# Building habit strength: A pilot intervention designed to improve food-safety behavior

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## Abstract

The purpose of this study was to firstly design an intervention to decrease cross-contamination in the home by the development of the habitual behavior of microwaving the dishcloth/sponge and secondly to determine if this behavior could be maintained over time. Participants were randomly assigned to either a high-frequency or low-frequency reminder habit building condition or a control condition. Results indicated that for both habit building conditions, food-safety behavior significantly increased compared to the control group and these changes were maintained at follow-up. Additionally, improvement in behavior was mediated by increase in habit strength. The major conclusion of this study is that providing a cue to action and reminders build food-safety habits that result in changes in food-safety behaviors. This has major implications for other food-safety interventions.


Keywords: habit; food-safety; food-hygiene; intervention; behavior change

## 1. Introduction

Foodborne disease is a public health problem in both developed and underdeveloped countries (Kuchenmüller, et al., 2009). There has been a steady increase in foodborne-illness in the past decade (McKercher, 2012) with approximately a quarter of Australians and North Americans experiencing foodborne-illness each year (McKercher, 2012; Scallan, et al., 2011). Young adults represent a population that is at a higher risk of experiencing foodborne-illness, as food safety has been found to be particularly poor in this population (Byrd-Bredbenner, et al., 2007). In addition to impacting upon individual health and wellbeing, foodborne-illness has societal costs and medical costs (Hall, et al., 2005; Mullan, 2009).

A substantial proportion of foodborne-illness occurs due to inappropriate consumer food handling, including poor hand-hygiene and cross-contamination (Griffith, Mullan, & Price, 1995). A systematic review of consumer food-safety interventions (Milton & Mullan, 2010) found only ten studies that attempted to change consumer food-safety behaviors. Among the interventions reviewed, only two used theory-based techniques to change behavior. In fact, many attempted to change behavior solely through the provision of education or instruction; techniques known to be ineffective when used in isolation, both in the area of health generally (Rimal, 2000) and in food-safety interventions (Mullan & Wong, 2010).

Factors from social cognition models are important in predicting safe food handling, including those from the health belief model (Rimal, 2000) and the health action process approach (Bearth, Cousin, & Siegrist, 2014; Chow & Mullan, 2010). Specifically, intention, and self-efficacy – the perceived ability to carry out a behavior – have been shown to predict preventative cross-contamination behaviors (Bearth, et

al., 2014). One of the most frequently used models in food research (Kim, Jang, & Kim, 2014; Kothe, Mullan, & Butow, 2012; Sainsbury, Mullan, & Sharpe, 2013) is the theory of planned behavior (Ajzen, 1991), which has been applied to the food handling behavior of both adults (Mari, Tiozzo, Capozza, & Ravarotto, 2012; Mullan & Wong, 2009; Seaman & Eves, 2010; Shapiro, Porticella, Jiang, & Gravani, 2011) and adolescents (Mullan, Wong, & Kothe, 2013). It has demonstrated that constructs such as attitudes, social norms and perceptions of control can account for about two thirds of the variance in intention to perform safe food handling behaviors.

Food-safety interventions, designed using the theory of planned behavior, have been moderately successful. Mullan and Wong (2010) designed an intervention to improve general food-safety behaviors in an undergraduate population. The study used behavior change techniques to target intentions and perceptions of control. The intervention was successful in improving perceptions of control but was not successful in changing behavior. Following this, an adapted version of the intervention, which included additional behavior change techniques, was conducted resulting in behavior change (Milton & Mullan, 2010). Importantly, results demonstrated a high correlation between self-report food-safety behaviors and observed food-safety behaviors, suggesting that for food-safety behaviors, self-report may offer a valid assessment of behavior. While these interventions were successful in changing perceptions of control, the inconsistent findings regarding changes in behavior suggests that there are additional constructs that could be targeted in food-safety interventions to engender behavior change.

Within the food-safety literature, past behavior has been found to be an important predictor of behavior (Chow & Mullan, 2010; Fulham & Mullan, 2011; Mullan & Wong, 2009). However, past behavior is not a causal antecedent of

intention (Ajzen, 2011), and by its nature, cannot be changed. Therefore, it may be worthwhile examining a related but modifiable construct: habit strength. Habit was found to be important in the food consumption behavior of olive oil consumption (Santosa, Clow, Sturzenberger, & Guinard, 2013). Further, one study into the role of habit in predicting the food-safety behaviors of workers in a turkey processing plant found that habit was a direct predictor of self-reported behavior (Hinsz, Nickell, & Park, 2007). As such, interventions in which safe food handling habits are built, may be effective at changing food-safety behavior. Habits are formed through the repetition of a behaviour in a consistent context or in response to a cue (Lally, van Jaarsveld, Potts, & Wardle, 2010). Byrd-Bredbenner, Berning, Martin-Biggers, and Quick (2013) noted that individuals may not be practicing food-safety behaviors in their homes due to a lack of cues to action that remind them to do so. Therefore, providing a cue to carry out food-safety behaviors, and building these behaviors as habits, may result in behavior change.

An important consideration in the design of an intervention aimed at building habit strength is the regularity with which the target behavior is already being performed (Lally & Gardner, 2013). In order to control for the effects of past behavior, a novel behavior is desired. The dishcloth/sponge is one of the main sources of cross-contamination in the kitchen. Recent research suggests that the most effective way to clean a kitchen dishcloth/sponge is by microwaving it (Sharma, Eastridge, & Mudd, 2009; Taché & Carpentier, 2014). As these findings are relatively recent, it is not likely that many individuals are already microwaving their dishcloth/sponge, and given that promotion of this behavior has the potential to substantially reduce foodborne-illness in the home, it is a desirable behavior to target

in an intervention that is aimed at building habit strength to improve food-safety behavior.

Therefore, the aim of the current study was to design an intervention to decrease cross-contamination in the home by the development of the habitual behavior of microwaving the dishcloth/sponge and to determine if this behavior can be maintained over time. As safe food handling behavior has been shown to be poor in young adults (Byrd-Bredbenner, et al., 2007) and undergraduate students (Mullan, et al., 2013), this population was targeted. It is hypothesized that individuals receiving the intervention designed to increase habit strength will carry out the behavior of microwaving their dishcloth more often than those who did not receive the intervention, and that these differences will be maintained over time. In addition, there is debate regarding the intensity needed for behavior change interventions and the regularity of messages that need to be sent to promote behavior change (Kothe, et al., 2012). Determining the optimal message frequency is not only essential to the development of cost-effective interventions but may also influence participant attrition (Warren, Fey, & Yoder, 2007). As such, a secondary aim was to manipulate the frequency of prompts reminding participants to microwave their dishcloth in order to determine whether frequency of messages influences behavior change. The final aim of the research was to establish that the mechanism by which behavior change occurred was through a change in habit strength, therefore it was hypothesized that change in behavior would be mediated by change in habit.

## 2. Materials and Method

### *2.1. Participants*

The sample consisted of 45 undergraduate students from an Australian university. The mean age was 22.91 years (*SD* = 7.49), ranging from 18 to 50 years. The majority of the sample was female (80%). The participants were recruited using the online registration system SONA and received course credit for participation. The university's human research ethics committee approved the study. Inclusion criteria included being responsible for washing their own dishes, at least some of the time, and not previously performing the behavior of microwaving their dishcloth/sponge.

### *2.2. Measures*

Behavior was assessed by asking participants to indicate how many days over the previous three weeks they had microwaved their dishcloth/sponge. Habit strength was assessed using the automaticity subscale (Gardner, Abraham, Lally, & de Bruijn, 2012) of the self-report habit index (SRHI; Verplanken & Orbell, 2003). The automaticity subscale is said to be a more valid estimate of the relationship between habit strength and behavior, as automaticity is the mechanism underlying habitual action (Gardner, 2014). Participants responded to the stem "Microwaving my dishcloth/sponge is something…", which was followed by 4 items including 'I do automatically', 'I do without having to consciously remember', 'I do without thinking' and 'I start doing before I realize I'm doing it'. Responses were given on 7-point Likert Scales (1 = strongly disagree, 7 = strongly agree). The 4 items demonstrated excellent reliability at each time point ($\alpha$ = .94; $\alpha$ = .99; $\alpha$ = .97).

### *2.3. Intervention*

The intervention involved two components, a poster and emails designed to establish the behavior of microwaving the dishcloth as a habit (Abraham, Kok, Schaalma, & Luszczynska, 2011). The poster was designed to act as a cue that

prompted the behavior by detailing how to disinfect a kitchen dishcloth/sponge by microwaving it for 1 minute (see supplementary material, Figure 1). Participants in the high-frequency and low-frequency reminder conditions were emailed a link to the SRHI every three and five days respectively, and were required to complete the SRHI on these days. Completion of the SRHI served as a reminder to microwave the dishcloth. Participants in the control condition were not given a poster and were emailed a link to a breakfast consumption diary every three days and were required to complete the breakfast consumption diary on these days. The diary consisted of a list of breakfast foods (e.g. fruit, juice, cereal) and participants were required to indicate whether or not they had consumed each of these items.

### *2.4. Design and procedure*

After providing informed consent, participants were first asked if they were responsible for washing their own dishes, and secondly, if they currently microwave their dishcloth/sponge. If participants did not meet inclusion criteria, they were not able to continue in the study and were debriefed. Participants who met inclusion criteria were then informed of the benefits of microwaving their dishcloth/sponge and given a 15x10x3cm yellow sponge to take home with them. Participants then completed baseline measurements including demographics, behavior and habit strength. Participants were randomly allocated to one of three conditions by a random number generator function in excel. Participants allocated to the two habit formation conditions were given a poster to take home with them, and were asked to hang it up in their kitchen. Participants in all conditions were informed that they would receive emails over the next three weeks requiring them to complete a brief survey. Over the following three weeks participants were sent emails according to the condition they were in: high-frequency reminder condition received emails every

three days requiring them to complete the SRHI on these days; low-frequency reminder condition received the same emails every five days requiring them to complete the SRHI on these days; control condition received an email every three days requiring them to complete the breakfast consumption diary. At post-intervention, participants returned to the laboratory and completed measures of habit strength and behavior. Finally, three weeks after post-intervention, participants returned to the laboratory once more and completed these measures again.

### *2.5. Analyses*

All analyses were conducted using SPSS 20.0. Multivariate analyses of variance and chi-squared analyses were used to assess for differences on the baseline continuous and categorical variables respectively, between conditions. The effectiveness of the intervention was tested in the General Linear Model with the effect of time (baseline, post-intervention and follow-up) as the within-participants factor and condition (high-frequency reminder, low-frequency reminder, control) as between-participants factor. Next, planned contrasts were conducted to test whether behavior and habit change differed across time according to condition. Changes from baseline to post-intervention and post-intervention to follow-up were assessed between intervention conditions and the control, and between intervention conditions themselves. A non-significant contrast estimate post-intervention to follow-up indicated that any change from baseline to post-intervention had been maintained. Finally, mediation analyses were conducted using bootstrapping techniques for simple mediation (Hayes, 2012), in order to determine whether change in habit mediated change in behavior.

## 3. Results

### *3.1. Sample characteristics*

There were no differences between conditions (high-frequency reminder: $n$ = 15; low-frequency reminder: $n$ = 17; control: $n$ = 13) at baseline in regards to age, sex, habit strength or behavior (all $p > .05$). No participant reported microwaving their dishcloth at baseline.

### *3.2. Food-safety behavior*

Overall, there was significant improvement in the target behavior over time, $F(2, 84) = 95.12$, $p < 0.01$. This was qualified by significant time by condition interaction, $F(4, 84) = 3.14$, $p = 0.04$. Paired samples t-tests conducted separately for each condition comparing performance of the target behavior from baseline to post-intervention revealed that both the high-frequency, $MD = 9.07$, $t(14) = 4.08$, $p < .01$, and low-frequency, $MD = 11.47$, $t(16) = 5.70$, $p < .01$, intervention conditions improved from baseline to post-intervention while the control condition did not, $MD = 3.08$, $t(12) = 1.83$, $p = .09$. Paired sample t-tests comparing performance of the target behavior from post-intervention to follow-up demonstrated greater performance at follow-up in the high-frequency condition, $MD = 7.67$, $t(14) = 3.39$, $p < .01$, the low-frequency condition, $MD = 5.65$, $t(16) = 3.213$, $p < .01$, and the control condition, $MD = 7.38$, $t(12) = 4.09$, $p < .01$. Importantly, planned contrasts revealed that change in performance of the target behavior from baseline to post-intervention was significantly greater in the intervention conditions compared to the control, $\psi = 7.19$, $F(1,42) = 7.78$, $p < 0.01$, and that this difference was maintained at follow-up, $\psi = 0.73$, $F(1,42) = 0.09$, $p = 0.77$. Intervention groups did not differ from each other in terms of change in performance of the target behavior from baseline to post-intervention, $\psi = 2.40$, $F(1,42) = 0.87$, $p = 0.39$, nor from post-intervention to follow-

up, $\psi = 2.69$, $F(1,42) = 0.57$, $p = 0.46$. Means and standard error for each condition at each time point are displayed in Figure 1.

Insert Figure 1 near here

### *3.3. Habit*

Overall, there was significant improvement in habit strength over time, $F(2, 84) = 47.54$, $p < 0.01$. This was qualified by significant time by condition interaction, $F(4, 84) = 5.46$, $p < 0.01$, eta2 = .21. Paired samples t-tests conducted separately for each condition comparing habit strength at baseline to post-intervention revealed increased habit strength in the high-frequency condition, $MD = 2.02$, $t(14) = 5.12$, $p < .01$, low-frequency condition, $MD = 3.03$, $t(16) = 9.60$, $p < .01$, and the control, $MD = 1.10$, $t(12) = 2.53$, $p = .03$. Comparing habit strength from post-intervention to follow-up revealed that habit strength did not change in the high-frequency condition, $MD$ = -..38, $t(14) = -.93$, $p = .37$, nor in the low-frequency condition, $MD = -.09$, $t(16) = -.24$, $p = .81$, but significantly decreased in the control condition, $MD = -.58$, $t(12) = -2.43$, $p = .03$. Planned contrasts revealed that change in habit strength from baseline to post-intervention was greater in the two intervention conditions, compared to the control, $\psi = 1.43$, $F(1,42) = 8.88$, $p < 0.01$, and that this difference was maintained at follow-up, $\psi = 0.34$, $F(1,42) = 0.56$, $p < 0.46$. Contrasts examining whether intervention groups differed from each other in terms of habit strength from baseline to post-intervention were not significant, $\psi = 1.01$, $F(1, 42) = 3.85$, $p = 0.06$; nor did these conditions differ from post-intervention to follow-up, $\psi = 0.30$, $F(1, 42) = .36$, $p = 0.55$. Means and standard error for each condition at each time point are displayed in Figure 2.

Insert Figure 2 near here

### *3.4. Mediation analysis*

The indirect effect of intervention condition on behavior change through change in habit strength was tested. As there were no differences between intervention conditions in terms of improvement in behavior from baseline to post-intervention, these conditions were grouped together and compared to the control condition. Change in behavior and change in habit strength variables were created by subtracting post-intervention scores from baseline scores. The significance of the indirect effect was assessed using 95% confidence intervals, calculated using 5000 bootstrap re-samples (Hayes, 2012). The indirect effect from intervention condition, through change in habit strength, to change in behavior was significant, $\beta = 0.22$, 95% [CI: 0.08, 0.40]. This mediation effect accounted for 12.99% of variance in the overall model. The effect of intervention condition on change in behavior was fully mediated by change in habit strength, as the effect of condition on behavior change was no longer significant once change in habit strength was added to the model. See Figure 3 for standardized coefficients between all variables.

Insert Figure 3 near here

## 4. Discussion

The aim of this study was to design an intervention to decrease cross-contamination by the development of the habitual behavior of microwaving the dishcloth/sponge and secondly to see if this change could be maintained over time. Overall, the intervention was successful with both intervention groups showing greater improvement in the behavior and habit strength compared to the control condition, and maintaining this improvement at follow-up. Additionally, change in

behavior was fully mediated by change in habit strength, indicating that habit strength was the mechanism by which behavior improved.

The results of this study demonstrate that providing a cue to action and reminders build food-safety habits that result in changes in behavior. Previous research has demonstrated that consistently linking a cue to action with a behavior results in the behavior being carried out without the need for intention (Lally, et al., 2010). As intention does not always lead to behavior change (McEachan, Conner, Taylor, & Lawton, 2011), interventions that target the development of habits may be particularly useful. Another recent intervention used habit formation to successfully change fruit and vegetable consumption (Rompotis, Grove, & Byrne, 2014) in a similar way to link particular situations with fruit consumption and significantly improved behavior. An avenue for future research would be to compare the efficacy of habit-building interventions, such as the current intervention, against theory-driven interventions such those based on the theory of planned behavior.

Interestingly, habit strength appeared to improve in the control condition from baseline to post-intervention, but decreased from post-intervention to follow-up. It may be the case that providing a dishcloth to the control condition acted as a cue to action, which increased habit strength. However, it would appear that in order for such a habit to be maintained, the cue to action needs to be linked with reminders (Lally & Gardner, 2013), as change in habit strength in the control condition was not maintained at follow-up, and greater changes in habit strength were observed in the two intervention conditions.

The results of the current study are particularly important as they demonstrate that a relatively simple intervention was sufficient to result in behavior change and

maintenance. Previous interventions attempting to change food-safety behavior have demonstrated limited success or have not measured maintenance (for review, see: Milton & Mullan, 2010). Generally, intervention strategies that result in behavior change do not necessarily engender maintenance of this change (van Stralen, De Vries, Mudde, Bolman, & Lechner, 2009). However, inherent in the formation of a healthy habit, is maintenance. Therefore, this technique may have utility in behavior maintenance across a wide range of behaviors. Further, through mediation analysis, the mechanism by which behavior change occurs was identified, demonstrating that habit strength was the active ingredient responsible for behavior change, and provides a target for future interventions aimed at changing other health behaviors.

Another objective was to determine whether the frequency of prompts influenced the strength of the habit and consequently the extent of the behavior change and no differences were identified. This is similar to the results of Kothe, et al. (2012) however, these authors concluded based on qualitative results that participants' preferences for frequency of reminders differed (Kothe & Mullan, 2014), and message frequency needs to be tailored to the individual.

There are some limitations to the current study. The sample size was small, however, previous research examining habit formation and health outcomes utilized a similar sample size and found comparable results (Rompotis, et al., 2014). Additionally, participants were students, which may limit the generalizability of the results. However, safe food handling behaviors in this population are poor (Byrd-Bredbenner, et al., 2007); therefore, there is a need for interventions in this population.

The brief, cost-effective strategy of providing individuals with a cue to action and email reminders appeared to engender the healthy habit of microwaving the dishcloth/sponge, and resulted in behavior change that was maintained over time. Future research needs to consider the application of this technique to other safe food handling behaviors, such as checking expiry dates, or cleaning kitchen surfaces, which may result in lower rates of foodborne-illness and consequently increase quality of life and lessen the economic burden brought about from loss of productivity and health care costs. However, given that these behaviors are less likely to be novel, they may be more difficult to alter, and additional strategies may be necessary in order to achieve and maintain behavior change.

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## Figure Captions

*Figure 1.* Means and standard error of behavior (number of days participants microwaved their dishcloth/sponge over the previous 3 weeks) for each condition at each time point. Note that at Time 1, none of the participants were engaging in the target behavior.

*Figure 2.* Means and standard error of dishcloth microwaving habit strength for each condition at each time point.

*Figure 3.* Simple mediation model depicting the indirect effect of intervention condition on change in behavior through change in habit. Standardized beta coefficients are noted in the diagram, $^{**}p < .01$. Coefficient in parentheses represents direct effect of intervention condition on behavior before mediator was accounted for.