Examining the predictive utility of an extended theory of planned behaviour

model in the context of specific individual safe food-handling.

Barbara Mullan[1], Vanessa Allom[1], Kirby Sainsbury[1], Lauren A. Monds[1,2]

[1] School of Psychology and Speech Pathology, Curtin University, Perth, WA, Australia

[2] School of Psychology, University of Sydney, Sydney, NSW, Australia

Correspondence should be addressed to: A/Prof. Barbara Mullan, Health Psychology & Behavioural Medicine Research Group, School of Psychology and Speech Pathology, Curtin University, WA, Australia; e-mail: barbara.mullan@curtin.edu.au; ph: +61 8 9266 2468.

1   **Examining the predictive utility of an extended theory of planned behavior model in the**
2   **context of specific individual safe food-handling.**

1   **Abstract**

2

3   Background: In order to minimise the occurrence of food-borne illness, it is recommended

4   that individuals perform safe food-handling behaviours, such as cooking food properly,

5   cleaning hands and surfaces before preparing food, keeping food at the correct temperature,

6   and avoiding unsafe foods. Previous research examining the determinants of safe food-

7   handling behaviour has producing mixed results; however, this may be due to the fact that

8   this research examined these behaviours as a totality, rather than considering the determinants

9   of each behaviour separately. As such, the objective for the present study was to examine the

10   predictors of the four aforementioned safe food-handling behaviours by applying an extended

11   theory of planned behaviour to the prediction of each distinct behaviour. Method: Participants

12   were 170 students who completed theory of planned behaviour measures, with the addition of

13   moral norm and habit strength at time 1, and behaviour measures one week later.

14   Results: While the influence of injunctive and descriptive norm and perceived behavioural

15   control differed between behaviours, it appeared that moral norm was an important predictor

16   of intention to engage in each of the four behaviours. Similarly, habit strength was an

17   important predictor of each of the behaviours and moderated the relationship between

18   intention and behaviour for the behaviour of avoiding unsafe food.

19   Conclusion: The implication of these findings is that examining safe food-handling

20   behaviours separately, rather than as a totality, may result in meaningful distinctions between

21   the predictors of these behaviours.

22   **Keywords:** The theory of planned behaviour, food-handling behaviours, food safety,

23   habit, moral norm

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1   **Introduction**

2   Foodborne disease is a global problem (Kuchenmüller et al., 2009) that not only affects

3   individual health and wellbeing, but also impacts upon society by way of extensive costs

4   related to both sick leave and medical expenses (Hall et al., 2005; Mullan, 2009). Data from

5   Australia and North America shows that approximately one quarter of the population will

6   experience illness due to foodborne pathogens each year (McKercher, 2012; Scallan et al.,

7   2011). It has, however, been suggested that this approximation underestimates the true rate of

8   foodborne disease, as many individuals do not seek medical treatment, resulting in an

9   underreporting of cases (Hall, Yohannes, Raupach, Becker, & Kirk, 2008; Majowicz et al.,

10   2005). Additionally, recent data suggests that the incidence of foodborne disease is increasing

11   (McKercher, 2012).

12   A substantial proportion of foodborne disease occurs in the home (Griffith, Mullan, &

13   Price, 1995), with estimates ranging from 50% to 87% (Clayton, Griffith, & Price, 2003).

14   Fortunately, many of these illnesses are preventable by safe food-handling behaviours

15   exercised during all stages of food preparation and storage (Scharff, 2010). For example,

16   early research suggested that correct temperature control, avoiding preparation of food too far

17   in advance of cooking, and avoiding cross-contamination from other foods and utensils, can

18   all reduce the risk of foodborne disease (Roberts, 1982; Bryan, 1988 as cited in Mullan,

19   2009). More recently, Azevedo, Albano, Silva, and Teixeira (2014) proposed that correct

20   hand hygiene and taking precautions when cooking, storing, and preparing food, could also

21   reduce this risk. Specifically in Australia, the National guidelines recommend that the

22   following four behaviours should be performed in order to minimise the occurrence of

23   foodborne disease: 'cook food properly', 'clean hands and surfaces before preparing food',

24   'keep food at the correct temperature', and 'avoid unsafe foods' (Food Safety and Regulatory

25   Activities, 2011). Previous research attempting to predict and explain engagement in safe

1   food-handling behaviour has produced inconsistent results (for a review, see: Redmond &

2   Griffith, 2003). This may be due to the fact that the majority of research to date has

3   considered safe food-handling behaviours as a totality (Mullan, Wong, Davis, Todd, &

4   Kothe, In Press), rather than considering the determinants of each of the different behaviours

5   separately. Given the variety of behaviours corresponding to safe food-handling (Azevedo et

6   al., 2014; Food Safety and Regulatory Activities, 2011), it is likely that individual safe food-

7   handling behaviours are determined by different factors.

8   Various theoretical frameworks have been applied to the explanation and prediction of

9   safe food-handling behaviours, including the Health Action Process Approach (Chow &

10 Mullan, 2010), and the Health Belief Model (Bearth, Cousin, & Siegrist, 2014; Rimal, 2000).

11 The model that appears to account for the most variance in behaviour is, however, the Theory

12 of Planned Behaviour (TPB; Mari, Tiozzo, Capozza, & Ravarotto, 2012; Mullan & Wong,

13 2009; Mullan, Wong, & Kothe, 2013; Seaman & Eves, 2010; Shapiro, Porticella, Jiang, &

14 Gravani, 2011), which has been applied to both overall safe food-handling behaviour, as well

15 as specific behaviours including hand hygiene (Clayton & Griffith, 2008) and cooking food

16 properly (Mari et al., 2012).

17   The TPB posits that the most proximal predictor of behaviour is one's intention to

18 perform that behaviour (Ajzen, 1991). Intention is in turn influenced by perceptions of the

19 likely outcome of behaviour and an evaluation of these outcomes as positive or negative

20 (attitudes), perceptions of pressure from significant others to perform the behaviour

21 (subjective norm), and perceptions of confidence or self-efficacy in overcoming any barriers

22 to the performance of the behaviour (perceived behavioural control; PBC). The TPB has been

23 shown to be a valid model in the prediction of intentions and behaviour across a wide range

24 of health-related behaviours (Armitage & Conner, 2001; McEachan, Conner, Taylor, &

25 Lawton, 2011). Regarding safe food-handling behaviours, the TPB constructs of attitude,

4

1   subjective norm, and PBC have been shown to account for two thirds of the variance in

2   intention to perform safe food-handling behaviours, although only subjective norms and

3   PBC, not attitudes, were significant predictors (Mullan & Wong, 2009).

4   Applications of the TPB to the prediction of safe food-handling behaviours do,

5   however, result in a finding that is common within the TPB literature; that is, that a

6   proportion of individuals fail to translate their positive intentions into behaviour, leaving

7   what is commonly referred to as the 'intention-behaviour gap' (Sheeran, 2002). For example,

8   Mullan and Wong (2009) found that intention only predicted 21 percent of the variance in

9   safe food-handling behaviour, leaving a significant proportion of the variance unexplained.

10 Consequently, the TPB, which is primarily a motivational rather than a volitional model, has

11 been criticised as being incomplete (Sniehotta, Presseau, & Araújo-Soares, 2014), and

12 numerous researchers have therefore included additional variables in attempts to improve the

13 prediction of behaviour and explain why some individuals fail to translate their (usually)

14 positive intentions into action (e.g., Reuter et al., 2010; Sainsbury, Mullan, & Sharpe, 2013;

15 Sniehotta, Scholz, & Schwarzer, 2005).

16   Moral norm is one variable that has been added to the standard TPB, both as a pre-

17 intentional predictor (Conner & Armitage, 1998; Manstead, 2000) and a direct predictor of

18 behaviour (Godin, Gagnon, Lambert, & Conner, 2005), as well as specifically to bridge the

19 gap between intentions and behaviour (Godin, Conner, & Sheeran, 2005). Moral norm refers

20 to the perceived moral correctness or incorrectness of a particular behaviour (Ajzen, 1991),

21 and is used to aid in the prediction of behaviours that have consequences beyond the

22 individual – for example, driving under the influence of alcohol (Moan & Rise, 2011) and

23 condom use (Godin, Gagnon, et al., 2005). Conner and Armitage (1998) reported an average

24 increase in the prediction of intention of four percent when moral norms were included in

25 addition to the standard TPB pre-intention variables (based on 11 studies).

1   Regarding the influence of moral norms on behaviour, Godin, Conner, et al. (2005)

2   conducted a moderation analysis using data from five previously conducted studies and

3   demonstrated that 'morally-aligned intentions' – intentions formed on the basis of the

4   perceived moral correctness of a behaviour – were better predictors of behaviour than

5   intentions that were formed based on the likely outcomes of a behaviour ('attitudinally-

6   aligned intentions'). Interestingly, despite evidence of an overall moderation effect, this was

7   only significant for the behaviours of smoking, driving over the speed limit, and nurses' use

8   of universal precautions, all of which would be considered to have a moral component as

9   such actions have the potential to impact other people. In contrast, in the two included studies

10   that measured physical activity – a behaviour that only minimally involves or impacts other

11   people – there was no evidence for a distinction between morally- or attitudinally-aligned

12   intentions on behaviour (Godin, Conner, et al., 2005). Given that cooking and food

13   preparation is an activity often performed for other people, the inclusion of a variable that

14   accounts for whether individuals consider the moral consequences of their actions may be of

15   particular value here (see Clayton & Griffith, 2008, for a relevant study investigating moral

16   norm in hand hygiene behaviours for caterers).

17   Another variable that has been proposed in order to narrow and explain the intention-

18   behaviour gap is habit strength (Gardner, de Bruijn, & Lally, 2011) – that is, the degree to

19   which the performance of a particular behaviour has become habitual or automatised

20   (Verplanken & Orbell, 2003). Habit strength represents another variable that may be of

21   particular importance in determining safe food-handling behaviour because for many

22   individuals food preparation is likely a repeatedly and routinely performed activity. Ouellette

23   and Wood (1998) contend that behaviours that are performed consistently in stable conditions

24   eventually become habitual and are executed without the need for conscious intention. Given

25   that the context involved in safe food-handling behaviour is typically consistent (i.e., the

1   kitchen), it is likely that the enactment of certain safe food-handling behaviours have become

2   habitual for many people. Indeed, Brennan, McCarthy and Ritson (2007) found that in

3   relation to engaging in safe food-handling behaviours, habit and past experience were

4   important predictors of future behaviour. Therefore, it may be useful to also account for the

5   role of habit in addition to the TPB variables in the prediction of safe food-handling

6   behaviour.

7   ***Study Aims and Hypotheses***

8   The aim of this study was to employ an extended TPB model in an attempt to improve

9   the prediction of the performance of specific safe food-handling behaviours. In particular, the

10   variables of moral norm and habit strength were added to the model and applied to the

11   prediction of four distinct safe food-handling behaviours in order to determine: (1) whether

12   these elements would add to the prediction of intention and behaviour over and above the

13   standard TPB; (2) whether the TPB and additional variables differentially predicted specific

14   safe food-handling behaviours; and (3) whether the addition of habit in particular moderated

15   the intention-behaviour gap. It was hypothesised that the TPB variables of attitude, subjective

16   norm, and PBC would significantly predict the intention to perform each of the four safe

17   food-handling behaviours, and that moral norm would add to the prediction when added after

18   the standard TPB variables. Regarding behaviour, it was predicted that intention and PBC

19   would significantly predict each of the four safe food-handling behaviours, and that habit

20   strength would add to the prediction when added after the TPB variables. Finally, it was

21   hypothesised that habit would interact with intention to predict behaviour, such that intention

22   would not guide the behaviour of individuals with strong safe food-handling behaviour

23   habits.

24   **Method**

25   ***Design***

1   A prospective design was employed, in which the variables hypothesised to predict

2 intention and behaviour were measured at Time 1, and engagement in safe food-handling

3 behaviours was assessed one week later at Time 2.

4 ***Participants***

5   Participants were recruited via the University research participation pool scheme, and

6 those who chose to volunteer were provided with course credit for participation. Eligibility

7 requirements included that participants had to regularly handle and cook food. It was made

8 clear to students enrolled in the scheme that participation was entirely voluntary. The

9 University's Human Research Ethics Committee approved the study, and all participants gave

10 informed consent prior to participation.

11 ***Materials***

12 *Demographics*

13   Participants reported their gender, age, living situation, and ethnicity.

14 *Theory of Planned Behaviour*

15   Attitudes, subjective norm, PBC, and intention were measured using previously

16 validated questionnaire items, modified to assess each of four distinct safe food-handling

17 behaviours: (1) Cooking food properly; (2) Cleaning hands and surfaces before preparing

18 food; (3) Keeping food at the correct temperature; (4) Avoiding unsafe foods. All items were

19 modified in line with the TPB guidelines (Ajzen, 2002; Francis et al., 2004).

20   Attitudes were assessed as the mean of six semantic differential scales for each

21 behaviour ("For me, cooking food properly/cleaning hands and surfaces before preparing

22 food/keeping food at the correct temperature/avoiding unsafe foods every time I prepare food

23 over the next week would be: very bad – very good, very unnecessary – very necessary, very

24 unpleasant – very pleasant, very unenjoyable – very enjoyable, very beneficial – very

25 harmful, very foolish – very wise"). Participants rated these items on a scale from 1–7 with a

1 higher score indicating a more positive attitude. The following internal consistency estimates

2 were obtained in this sample (cook food properly: $\alpha = .882$; wash hands/clean surfaces: $\alpha =$

3 .848; correct temperature: $\alpha = .878$; avoid unsafe foods: $\alpha = .856$).

4   Subjective Norm was divided into injunctive norm ("Most people who are important to

5 me would want me to cook food properly/clean my hands and surfaces before preparing

6 food/keep food at the correct temperature/avoid unsafe foods every time I prepare food over

7 the next week") and descriptive norm ("Most people who are important to me will cook food

8 properly/clean hands and surfaces before preparing food/keep food at the correct

9 temperature/avoid unsafe foods every time they prepare food over the next week"), for each

10 behaviour. Participants rated each item on a seven-point scale (1 = strongly disagree; 7 =

11 strongly agree), with higher scores indicating higher perceptions of normative pressure. The

12 decision to use separate scores for injunctive and descriptive norms, rather than use a

13 composite subjective norm score, was based on low internal consistency estimates when the

14 scores were combined.

15   PBC was assessed as the mean of three items for each behaviour (e.g., "If I wanted to, I

16 could easily cook food properly/clean hands and surfaces before preparing food/keep food at

17 the correct temperature/avoid unsafe foods every time I prepare food over the next week"),

18 rated on a seven-point scale (1 = strongly disagree; 7 = strongly agree), with higher scores

19 indicating greater perceived control over the behaviours. The following internal consistency

20 estimates were obtained in this sample (cook food properly: $\alpha = .766$; wash hands/clean

21 surfaces: $\alpha = .805$; correct temperature: $\alpha = .764$; avoid unsafe foods: $\alpha = .749$).

22   Behavioural Intention was assessed using two items for each behaviour (e.g., "I intend

23 to cook food properly/clean hands and surfaces before preparing food/keep food at the correct

24 temperature/avoid unsafe foods every time I prepare food over the next week"), rated on a

25 seven-point scale (1 = strongly disagree; 7 = strongly agree), with higher scores indicating

1   greater intention to perform safe food-handling behaviours. The following internal

2   consistency estimates were obtained in this sample (cook food properly: $\alpha = .906$; wash

3   hands/clean surfaces: $\alpha = .875$; correct temperature: $\alpha = .900$; avoid unsafe foods: $\alpha = .914$).

4   Behaviour was measured by a self-report item in which participants were asked to

5   indicate their engagement in each of the four safe food-handling behaviours over the previous

6   week ("How many times over the past week did you prepare food? Of these how many times

7   did you cook food properly/clean hands and surfaces before preparing food/keep food at the

8   correct temperature/avoid unsafe foods?"). The total number of times each participant had

9   prepared food over the week (maximum = 28; based on breakfast, lunch, dinner, and snacks

10   over the course of a 7-day week) was then calculated and formed the denominator of each

11   ratio; the total number of times each participant had prepared food hygienically by engaging

12   in each of the four specific safe food-handling behaviours was also calculated and formed the

13   numerator for each ratio. The final behavioural outcome variables reflected the proportion of

14   times (%) that participants had prepared food hygienically using each of the four specified

15   behaviours.

16   *Moral Norm*

17   Moral norm was measured as the mean of four items, assessed separately for each of

18   the four behaviours (e.g., "It is within my principles to cook food properly/clean my hands

19   and surfaces before preparing food/keep food at the correct temperature/avoid unsafe foods

20   every time I prepare food over the next week"). Participants rated items on a seven-point

21   scale (1 = strongly disagree; 7 = strongly agree), with higher scores indicating greater

22   perceived moral correctness of safe food-handling behaviour. The following internal

23   consistency estimates were obtained in this sample (cook food properly: $\alpha = .695$; wash

24   hands/clean surfaces: $\alpha = .778$; correct temperature: $\alpha = .779$; avoid unsafe foods: $\alpha = .712$).

25   *Habit Strength*

1   Habit strength of each behaviour was measured using the 4-item self-report behavioural

2   automaticity index (Gardner, Abraham, Lally, & de Bruijn, 2012). Participants indicated on a

3   seven-point scale (1 = strongly disagree – 7 = strongly agree) the extent to which each

4   behaviour was something: "I do automatically"; "I do without having to consciously

5   remember", "I do without thinking", "I start doing before I realise I'm doing". Total

6   automaticity scores range from 1 to 7 (weighted sum of four items) and higher scores indicate

7   greater habit strength. The following internal consistency estimates were obtained (cook food

8   properly: α = .937; wash hands/clean surfaces: α = .977; correct temperature: α = .948; avoid

9   unsafe foods: α = .959).

10   ***Procedure***

11   Participants completed two online questionnaires spaced one week apart. After

12   signing up to the study and providing informed consent, participants were directed to a

13   survey that firstly included descriptions of the four safe food-handling behaviours and what

14   each involved. Participants then completed demographic measures, TPB variables (attitudes,

15   subjective norms, perceived behavioural control, and intention), and measures of moral norm

16   and habit. At time two, participants reported their safe food-handling behaviours over the past

17   week and were then fully debriefed.

18   ***Data Analysis***

19   A series of hierarchical regression analyses were used to determine the significant

20   predictors of intention to perform each of the following safe food-handling behaviours: (1)

21   Cook food properly; (2) Wash hands and clean cooking surfaces before food preparation; (3)

22   Keep food at the correct temperature; and (4) Avoid unsafe foods. In each case, attitude,

23   injunctive and descriptive norms, and PBC were added at step 1, followed by moral norm at

24   step 2.

1   A series of hierarchical regression analyses were also used to determine the significant

2   predictors of the four safe food-handling behaviours. In each case, intention and PBC were

3   entered at step 1, followed by habit at step 3, and the intention x habit interaction term at step

4   3. Simple slopes analyses were used to determine the significance and direction of any

5   significant moderation effects.

6   **Results**

7   *Sample characteristics*

8   One hundred and eighty-eight participants, (77.1% female; age: $M = 19.8$, $SD = 4.39$,

9   range 17-47), completed the time one questionnaires. The majority of the sample was single,

10   (89.4%), and lived with their parents, (70.7%). Five participants (2.7%), reported that they

11   had children. Of these, 170 also completed the time 2 behaviour measures.

12   *Descriptive statistics*

13   Participants reported preparing between 1 and 28 meals in the previous week ($M =$

14   11.8, $SD = 4.9$). As shown in Table 1, rates of each of the four safe food-handling behaviours

15   were reasonably high, 77-90%. There were no gender differences in the rates of performance

16   of each of the behaviours, all $p > .05$, and nor was age correlated with any of the behaviours,

17   all $p > .05$. Regarding the TPB and additional variables, participants appeared to hold

18   reasonably positive beliefs and intentions towards safe food-handling, and such behaviours

19   also appeared to have become reasonably habitual (see Table 1).

1 **Table 1.** Means, standard deviations (SD), and range for all measured variables

	Cook food properly			Wash hands/clean surfaces			Correct temperature			Avoid unsafe foods		
	Mean	**SD**	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Range**
Intention	5.34	0.70	3 – 6	5.28	0.71	3 – 6	5.27	0.72	3 – 6	5.34	0.70	3.5 – 6
Attitude	6.08	0.85	1 – 7	5.85	0.81	2.5 – 7	5.88	0.81	3 – 7	6.01	0.81	3 – 7
Injunctive norm	6.25	0.86	3 – 7	6.23	0.88	3 – 7	6.20	0.88	3 – 7	6.28	0.83	3 – 7
Descriptive norm	5.94	1.03	2 – 7	5.51	1.27	1 – 7	5.64	1.19	1 – 7	5.92	1.13	2 – 7
PBC	6.30	0.75	3.33 – 7	6.42	0.70	3.33 – 7	6.32	0.71	4 – 7	6.40	0.67	4 – 7
Moral norm	6.04	0.80	2.5 – 7	5.95	0.94	2.75 – 7	5.79	0.97	2 – 7	6.13	0.84	3.25 – 7
Habit	5.77	1.10	2 – 7	5.61	1.34	1 – 7	5.32	1.25	1 – 7	5.54	1.29	1 – 7
Behaviour (%)	87.72	24.72	0 - 100	77.13	31.21	0 - 100	85.92	25.00	0 – 100	90.15	22.79	0 – 100

2 Note: PBC = perceived behavioural control

1	 As can be seen in Tables 2 – 5, strong positive inter-correlations were observed

2	between the TPB variables for each of the four behaviours, as well as between TPB variables

3	and habit. The relationships with behaviour were more variable – none of the TPB or

4	additional variables was significantly related to cooking food properly. Regarding washing

5	hands and cleaning surfaces, all variables with the exception of injunctive norms were

6	significantly positively correlated with behaviour. Regarding keeping food at the correct

7	temperature, all variables except intention and descriptive norms were related to behaviour.

8	Finally, regarding avoiding unsafe food, higher rates of behaviour were significantly related

9	to intention, attitude, moral norms, and habit. Strong positive correlations were also observed

10	across behaviours for each of intention, attitude, descriptive, injunctive, and moral norms,

11	PBC, and habit, all $p < .001$; not shown.

1   **Table 2.** Correlations between TPB and additional variables: Cook food properly

	Attitude	DN	IN	PBC	MN	Habit	Behaviour
Intention	.370***	.310***	.554***	.681***	.550***	.405***	-.020
Attitude	-	.298***	.481***	.536***	.596***	.321***	-.001
DN		-	.425***	.370***	.373***	.305***	-.069
IN			-	.626***	.580***	.321***	-.001
PBC				-	.649***	.442***	.113
MN					-	.497***	.042
Habit						-	.044
Behaviour							-

2   Note: DN = descriptive norm; IN = injunctive norm; PBC = perceived behavioural

3   control; MN = moral norm, ***$p < .001$

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1   **Table 3.** Correlations between TPB and additional variables: Wash hands and clean

2   surfaces

	Attitude	DN	IN	PBC	MN	Habit	Behaviour
Intention	.448***	.251***	.534***	.640***	.607***	.499***	.204**
Attitude	-	.276***	.429***	.447***	.610***	.416***	.201**
DN		-	.397***	.249**	.411***	.399***	.152*
IN			-	.646***	.512***	.467***	.071
PBC				-	.572***	.472***	.183*
MN					-	.664***	.272***
Habit						-	.338***
Behaviour							-

3   Note: DN = descriptive norm; IN = injunctive norm; PBC = perceived behavioural

4   control; MN = moral norm, ***$p < .001$, **$p < .01$, *$p < .05$.

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Table 4. Correlations between TPB and additional variables: Keep food at the correct temperature

	Attitude	DN	IN	PBC	MN	Habit	Behaviour
Intention	.481***	.254***	.531***	.643***	.539***	.365***	.097
Attitude		.325***	.536***	.562***	.525***	.340***	.150*
DN			.396***	.319***	.465***	.329***	.020
IN				.651***	.493***	.252***	.158*
PBC					.581***	.319***	.187*
MN						.582***	.190*
Habit							.278***
Behaviour							-

Note: DN = descriptive norm; IN = injunctive norm; PBC = perceived behavioural control; MN = moral norm, ***$p < .001$, *$p < .05$

1   **Table 5.** Correlations between TPB and additional variables: Avoid unsafe foods

	Attitude	DN	IN	PBC	MN	Habit	Behaviour
Intention	.463***	.289***	.480***	.571***	.550***	.313***	.170*
Attitude		.449***	.552***	.544***	.591***	.439***	.274***
DN			.422***	.357***	.422***	.350***	.030
IN				.560***	.420***	.321***	.145
PBC					.593***	.399***	.112
MN						.473***	.184*
Habit							.226**
Behaviour							-

2   Note: DN = descriptive norm; IN = injunctive norm; PBC = perceived behavioural

3   control; MN = moral norm, ***$p < .001$, **$p < .01$, *$p < .05$.

4

5   ***Predicting intention and behaviour***

6   *Cooking food properly*

7   Intention: At step 1, the TPB variables of attitude, injunctive and descriptive

8   norms, and PBC accounted for 49.2% of the variance in intention to cook food

9   properly, $F(4, 183) = 44.4$, $p < .001$. Injunctive norm, $\beta = .212$, $p < .01$, and PBC, $\beta =$

10   .61, $p < .001$ were the only significant predictors. At step 2, the addition of moral norm

11   furthered the prediction by 1.3%, $p < .05$; $R^2 = .505$, $F(5, 182) = 37.17$, $p < .001$. At

12   this step, injunctive norm, $\beta = .180$, $p < .05$; PBC, $\beta = .504$, $p < .001$, and moral norm,

13    $\beta = .167$, $p < .05$, were significant predictors, all other $p > .05$.

14   Behaviour: None of the included variables (intention, PBC, habit, intention x

15   habit interaction) were significant predictors of the rates of cooking food properly

1 over the past week, all $p > .05$. The amount of variance accounted for was very low

2 and non-significant at each step, final step: $R^2 = .033$, F(4, 167) = 1.44, $p = .223$.

3 Despite the overall model failing to reach significance, PBC was a significant

4 predictor at all three steps, final step: $\beta = .245$, $p < .05$.

5 *Washing hands/cleaning surfaces*

6 Intention: At step 1, the TPB variables of attitude, injunctive and descriptive

7 norms, and PBC accounted for 46.5% of the variance in the model, $F(4, 183) = 39.84$,

8 $p < .001$, with attitude, $\beta = .196$, $p < .01$, injunctive norm, $\beta = .149$, $p = .05$, and PBC,

9 $\beta = .450$, $p < .001$, but not descriptive norm, $p > .05$, making significant independent

10 contributions to the model. At step 2, the addition of moral norm furthered the

11 prediction by 4.4%, $p < .001$; $R^2 = .509$, $F(5, 182) = 37.73$, $p < .001$. At this step,

12 PBC, $\beta = .358$, $p < .001$, and moral norm, $\beta = .304$, $p < .001$, were significant

13 predictors, while the influence of attitude, $p = .246$, and injunctive norm, $p = .081$,

14 were reduced to non-significance.

15 Behaviour: At step 1, intention, $\beta = .148$, $p = .154$, and PBC, $\beta = .082$, $p =$

16 .429, accounted for 4.5% of the variance, $F(2, 169) = 3.98$, $p < .05$, although neither

17 variable was independently significant. The addition of habit at step 2 added a further

18 7.1% to the model, $R^2 = .116$, $p < .001$; $F(3, 168) = 7.38$, $p < .001$, and was the only

19 significant predictor, $\beta = .313$, $p < .001$. At step 3, the intention x habit interaction

20 accounted for a further 1.3% of the variance but was not significant, $p > .05$; $R^2 =$

21 .130, $F(4, 167) = 6.23$, $p < .001$.

22 *Correct temperature*

23 Intention: At step 1, the TPB variables of attitude, subjective norm, and PBC

24 accounted for 44.7% of the variance in intention to keep food at the correct

25 temperature during preparation, $F(4, 183) = 36.96$, $p < .001$, with attitude, $\beta = .137$, p

1 = .05, injunctive norm, β = .155, p < .05, and PBC, β = .465, p < .001, as significant

2 predictors. At step 2, the addition of moral norm furthered the prediction by 2.7%, p <

3 .01; R^2 = .474, $F(5, 182)$ = 32.81, p < .001. At this step, PBC, β = .388, p < .001, and

4 moral norm, β = .225, p < .01, were significant predictors. Behaviour: At step 1,

5 intention and PBC accounted for 3.6% of the variance in the rate of keeping food at

6 the right temperature over the past week, $F(2, 169)$ = 3.19, p < .05, although only

7 PBC, β = .220, p < .05, made a significant contribution to the model. The addition of

8 habit at step 2 accounted for a further 5.8% of the variance, p < .01; R^2 = .095, $F(3,$

9 $168)$ = 5.86, p < .01. At this step habit was the only significant predictor, β = .260, p <

10 .01. The intention x habit interaction term did not contribute significantly to the model

11 at step 3, p = .998.

12 *Avoid unsafe foods*

13   Intention: At step 1, the TPB variables of attitude, descriptive and injunctive

14 norms, and PBC accounted for 37.8% of the variance in intention to avoid unsafe

15 foods, $F(4, 183)$ = 27.81, p < .001; injunctive norm, β = .177, p < .05; and PBC, β =

16 .386, p < .001, were significant predictors. At step 2, the addition of moral norm

17 furthered the prediction by 4.5%, p < .001; R^2 = .423, $F(5, 182)$ = 26.64, p < .001. At

18 this step, injunctive norm, β = .190, p < .05; PBC, β = .277, p = .001; and moral norm,

19 β = .290, p < .001, were significant predictors.

20   Behaviour: At step 1, intention and PBC accounted for 2.9% of the variance in

21 rates of avoiding unsafe food, but this was not significant, $F(2, 169)$ = 2.52, p = .084.

22 The addition of habit at step 2 accounted for a further 3.3% of the variance, p < .05;

23 R^2 = .062, $F(3, 168)$ = 3.70, p < .05; habit was the only significant predictor, β = .198,

24 p < .05. At step 3, the intention x habit interaction term was also significant and added

25 a further 2.7% to the model, p < .05; R^2 = .089, $F(4, 167)$ = 4.06, p < .01, with both

1   habit, $\beta = .180$, $p < .05$, and the interaction term, $\beta = -.170$, $p < .05$, making

2   significant independent contributions.

3   Simple slope analyses revealed that for low levels of habit (1 *SD* below the

4   mean) the gradient of the slope, $\beta = 9.667$, was significant, $t(171) = 2.451$, $p = .015$,

5   indicating that intention predicted behaviour within individuals whose habit strength

6   regarding avoiding unsafe foods was low. For high levels of habit (1 *SD* above the

7   mean) the gradient of slope, $\beta = -.613$, was not significant, $t(171) = -.163$, $p = .871$,

8   indicating that for those who were avoiding unsafe foods habitually, intention did not

9   predict behaviour (see Figure 1).
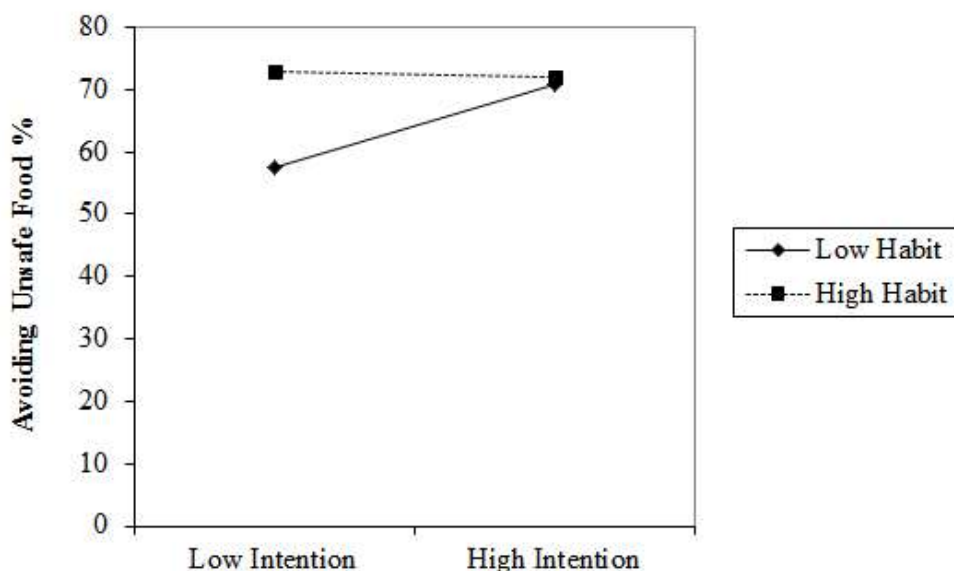
10

11   **Figure 1.** Intention-habit interaction effect for avoiding unsafe food

12

13   **Discussion**

14   The aim of this study was to examine whether an extended TPB model, which

15   included moral norm and habit strength, could predict four distinct safe food-handling

16   behaviours: cooking food properly, washing hands and cleaning surfaces, keeping

17   food at the correct temperature, and avoiding unsafe food. Consistent with

1   expectations, the extended TPB predicted between 42 and 51 percent of the variance

2   in intentions for all four behaviours. Previous research using the TPB found that the

3   model could accounted for 66 per cent of the variance in intention (Mullan & Wong,

4   2009). The lower proportion of variance accounted for here may reflect a discrepancy

5   between an individual's overall intention to engage in a general set of behaviours (i.e.,

6   safe food-handling), and their motivation to actually carry out specific behaviours

7   required to enact that intention. That is, while an individual may hold positive overall

8   beliefs about the importance of safe food-handling, their motivation to perform

9   specific behaviours, which could be perceived as time consuming and requiring

10   conscious effort, may be more limited, meaning that their prediction from such beliefs

11   is also limited. In contrast, another TPB study found that 48 percent of the variance in

12   safe food-handling intentions was accounted for by attitudes, subjective norms, and

13   PBC. This study was, however, conducted on people working in the food industry, 60

14   percent of whom had undergone safe food-handling training, and as such may have

15   led to different results compared to an untrained sample from the general population.

16   Although not directly compared here, a similar pattern of results was found in

17   a recently conducted TPB-based study of motivation to recover from anorexia nervosa

18   (Dawson, Mullan, & Sainsbury). Specifically, it was found that while individuals

19   reported strong motivation for recovery in general, they were less motivated to eat

20   normally and gain weight (i.e., the specific behaviours required to achieve recovery).

21   Further, the TPB was found to predict a greater proportion of general recovery-related

22   intentions than behaviour-specific intentions (i.e., eat normally/gain weight). The

23   discrepancy in findings when measuring general versus behaviour-specific intentions

24   is likely to have important implications for measurement in future predictive research,

25   as well as when designing interventions to improve safe food-handling behaviour.

1   While the extended TPB model was significant in the prediction of intentions

2   across behaviours, subtle differences in the pattern and magnitude of significant

3   predictors for each of the four target behaviours were observed. In line with

4   expectations, normative influences – either injunctive, moral or both – were important

5   predictors of intentions. This was consistent with previous research, whereby moral

6   norm has been shown to be a strong predictor of intentions for behaviours that have

7   consequences beyond the individual (Clayton & Griffith, 2008; Conner & Armitage,

8   1998; Manstead, 2000). In the cases of washing hands/cleaning surfaces and keeping

9   food at the correct temperature, injunctive norm was significant in the first step, but

10   reduced to non-significance when moral norm was included at step two, whereas for

11   the other two behaviours both moral and injunctive norms were important. It was also

12   interesting to note that participants' perceptions of what other people actually did (i.e.,

13   descriptive norms) were not a significant predictor of intention to perform any

14   behaviour.

15   Subjective norm has been found to be the weakest predictor of intention across

16   a wide range of behaviours (Armitage & Conner, 2001). The results of the present

17   study, in which descriptive norm did not influence intention to perform any of the

18   behaviours, and the significance of injunctive norm was reduced by the addition of

19   moral norm, reiterate these results. The current results instead suggest that moral

20   norm is a useful predictor of intention to perform safe food-handling behaviours.

21   Thus, it appears that for behaviours that involve or impact upon other people,

22   compared to more individually focused behaviours, intention is more likely to be

23   influenced by moral norm than subjective norm.

24   Attitudes were significant in the prediction of intentions to wash hands/clean

25   surfaces, keep food at the correct temperature, and avoid unsafe foods ($p = .051$) at

step one, but in all cases were reduced to non-significance when moral norms were added to the model at step two. This is consistent with previous safe food-handling research, where it was found that attitudes represented the weakest, and in some cases a non-significant, predictor of intentions after subjective norm and PBC (Fulham & Mullan, 2011; Mullan & Wong, 2009; Seaman & Eves, 2010). Although a moderation analysis according to morally- vs. attitudinally-aligned intentions, as was conducted by Godin, Conner, et al. (2005), was not possible in this study, this finding indirectly supports the idea that moral norms are an important consideration when examining behaviours that have consequences beyond the individual, and may influence the likelihood of translating positive intentions into behaviour. This is important for designing safe food-handling interventions, as it may be that people are more inclined to modify their behaviour if it is perceived to also benefit others, compared to behaviours perceived to only benefit the individual.

Consistent with previous research (Fulham & Mullan, 2011; Mullan & Wong, 2009; Seaman & Eves, 2010), PBC was an important predictor of the intention to perform all four safe food-handling behaviours. This suggests that interventions targeting PBC are likely to be of benefit to consumers. Indeed, an intervention conducted by Milton and Mullan (2012) was successful in improving both PBC and safe food-handling behaviour (see however, Clayton et al., 2003, for a discrepant finding). Further, after controlling for condition, the change in PBC accounted for significant variance (trend level: $p = .052$) in the change in behaviour from baseline to post-intervention. More research is needed to design and evaluate cost-efficient means of improving safe food-handling behaviour. The current, and previous research, would suggest that targeting PBC (which has positive flow-on effects to both intention and behaviour) is likely to be effective.

1   The amount of variance accounted for in the actual performance of these food

2   hygiene behaviours was generally low (3-12%), with none of the TPB predictors

3   showing consistent relationships with behaviour. This was contrary to previous

4   research using the TPB, where it was found that, although lower than the prediction of

5   intention, the TPB accounted for between 16 and 21 percent of the variance in safe

6   food-handling behaviour (Fulham & Mullan, 2011; Mullan & Wong, 2009). Again,

7   the lower proportion of variance accounted for here may suggest that individuals are

8   prone to overestimating their performance of safe food-handling behaviour when

9   asked about overall/general behaviour. In contrast, when asked about specific and

10   distinct behaviours, it appears that individuals are better able to accurately recall and

11   provide a temporally relevant estimate of their behaviour, which although lower, is

12   more reflective of the disjunct between relevant cognitions and intentions, and actual

13   behaviour. Further, in a study of hand hygiene that also asked about specific

14   behaviours, less of the variance in intention was explained than in the present study

15   (Clayton & Griffith, 2008). The differences found may be due to the fact that their

16   study was conducted on commercial food handlers as opposed to people preparing

17   food for themselves and others in their household.

18   Despite the low proportion of variance accounted for across behaviours, a

19   fairly consistent finding was that habit was a significant predictor, such that those

20   with stronger habits were more likely to engage in safe food-handling behaviours (all

21   bar cooking food properly). This is consistent with previous research, which has

22   suggested that for behaviours that are performed repetitively and routinely in stable

23   environments, habit is likely to be a significant predictor of behaviour (Lally, van

24   Jaarsveld, Potts, & Wardle, 2010). Although not previously studied in the context of

25   safe food-handling behaviour, this finding is similar to previous research that found

1   that past behaviour was the most significant predictor of safe food-handling

2   behaviour, adding 26 percent over and above the standard TPB variables (Fulham &

3   Mullan, 2011). Presumably the more that an individual performs a particular

4   behaviour, the more habitual it will be become, suggesting that both habit and past

5   behaviour are likely to be important in this area.

6   Further, regarding the behaviour of avoiding unsafe foods, results revealed a

7   significant interaction between habit and intention, whereby intention was only an

8   important predictor for individuals who did not have strong habits. This is consistent

9   with previous studies that have examined such an interaction, with most finding that

10   when a behaviour has become habitual, it is likely to be executed without the need for

11   conscious intention (Allom, Mullan, & Sebastian, 2013; Ouellette & Wood, 1998).

12   This finding also has important implications for the design of interventions.

13   Specifically, it is likely that improving intentions to perform safe food-handling

14   behaviours will only go part of the way to improving actual behaviour. Instead, what

15   appears to be needed is the provision of behaviour change techniques to prompt

16   behaviour and the formation of safe food-handling habits. In this way, the influence or

17   need for a positive intention is reduced as, once habitual; behaviour is no longer

18   dependent on conscious motivation. Indeed, a recently published safe food-handling

19   intervention, which included behaviour change techniques such as providing a cue to

20   action and reminders (linked to habit formation), was found to be effective in

21   improving the performance of safe food-handling behaviours relative to an active

22   control group (Mullan, Allom, Fayn, & Johnston). In addition, a mediator analysis

23   revealed that the mechanism responsible for change in behaviour was change in habit

24   strength.

25   ***Limitations and Conclusion***

1   This study had some limitations that should be considered when interpreting

2   the results. Firstly, safe food-handling behaviour was measured using self-report,

3   which may have led to an over- or under-estimation of the rates of actual behaviour.

4   Milton and Mullan (2012), however, found that self-reports of safe food-handling

5   behaviour correlated well with objective observations, suggesting that individuals are

6   able to provide a reasonably accurate estimate of their safe food-handling behaviour.

7   Secondly, the study was conducted on a sample of undergraduate university students,

8   and as such the results may not generalise to other populations. Indeed, previous

9   research has found that young adults are particularly bad at performing safe food-

10   handling behaviours (Byrd-Bredbenner et al., 2007). In addition, as 71% of

11   participants indicated they lived with their parents, this means it is likely that

12   participants are not always responsible for food preparation. Further, previous

13   research has also revealed differences in the utility of the TPB according to age, such

14   that intention and PBC were predictive of safe food-handling behaviour amongst

15   young adults, but were not shown to be predictive amongst older adults (Mari et al.,

16   2012). It may therefore be the case that different predictors are relevant for different

17   age groups. More research is needed to replicate the findings across populations of

18   different ages, as any differences will have important implications for the design of

19   effective, theory-based interventions to improve safe food-handling behaviour and

20   reduce the incidence of foodborne illness. Further, analyses such as SEM may be

21   useful in future studies to consider the relationships between the constructs in more

22   detail. Another potential limitation relates to the fact that while norms were

23   considered, participants were not given the opportunity to specify who the important

24   people are that could influence their behaviour. Perhaps the findings may be different

25   if the salient people were specified. Finally, future research may benefit from

1   measuring the extent to which individuals view safe food-handling behaviours to be a

2   moral issue, in order to determine whether morally-aligned intentions, versus

3   attitudinally-aligned intentions, better predict behaviours that are perceived to be a

4   moral issue (Godin, Conner, et al., 2005).

5   There are several important implications of this study, for future research as

6   well as for the design of theory-based interventions to improve safe food-handling

7   behaviour. Firstly, comparing the results of this study with similar previous research,

8   it appears that measurement of *general* safe food-handling behaviour may lead to an

9   overestimation of intention and behaviour. It is therefore important in future research

10   to examine the prediction of specific safe food-handling behaviours, as it may be that

11   participants are able to more accurately estimate such behaviours. This may also have

12   implications when designing interventions to improve safe food-handling, as it may

13   be that base line levels of behaviours are lower than previous studies have

14   demonstrated and maybe measuring specific behaviours will lead to clearer

15   indications as to efficacy of interventions. Further support for this idea comes from

16   evidence that the translation of intentions into actual behaviour is improved when

17   participants are clear on what, when, and how they are to change their behaviour (e.g.,

18   implementation intentions; Gollwitzer, 1999).

19

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Highlights

- The TPB predicted each of the four distinct target food hygiene behaviours

- Moral norm was also an important predictor of food hygiene intentions

- Habit strength added to the prediction of behaviour over and above the TPB

- Habit moderated the intention-behaviour gap for avoiding unsafe foods