and definitions of strict adherence (Hall et al., 2009). Additional limitations of previous research have included the lack of a validated measure of adherence, and study designs whereby factors are studied in isolation rather than attempts to address the interaction between the demographic, disease, emotional, social, and behavioural factors influencing adherence (Hall et al., 2009). Given the seriousness of non-adherence in this population and the level of difficulty inherent in implementing and maintaining any strict dietary behaviour, the identification of such factors is integral so that effective interventions to improve GFD adherence in coeliac disease can be developed.

The theory of planned behaviour (Ajzen, 1991) represents the only theoretical model to have been applied to the understanding and prediction of GFD adherence. Consistent with

the model's hypotheses, it was found that participants with coeliac disease who had more positive attitudes and higher perceptions of control (perceived behavioural control; PBC) had more positive intentions to strictly adhere to the GFD (Sainsbury and Mullan, 2011; Sainsbury et al., 2013a). In turn, individuals with more positive intentions and higher perceptions of control had better adherence (Sainsbury and Mullan, 2011; Sainsbury et al., 2013a). Another study, which also included constructs drawn from the theory of planned behaviour, confirmed these relationships for both intentional and inadvertent gluten consumption (Hall et al., 2013). Despite the demonstrated utility of the theory of planned behaviour in this behaviour, an intention-behaviour gap was found, which was largely attributable to a proportion of the sample (~30%) failing to translate their positive intentions into strict adherence (Sainsbury et al., 2013a). Further examination of the differences between the inclined abstainers (not currently translating their positive intention into action) and inclined actors (consistent positive intention-behaviour relationship; Orbell and Sheeran, 1998; McBroom and Reed, 1992), showed that higher levels of all measured psychological symptoms (depression, anxiety, stress, eating disorder risk) and greater reliance on maladaptive coping strategies were associated with greater difficulty translating positive intentions into strict adherence. Depression in particular also added directly to the prediction of adherence over and above the influence of the theory of planned behaviour (Sainsbury et al., 2013a). While such extended TPB research improves understanding of the prediction of GFD adherence, there is still unaccounted for variance (after theory of planned behaviour variables and depression) suggesting that more research is needed to determine additional factors that impact adherence; in particular those that may limit the translation of intention into behaviour.

In formulating the theory of planned behaviour, Ajzen (1985) initially predicted a PBC-intention interaction, such that intentions should only predict behaviour when a person

*correctly* perceives that the behaviour is under their control. Consistent with this assumption, it was reported that nine of nineteen relevant studies found that higher levels of PBC were associated with stronger intention-behaviour relationships (meta-analysis; Armitage and Conner, 2001). It was, however, noted that interactions were not routinely reported in applications of the theory of planned behaviour, making it difficult to draw conclusions about the true extent of the combined influence of PBC and intention on behaviour (Armitage and Conner, 2001). A potential interaction between PBC and intention might be of particular relevance in the context of GFD adherence, since many individuals with coeliac disease report that they experience difficulty in adhering to the diet despite wanting to do so (e.g., Barratt et al., 2011; Sverker et al., 2005), and therefore a lack of confidence or ability to overcome barriers may limit the translation of positive intentions into behaviour. To date, no intention-based GFD adherence study (i.e., Hall et al., 2013; Sainsbury and Mullan, 2011; Sainsbury et al., 2013a) has specifically investigated this question.

Another post-intentional factor relevant to the translation of intentions into behaviour is habit. Habit, defined as the “the automatic elicitation of behaviour upon encountering specific cues in the context of an activated goal” (Verplanken and Orbell, 2003: 1317), has been linked to behaviour across a range of contexts, including as a moderator of the intention-behaviour gap (Gardner et al., 2011). Habit should be a stronger predictor of behaviours that are repeatedly or continuously performed (Hall and Fong, 2007), and indeed, behavioural frequency is strongly associated with habit formation (Verplanken and Orbell, 2003). There are, however, some important qualifiers to the circumstances under which habit will be predictive of behaviour – these include the stability of the environment in which behaviour is performed (Hall and Fong, 2007), the degree of control one has over behaviour (or the extent to which behaviour requires effort), and how well-learned the behaviour has become (Ouellette and Wood, 1998).

GFD adherence is a complex behaviour, and when habit is defined as above, it is likely that certain aspects of the management of coeliac disease have indeed become habitual. For example, reading labels and identifying gluten-containing ingredients is a discrete behaviour within GFD adherence that has likely become habitual for many people with coeliac disease, as food-labelling laws dictate that allergens must be clearly identified (meaning that there is little room for misinterpretation of the gluten-free status of packaged goods). Similarly, asking questions about ingredients and cross-contamination when eating out is likely habitual, although the environment itself is clearly less stable than the home environment. Engaging in the behaviours relevant to maintaining good GFD adherence does not, of course, actually guarantee success (additional factors include having adequate knowledge to make decisions and ask appropriate questions, as well as factors outside the individual's control such as inadequate knowledge of kitchen and food staff; Sainsbury and Mullan, 2011), in the same way that having a positive intention to adhere does not guarantee actual adherence.

Despite this, the repetitive nature of the discrete behaviours that make up this complex behaviour do suggest that the addition of habit to the TPB may go some way towards narrowing the intention-behaviour gap thus far observed. Specifically, for behaviours that are associated with high demands and are performed in relatively unsupported environments, behaviour is hypothesised to be the joint product of intentions and habit, whereas for low-demand behaviours performed in a supportive environment habit will be the stronger predictor of behaviour, with the influence of intentions being minimal (Hall and Fong, 2007). Thus, regardless of whether GFD adherence is classified as a high- or low-demand behaviour, performed in a supportive or unsupportive environment, the influence of habit on behaviour is likely to be significant.

Taken together, these arguments imply that intention, PBC, and habit are likely to interact with regard to the prediction of GFD adherence. Therefore, the aim of the current study was to extend past research by assessing the role of interactions between habit, intention, and PBC in understanding adherence to a GFD among individuals with coeliac disease. In line with previous research in this area it was expected that the theory of planned behaviour would provide a good model of intention to adhere to a GFD, as well as actual adherence behaviour. It was also expected that interactions between habit, intention, and PBC constructs would account for a significant proportion of variance over and above their independent effects, such that: (1) when an individual has strong habits, the influence of intention on behaviour will be reduced as the need for conscious deliberation or motivation is reduced; (2) individuals with high PBC will be more likely to translate their positive intentions into behaviour; and (3) individuals with high habits and high PBC will be more likely to have good adherence, regardless of their level of intention.

## **METHOD**

### *Participants and procedure*

Participants were recruited from the Coeliac Societies of Victoria/Tasmania, Queensland, and Western Australia. Each organisation included a recruitment advertisement in their general monthly email, which is sent to all members on the first day of each calendar month. Interested members were instructed to click on the link to access the participant information statement, and to provide consent prior to completing the study questionnaire. To be eligible for participation, members needed to have a biopsy-confirmed diagnosis of coeliac disease and be over the age of 18 years. Questionnaires were completed online using Lime Survey and all data were submitted anonymously. This study was approved by the University Human Research Ethics Committee.

## *Measures*

Participants initially completed a demographics questionnaire (e.g., age, gender, and highest level of education) and information about their coeliac disease diagnosis (e.g., age at diagnosis, symptoms experienced prior to diagnosis, GFD duration, and additional intolerances/autoimmune diseases). They then completed the following measures of GFD adherence, theory of planned behaviour variables, and habit.

The Coeliac Dietary Adherence Test (CDAT; Leffler et al., 2009) is a seven-item self-report questionnaire measuring adherence to the GFD in coeliac disease. It consists of items pertaining to coeliac disease-related symptoms, gluten avoidance habits, and self-efficacy, and currently represents the only validated survey designed for this purpose. The CDAT has been shown to correlate highly with the dietitian-rated estimate of adherence (considered the gold standard), and was more accurate at detecting incomplete adherence than several more objective measures (e.g., serological and histological analysis). Each item is rated on a 5-point Likert scale; total scores represent the sum of all responses (range = 7 – 35). In addition to being used as a continuous measure, for the purposes of description patients can be classified as having excellent or very good adherence, moderate adherence, or fair-to-poor adherence. For ease of interpretation within the regression analyses (specifically so that all variables within the interactions were scored in the same direction), CDAT scores were reverse coded such that higher scores indicate *better* adherence within this study (when reversed: excellent or very good = 30 – 35; moderate = 25 – 29; fair-to-poor = 7 – 24).

The Theory of Planned Behaviour Coeliac Disease Questionnaire (Sainsbury and Mullan, 2011) is a 17-item, purpose-designed questionnaire measuring the components of the theory of planned behaviour in relation to adherence to a strict GFD. The intention, attitude, and PBC subscales all have demonstrated internal consistency; the subjective norm subscale was not administered here as it has poor reliability and does not predict intention to adhere to



a strict GFD (Sainsbury and Mullan, 2011). All items are rated on a 7-point Likert scale, with composite scores reflecting the weighted sum of the relevant items. Higher scores indicate more positive intentions and attitudes, and higher perceptions of control.

The Self-Reported Habit Index (Verplanken and Orbell, 2003) is a 12-item questionnaire used to assess habit strength. Participants rated their level of agreement with each of the items in relation to following a strict GFD. Each item is rated on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree); habit strength represents the weighted mean of all items, and higher scores indicate greater habit strength. The self-report habit index is a reliable and validated measurement tool with high test-retest and internal reliability (Verplanken and Orbell, 2003). An important distinction between the measurement of habit in relation to a GFD and the included measure of behaviour (CDAT) is that whereas the CDAT indicates the degree to which an individual has been *successfully* able to adhere to the diet, the habit index reflects only the degree to which performance of the behaviours relevant to adherence have become automatic.

#### *Data analysis*

Pearson's correlations were used to examine the associations between GFD adherence and each of the theory of planned behaviour variables, and habit strength. A hierarchical regression analysis was conducted to confirm the significant predictors of intention (attitude and PBC). A second hierarchical regression analysis was used to determine the significant predictors of GFD adherence. As per the TPB, intention and PBC were added at step 1, followed by habit strength (step 2), and the following interaction terms: intention\*PBC; intention\*habit; habit\*PBC; habit\*PBC\*intention (step 3). All independent variables were mean centered prior to the calculation of interaction terms and these mean centered variables were used in the regression analyses.

The conduct of the above regression analysis and the interpretation of the three-way interaction was based on guidelines by Dawson and Richter (2006), which state that each independent variable should be entered separately into the model (steps 1 and 2 above), followed by the possible two-way interactions (i.e., intention x habit, intention x PBC, habit x PBC), and the three-way interaction of interest (step 3). When the three-way interaction is significant in contributing to the prediction of the dependent variable over and above the separate effects of the independent variables (as in Table 2), there is no need to interpret the two-way interactions. Significant three-way interactions are then graphed (as in Figure 1) and subject to a test of the difference in simple slopes between each of the four possible combinations of high and low values for the two moderators (i.e., high habit/high PBC; high habit/low PBC; low habit/high PBC; low habit/low PBC) in their effects on the relationship between the independent and dependent variables (i.e., the intention-behaviour relationship). Thus, six pairwise comparisons are conducted, with significant *p*-values indicating that there is a significant difference between the two particular slopes of interest (as in Table 3). High and low values of each variable are defined as one standard deviation above and below the mean for each target variable respectively (i.e., intention, habit, and PBC; Dawson and Richter, 2006).

## **RESULTS**

### *Sample characteristics*

The final sample consisted of 228 individuals with biopsy-confirmed coeliac disease (89.5% female; mean age = 45.2, range = 18 – 80 years, *SD* = 14.3). The mean age at diagnosis was 37.5 years (*SD* = 14.3), and participants had been on a GFD for an average of 7.3 years (range = 2 months – 48.5 years; *SD* = 7.4). Participants had been experiencing symptoms for an average of 10.7 years (*SD* = 14.3; range = 0 months – 74 years) prior to diagnosis and the most commonly reported symptoms at this time were fatigue, weakness, or

lethargy (81.1%), flatulence or abdominal distention (71.5%), cramping or bloating (65.4%), diarrhoea (61.8%), and anaemia (58.3%). When consuming gluten since diagnosis and onset of the GFD, participants reported experiencing mild (9.6%), moderate (21.9%), severe (21.5%), or very severe symptoms (22.4%) with 3.9% experiencing no symptoms and 20.6% unsure/have not consumed gluten. Thirty-one percent of the sample reported a family history of coeliac disease; 29.4% reported suffering from non-gluten food intolerances (most commonly dairy:  $n = 41$ ), and 27.6% reported suffering from another autoimmune disorder.

#### *Descriptive statistics*

The mean score for GFD adherence fell in the excellent or very good range, with 68% of the sample falling in this range (24.1% moderate, 7.9% fair-to-poor). As seen in Table 1, participants generally had very positive intentions and perceptions of control, while attitude and habit scores were slightly lower. There were no significant gender differences on any of the variables of interest (all  $p > .05$ ). All the variables were significantly inter-correlated such that better GFD adherence was associated with more positive intentions and attitudes, higher perceptions of control, and stronger habits. Positive relationships between the theory of planned behaviour variables and habit scores were also observed.

#### *Predicting intention*

As can be seen in Table 2, attitude and PBC accounted for 24.2% of the variance in intention to adhere to a strict GFD, with both variables making significant independent contributions to the model.

#### *Predicting GFD adherence*

At step 1, intention and PBC accounted for 18.2% of the variance in GFD adherence, although only PBC was an independent predictor (see Table 2). At step 2, habit contributed a further 0.6% to the model but was not significant. Finally, the addition of the interaction

terms accounted for an additional 11.6% of the variance in behaviour. The three-way interaction between intention, PBC, and habit was a significant predictor of adherence.

**INSERT TABLE 2 ABOUT HERE**

As can be seen in Table 3, the test for the difference between slopes (Dawson and Richter, 2006) revealed that the relationship between intention and behaviour for individual's with high habit and low PBC was significantly different to the intention-behaviour relationship for the other three groups (i.e., high habit/high PBC, low habit/high PBC, and low habit/low PBC). As can be seen in Figure 1, for individuals with high habit and low PBC, GFD adherence improved as a function of intention, whereas for the other three slopes behaviour did not change according to differences in intention (all  $p > .05$ ). Figure 1 also shows that individuals with high habits and high PBC, and those with low habits and high PBC had reasonably good adherence regardless of intention, whereas those with low habits and low PBC had poorer adherence (again regardless of intention).

**INSERT TABLE 3 ABOUT HERE**

**INSERT FIGURE 1 ABOUT HERE**

*Discussion*

The primary aim of this study was to determine the influence of habit and PBC in moderating the intention-behaviour relationship in GFD adherence in coeliac disease. The secondary aim was to replicate previous findings in demonstrating that the theory of planned behaviour provides a good fit for the factors influencing GFD adherence. Previous research using the theory of planned behaviour in coeliac disease found that participants who had more positive attitudes and higher perceptions of control over their ability to adhere to a strict GFD had more positive intentions (Sainsbury and Mullan, 2011; Sainsbury et al., 2013a; Hall et al., 2013). As expected, this pattern of significant predictors was replicated here. Specifically, attitude and PBC accounted for a quarter of the variance in intention, which was

lower than in previous studies (37-46%; Sainsbury and Mullan, 2011; Sainsbury et al., 2013a; Hall et al., 2013), despite the mean scores for all TPB variables being comparable. This may reflect the additional, although non-significant, variance accounted for by subjective norm, which was not included here due to its poor predictive capacity in previous studies.

To date, studies that have investigated the role of intention in GFD adherence within a theory of planned behaviour framework have reported mixed findings. For example, Sainsbury and Mullan (2011) found that although intention and adherence were significantly correlated, only PBC made a significant independent contribution to the prediction of GFD adherence. In contrast, when also including measures of GFD knowledge and symptom severity, Sainsbury et al. (2013a) found that both intention and PBC predicted adherence. Finally, Hall et al. (2013) found that while self-efficacy was an important predictor of both inadvertent and intentional gluten consumption, intention was only significant in the prediction of the latter. Consistent with two of these studies (Sainsbury et al., 2013a; Hall et al., 2013), this study found that despite a positive association between intention and adherence, when PBC was included in the model, intention was not a significant independent predictor of GFD adherence. Of note, the correlation observed between intention and GFD adherence here ( $r = .19$ ) was lower than in previous studies ( $r = .30 - .49$ ; Sainsbury, 2013; Sainsbury and Mullan, 2011; Sainsbury et al., 2013a), although the reason for this discrepancy is unclear. Some possibilities are that restricted variance in intention (scores ranged from 3 – 7, with 89% scoring 6 or 7) and a near ceiling effect limited the strength of the correlation, or that differences in participant characteristics obscured the results – that is, the strongest correlation was observed in an intervention study (Sainsbury et al., 2013b), whereas other studies have utilised cross-sectional, one-off data collection designs.

In addition to the weaker intention-behaviour relationship, based on the subsequent steps in the regression model, it would appear that the failure of intention to predict behaviour

might also partially reflect the influence of PBC and habit in moderating the intention-behaviour relationship. This study is novel in that it is both the first to examine the role of habit in predicting GFD adherence among individuals with coeliac disease and the first to examine the effect of habit and PBC in moderating the intention-behaviour relationship. The addition of the interaction between intention, PBC, and habit goes some way towards narrowing the intention-behaviour gap and determining the conditions under which people with coeliac disease are most likely to exhibit good adherence. In particular, these results may explain discrepant findings between studies, since intention does predict adherence under some circumstances. Specifically, it appears that among individuals who perceived that they had little control over their adherence to the GFD *but* reported that their adherence was habitual, adherence increased as a function of intention. This is contrary to the hypothesis that strong habits would negate the need for good intentions and generally inconsistent with previous studies that have examined the interaction of habit and intention within the theory of planned behaviour in other health behaviours (e.g., de Bruijn et al., 2007; Danner et al., 2008). Although the reason for this discrepancy is not clear, it may indicate the greater need for a combination of intentions and habit for complex behaviours that involve the performance of multiple actions such as those required to successfully adhere to the GFD, as well as in circumstances when an individual is not overly confident in their ability to perform the behaviour in question (i.e., low PBC). Indeed, no previous study has included both habit and PBC as joint moderators of the intention-behaviour relationship and as such it is difficult to directly compare this unique and unexpected finding. Given the complexity of adherence in coeliac disease, it may be useful to differentiate the specific behaviours necessary to ensure good adherence (e.g., label reading, asking questions about cross-contamination) in order to determine the impact of habit, PBC, and intention on the performance of each of these. For other individuals (i.e., individuals with low PBC/low habit; high PBC/high habit; high

PBC/low habit), intention had no effect on adherence. From a statistical point of view, again the near ceiling effect observed for intention probably also partially account for why intention was not more widely predictive of behaviour.

Given Ajzen's prior work on PBC, it was expected that intention would be a stronger predictor of behaviour when PBC was high. This is because a lack of control over behaviour which stops an individual from being able to enact their intentions is the usual mechanism proposed for why PBC might moderate the intention-behaviour relationship (Ajzen, 1985). Instead, intention only predicted behaviour when PBC was low and habit was high. As such, it appeared that individuals were able to compensate for low PBC through a combination of habit and intention. Again, given that most individuals appear to be relatively confident in their ability to adhere to the diet (high PBC), and habit appears to be predictive of adherence only when PBC is low, the failure of habit to uniquely predict behaviour is likely a statistical artefact rather than an indicator that its influence is not important.

In addition to understanding the extent to which intention predicted adherence under different circumstances, it is also useful to consider average adherence scores for individuals with different combinations of PBC, habit, and intention. Adherence was relatively low for those individuals who reported a combination of low habit and low PBC (regardless of low or high intention). This suggests that intention in the absence of good habits and confidence is not enough to ensure adequate adherence. Indeed, this is one of the major criticisms of the theory of planned behaviour – that while the model generally provides a good account of the motivational influences on behaviour (i.e., the pre-intention variables), its ability to account for variance in behaviour is more limited due to the lack of volitional determinants (e.g., habit) included in the model (Conner and Armitage, 1998; Sheeran, 2002). Conversely, adherence to the GFD was relatively high among those with high PBC regardless of their intention or reported habit strength, and for those who reported a combination of high habit,

high intention, and low PBC. In this manner it appears that while PBC generally predicted adherence, individuals were able to compensate for a lack of PBC through a combination of strong habits and intention. This has implications for interventions in this population and suggests that interventions need to be tailored to individuals dependent upon their pre-intervention levels of PBC, intention and habit.

Given the difficulty of maintaining a GFD and its lifelong nature, it would be expected that both habit and PBC would strengthen with increased (successful) time on the diet. Despite this, the majority of studies have failed to confirm a relationship between time since diagnosis or GFD duration and adherence (Hall et al., 2009). In contrast, significant positive correlations were observed between GFD duration and each of PBC, habit strength, and GFD adherence, but not intention within this study (not reported). While beyond the scope of this study, an important question for future research is how the interaction between intention, habit, and PBC changes with increased time on the GFD, as differences may indicate that intervention efforts need also differ depending on the particular characteristics of the sample.

#### *Limitations and conclusions*

There are several limitations of this study that should be considered when interpreting the findings. Firstly, recruitment was limited to members of the Coeliac Society, and as such may have been biased towards a more adherent sample than is typical within the wider coeliac disease population. Despite this, there was a reasonable range in the observed adherence scores, and a very similar breakdown in adherence categories when compared to previous studies that have used the CDAT to measure adherence (Sainsbury and Mullan, 2011; Sainsbury et al., 2013a; Sainsbury et al., 2013b; van Hees et al., 2014). It is, however, important to note that the vast majority of this (and previous) samples had very positive intentions and PBC (Sainsbury and Mullan, 2011; Sainsbury et al., 2013a). Thus, it may be



the case that restricted variance in the *independent* variables limited the ability of these constructs to account for unique variance in adherence. Despite the attractiveness of this possibility on statistical grounds, however, from a practical point of view, it appears that individuals with negative intentions to adhere to the GFD are few in number, meaning that a more evenly distributed sample would be difficult to find and is unlikely to offer additional insight into the target relationships.

Secondly, the cross-sectional nature of data collection means that the direction of the relationships between adherence, intention, PBC, and habit cannot be confirmed. As previously mentioned, it is possible that the duration of the GFD may account for some of the differences in PBC and habit in particular, and this will be an important avenue for further research. Further, although not encompassed by the theory of planned behaviour, there are likely positive feedback loops occurring whereby successful adherence leads to subsequent improvements in PBC (as confidence comes from previous successes) and intention (as improvements in gastrointestinal symptoms resulting from improved adherence increase the salience of the need for a strict GFD and therefore boost motivation). Finally, the use of online, self-report questionnaires to assess the constructs of interest may have led to an overestimation of habit and adherence, as well as the accuracy of PBC as a proxy for actual behavioural control. Regarding habit in particular, it may be useful in future research to differentiate between the discrete behaviours required to maintain adherence (i.e., label reading, asking questions about contamination etc.), as it is possible that different behaviours are more or less habitual than others, and this may impact the findings and specifically the potential of this variable to account for unique variance in GFD adherence. Although the findings were comparable to previous studies and validated measures of all constructs were utilised, the results would also be strengthened by the inclusion of the more objective ‘gold standard’ dietitian rated estimate of adherence (Leffler et al., 2007).

This study was the first to investigate potential moderators of the intention-behaviour relationship within the context of GFD adherence in coeliac disease – specifically, the combined roles of habit and PBC. Based on theoretical and empirical work on the influence of PBC and habit on behaviour, it was expected that these constructs would act as important boundary conditions for the intention-behaviour relationship within the context of GFD adherence. Overall, the pattern of results support this expectation, since intention appeared to only predict behaviour when PBC was low and habit was high. This is an important advancement in research within this area, since it provides partial insight into why intention may have been a relatively weak predictor of adherence to the GFD in previous studies (Hall et al., 2013; Sainsbury et al., 2013a).

Further, when combined with the observation that the majority of individuals with coeliac disease already have very positive intentions to adhere to the GFD, these results suggest that attempts to increase adherence by targeting intention may meet with limited success. Instead, skills to manage the complexities of the GFD (e.g., problem solving and assertive communication; akin to improving *actual* behavioural control, although also likely to improve *perceived* control) may be a more useful target for interventions to improve GFD adherence, the repeated performance of which is likely to strengthen the habitual component of these behaviours. Indeed, a recently published intervention which included such behaviour change techniques was shown to successfully improve GFD adherence relative to a waitlist control group (Sainsbury et al., 2013b). Given the significant interaction results observed here, however, it appears that interventions would benefit from targeting the combination of intentions, behavioural skills, and habits in order to be successful in achieving and maintaining strict adherence to the GFD.

## References

- Ajzen I. (1985) From intentions to actions: A theory of planned behavior. In: Kuhl J and Beckmann J (eds) *Action-control: From cognition to behavior* Heidelberg: Springer, 11-39.
- Ajzen I. (1991) The theory of planned behavior. *Organisational Behaviour and Human Decision Processes* 50: 179-211.
- Armitage CJ and Conner M. (2001) Efficacy of the theory of planned behaviour: A meta-analytic review. *The British Journal of Social Psychology* 40: 471-499.
- Barratt SM, Leeds JS and Sanders DS. (2011) Quality of life in coeliac disease is determined by perceived degree of difficulty adhering to a gluten-free diet, not the level of dietary adherence ultimately achieved. *Journal of Gastrointestinal and Liver Disease* 20: 241-245.
- Biagi F, Campanella J, Martucci S, et al. (2004) A milligram of gluten a day keeps the mucosal recovery away: A case report. *Nutrition Reviews* 62: 360 -363.
- Conner M and Armitage CJ. (1998) Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology* 28: 1429-1464.
- Danner UN, Aarts H and de Vries NK. (2008) Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour. *British Journal of Social Psychology* 47: 245-265.
- Dawson JF and Richter AW. (2006) Probing three-way interactions in moderated multiple regression: development and application of a slope difference test. *Journal of Applied Psychology* 91: 917.

- de Bruijn G-J, Kremers SPJ, de Vet E, et al. (2007) Does habit strength moderate the intention-behaviour relationship in the theory of planned behaviour? The case of fruit consumption. *Psychology and Health* 22: 899-916.
- Gardner B, de Bruijn G-J and Lally P. (2011) A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine* 42: 174-187.
- Green PHR and Cellier C. (2007) Celiac disease. *The New England Journal of Medicine* 357: 1731-1743.
- Green PHR and Jabri B. (2003) Coeliac disease. *Lancet* 362: 383-391.
- Hall NH, Rubin GP and Charnock A. (2013) Intentional and inadvertent non-adherence in adult coeliac disease: A cross-sectional survey. *Appetite* 68: 56-62.
- Hall NJ, Rubin G and Charnock A. (2009) Systematic review: Adherence to a gluten-free diet in adult patients with coeliac disease. *Alimentary Pharmacology and Therapeutics* 30: 315-330.
- Hall PA and Fong GT. (2007) Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review* 1: 6-52.
- Leffler DA, Dennis M, Edwards-George J, et al. (2009) A simple validated gluten-free diet adherence survey for adults with celiac disease. *Clinical Gastroenterology and Hepatology* 7: 530-536.
- Leffler DA, Edwards-George J, Dennis M, et al. (2007) A prospective comparative study of five measures of gluten-free diet adherence in adults with coeliac disease. *Alimentary Pharmacology and Therapeutics* 26: 1227-1235.
- McBroom WH and Reed FW. (1992) Toward a reconceptualization of attitude-behavior consistency. *Social Psychology Quarterly*: 205-216.

- Orbell S and Sheeran P. (1998) 'Inclined abstainers': A problem for predicting health-related behaviour. *British Journal of Social Psychology* 37: 151-165.
- Ouellette JA and Wood W. (1998) Habit and intention in everyday life: the multiple processes by which past behavior predicts future behavior. *Psychological Bulletin* 124: 54.
- Sainsbury K. (2013) Adherence to the gluten free diet in coeliac disease: An intervention mapping approach using the theory of planned behaviour and psychological symptoms. *Clinical Psychology Unit*. The University of Sydney.
- Sainsbury K and Mullan B. (2011) Measuring beliefs about gluten free diet adherence in adult coeliac disease using the theory of planned behaviour. *Appetite* 56: 476-483.
- Sainsbury K, Mullan B and Sharpe L. (2013a) Gluten free diet adherence in coeliac disease: The role of psychological symptoms in bridging the intention-behaviour gap *Appetite* 61: 52-58.
- Sainsbury K, Mullan B and Sharpe L. (2013b) A randomized controlled trial of an online intervention to improve gluten free diet adherence in celiac disease. *American Journal of Gastroenterology* 108: 811-817.
- Sheeran P. (2002) Intention-behavior relations: A conceptual and empirical review. *European Review of Social Psychology* 12: 1-36.
- Sverker A, Hensing G and Hallert C. (2005) 'Controlled by food'- Lived experiences of coeliac disease. *Journal of Human Nutrition and Dietetics* 18: 171-180.
- van Hees NJM, Giltay EJ, Geleijnse JM, et al. (2014) DHA serum levels were significantly higher in celiac disease patients compared to healthy controls and were unrelated to depression. *PLoS ONE* 9: e97778.
- Verplanken B and Orbell S. (2003) Reflections on Past Behavior: A Self-Report Index of Habit Strength. *Journal of Applied Social Psychology* 33: 1313-1330.



**Table 1.** Means (SD) and correlations between GFD adherence, theory of planned behaviour variables, and habit

	Mean (SD)	Range	Intention	Attitude	PBC	Habit
GFD adherence (R)	30.61 (3.4)	16 – 35	.191**	.347***	.426***	.240***
Intention	6.7 (0.7)	3 – 7	-	.287***	.475***	.201**
Attitude	5.8 (0.8)	3.4 – 7	-	-	.351***	.350***
PBC	6.5 (0.6)	3 – 7	-	-	-	.400***
Habit	5.8 (1.3)	1 – 7	-	-	-	-

Note: SD = standard deviation; GFD = gluten free diet; PBC = perceived behavioural control; Possible range of scores: TPB variables (intention, attitude, PBC) = 1 – 7; Habit = 1 – 7; GFD adherence (reverse coded) = 7 – 35 (higher scores indicate *better* adherence; \*\*\*  $p < .001$ , \*\*  $p < .01$ ).

**Table 2.** Regression model predicting intention and GFD adherence (reverse coded CDAT scores)

	$\beta$	$R^2 \Delta$	$F$	$p$
Predicting Intention				
Step 1		.242	35.978	< .001
Attitude	.136			.029
PBC	.473			< .001
Predicting GFD adherence				
Step 1		.182	24.972	<.001
Intention	-.014			.835
PBC	.433			<.001
Step 2		.006	17.228	.207
Intention	-.016			.821
PBC	.083			<.001
Habit	.077			.207
Step 3		.116	13.698	<.001
Intention	.092			.182
PBC	.438			<.001
Habit	.123			.052
Intention * PBC	-.296			.090
Intention * Habit	.252			.013
Habit * PBC	-.451			<.001
Intention * Habit * PBC	-.731			<.001

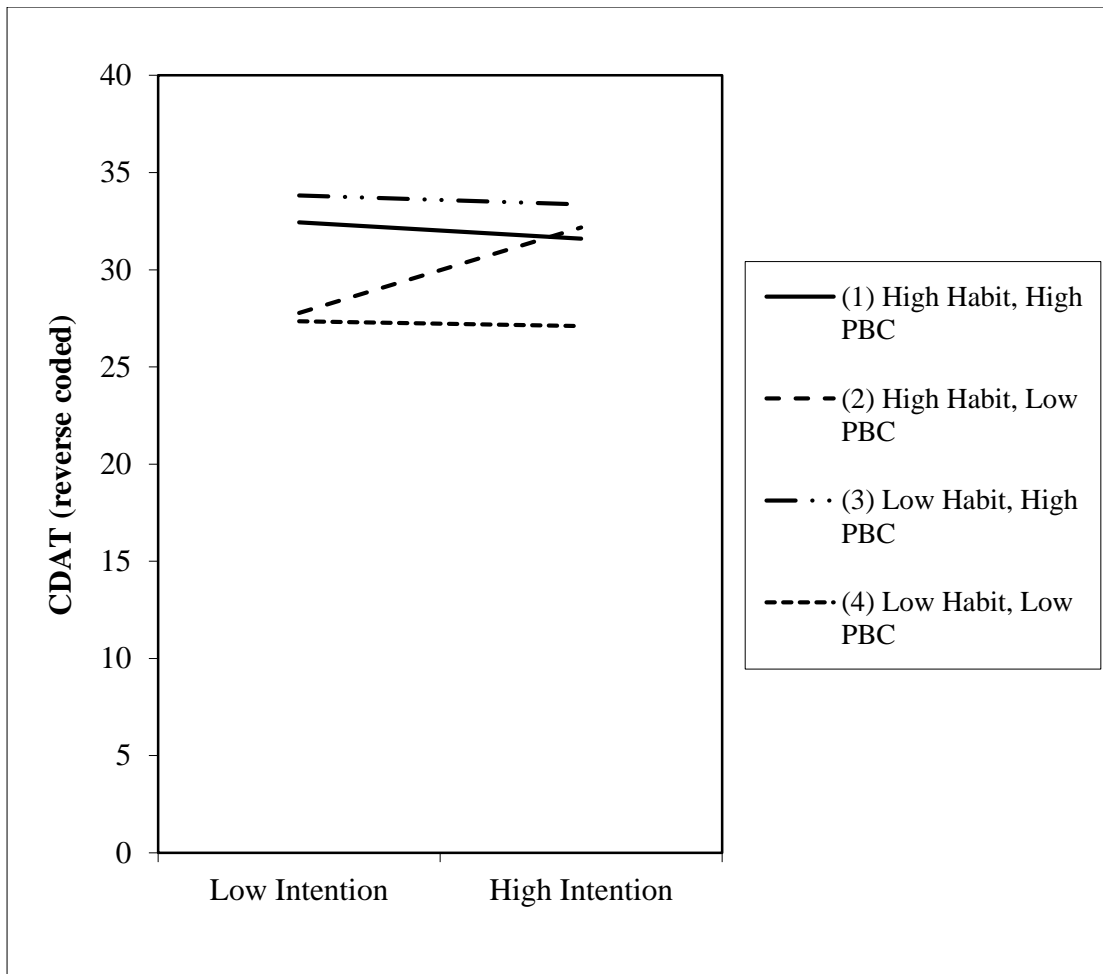
Note: PBC = perceived behavioural control



**Table 3.** Evaluation of differences in the intention-behaviour relationship for each level of habit and PBC.

Pair of slopes	<i>t</i>	<i>p</i>
High Habit/High PBC vs. <b>High Habit/Low PBC</b>	-2.155	<b>0.032</b>
High Habit/High PBC vs. Low Habit/High PBC	-0.299	0.765
High Habit/High PBC vs. Low Habit/Low PBC	-0.284	0.776
<b>High Habit/Low PBC</b> vs. Low Habit/High PBC	2.253	<b>0.025</b>
<b>High Habit/Low PBC</b> vs. Low Habit/Low PBC	5.100	<b>&lt;0.001</b>
Low Habit/High PBC vs. Low Habit/Low PBC	-0.145	0.885

Note: PBC = perceived behavioural control; *t* and *p* values derived from the Dawson and Richter test of the difference between slopes in a three-way interaction.



**Figure 1.** Three-way interaction effect showing the impact of different combinations of habit and PBC on the intention-behaviour (GFD adherence) relationship

Note: CDAT scores are reverse coded (higher scores indicate *better* adherence): excellent or very good = 30 – 35; moderate = 25 – 29; fair-to-poor = 7 – 24).