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

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## 14 Abstract

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

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

## 27 **1. Introduction**

28 Foodborne disease is a public health problem in both developed and  
29 underdeveloped countries (Kuchenmüller, et al., 2009). There has been a steady  
30 increase in foodborne-illness in the past decade (McKercher, 2012) with  
31 approximately a quarter of Australians and North Americans experiencing foodborne-  
32 illness each year (McKercher, 2012; Scallan, et al., 2011). Young adults represent a  
33 population that is at a higher risk of experiencing foodborne-illness, as food safety  
34 has been found to be particularly poor in this population (Byrd-Bredbenner, et al.,  
35 2007). In addition to impacting upon individual health and wellbeing, foodborne-  
36 illness has societal costs and medical costs (Hall, et al., 2005; Mullan, 2009).

37 A substantial proportion of foodborne-illness occurs due to inappropriate  
38 consumer food handling, including poor hand-hygiene and cross-contamination  
39 (Griffith, Mullan, & Price, 1995). A systematic review of consumer food-safety  
40 interventions (Milton & Mullan, 2010) found only ten studies that attempted to change  
41 consumer food-safety behaviors. Among the interventions reviewed, only two used  
42 theory-based techniques to change behavior. In fact, many attempted to change  
43 behavior solely through the provision of education or instruction; techniques known  
44 to be ineffective when used in isolation, both in the area of health generally (Rimal,  
45 2000) and in food-safety interventions (Mullan & Wong, 2010).

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

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

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

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

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

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

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

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

## 121 **2. Materials and Method**

### 122 *2.1. Participants*

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

### 130 *2.2. Measures*

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

### 143 *2.3. Intervention*

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



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

#### 157 *2.4. Design and procedure*

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

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

### 179 2.5. Analyses

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

## 195 3. Results

196 3.1. *Sample characteristics*

197           There were no differences between conditions (high-frequency reminder:  $n =$   
198 15; low-frequency reminder:  $n = 17$ ; control:  $n = 13$ ) at baseline in regards to age,  
199 sex, habit strength or behavior (all  $p > .05$ ). No participant reported microwaving their  
200 dishcloth at baseline.

201 3.2. *Food-safety behavior*

202           Overall, there was significant improvement in the target behavior over time,  
203  $F(2, 84) = 95.12, p < 0.01$ . This was qualified by significant time by condition  
204 interaction,  $F(4, 84) = 3.14, p = 0.04$ . Paired samples t-tests conducted separately  
205 for each condition comparing performance of the target behavior from baseline to  
206 post-intervention revealed that both the high-frequency,  $MD = 9.07, t(14) = 4.08, p <$   
207  $.01$ , and low-frequency,  $MD = 11.47, t(16) = 5.70, p < .01$ , intervention conditions  
208 improved from baseline to post-intervention while the control condition did not,  $MD =$   
209  $3.08, t(12) = 1.83, p = .09$ . Paired sample t-tests comparing performance of the  
210 target behavior from post-intervention to follow-up demonstrated greater  
211 performance at follow-up in the high-frequency condition,  $MD = 7.67, t(14) = 3.39, p$   
212  $< .01$ , the low-frequency condition,  $MD = 5.65, t(16) = 3.213, p < .01$ , and the control  
213 condition,  $MD = 7.38, t(12) = 4.09, p < .01$ . Importantly, planned contrasts revealed  
214 that change in performance of the target behavior from baseline to post-intervention  
215 was significantly greater in the intervention conditions compared to the control,  $\psi =$   
216  $7.19, F(1,42) = 7.78, p < 0.01$ , and that this difference was maintained at follow-up,  $\psi$   
217  $= 0.73, F(1,42) = 0.09, p = 0.77$ . Intervention groups did not differ from each other in  
218 terms of change in performance of the target behavior from baseline to post-  
219 intervention,  $\psi = 2.40, F(1,42) = 0.87, p = 0.39$ , nor from post-intervention to follow-

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

222 Insert Figure 1 near here

### 223 3.3. *Habit*

224 Overall, there was significant improvement in habit strength over time,  $F(2,$   
225  $84) = 47.54$ ,  $p < 0.01$ . This was qualified by significant time by condition interaction,  
226  $F(4, 84) = 5.46$ ,  $p < 0.01$ ,  $\eta^2 = .21$ . Paired samples t-tests conducted separately for  
227 each condition comparing habit strength at baseline to post-intervention revealed  
228 increased habit strength in the high-frequency condition,  $MD = 2.02$ ,  $t(14) = 5.12$ ,  $p <$   
229  $.01$ , low-frequency condition,  $MD = 3.03$ ,  $t(16) = 9.60$ ,  $p <.01$ , and the control,  $MD =$   
230  $1.10$ ,  $t(12) = 2.53$ ,  $p =.03$ . Comparing habit strength from post-intervention to follow-  
231 up revealed that habit strength did not change in the high-frequency condition,  $MD =$   
232  $-.38$ ,  $t(14) = -.93$ ,  $p = .37$ , nor in the low-frequency condition,  $MD = -.09$ ,  $t(16) = -.24$ ,  
233  $p = .81$ , but significantly decreased in the control condition,  $MD = -.58$ ,  $t(12) = -2.43$ ,  
234  $p = .03$ . Planned contrasts revealed that change in habit strength from baseline to  
235 post-intervention was greater in the two intervention conditions, compared to the  
236 control,  $\psi = 1.43$ ,  $F(1,42) = 8.88$ ,  $p < 0.01$ , and that this difference was maintained at  
237 follow-up,  $\psi = 0.34$ ,  $F(1,42) = 0.56$ ,  $p < 0.46$ . Contrasts examining whether  
238 intervention groups differed from each other in terms of habit strength from baseline  
239 to post-intervention were not significant,  $\psi = 1.01$ ,  $F(1, 42) = 3.85$ ,  $p = 0.06$ ; nor did  
240 these conditions differ from post-intervention to follow-up,  $\psi = 0.30$ ,  $F(1, 42) = .36$ ,  $p$   
241  $= 0.55$ . Means and standard error for each condition at each time point are displayed  
242 in Figure 2.

243 Insert Figure 2 near here

### 244 3.4. Mediation analysis

245 The indirect effect of intervention condition on behavior change through change  
246 in habit strength was tested. As there were no differences between intervention  
247 conditions in terms of improvement in behavior from baseline to post-intervention,  
248 these conditions were grouped together and compared to the control condition.  
249 Change in behavior and change in habit strength variables were created by  
250 subtracting post-intervention scores from baseline scores. The significance of the  
251 indirect effect was assessed using 95% confidence intervals, calculated using 5000  
252 bootstrap re-samples (Hayes, 2012). The indirect effect from intervention condition,  
253 through change in habit strength, to change in behavior was significant,  $\beta = 0.22$ ,  
254 95% [CI: 0.08, 0.40]. This mediation effect accounted for 12.99% of variance in the  
255 overall model. The effect of intervention condition on change in behavior was fully  
256 mediated by change in habit strength, as the effect of condition on behavior change  
257 was no longer significant once change in habit strength was added to the model. See  
258 Figure 3 for standardized coefficients between all variables.

259 

## 260 4. Discussion

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

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

269         The results of this study demonstrate that providing a cue to action and  
270 reminders build food-safety habits that result in changes in behavior. Previous  
271 research has demonstrated that consistently linking a cue to action with a behavior  
272 results in the behavior being carried out without the need for intention (Lally, et al.,  
273 2010). As intention does not always lead to behavior change (McEachan, Conner,  
274 Taylor, & Lawton, 2011), interventions that target the development of habits may be  
275 particularly useful. Another recent intervention used habit formation to successfully  
276 change fruit and vegetable consumption (Rompotis, Grove, & Byrne, 2014) in a  
277 similar way to link particular situations with fruit consumption and significantly  
278 improved behavior. An avenue for future research would be to compare the efficacy  
279 of habit-building interventions, such as the current intervention, against theory-driven  
280 interventions such those based on the theory of planned behavior.

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

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

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

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

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

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



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438

**Figure Captions**

439

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

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

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