 The final article is published as: Lunn, P. D., Timmons, S., Julienne, H., Belton, C.A., Barjaková, M., Lavin, C. and McGowan, F.P. (2020). Using Decision Aids to Support Self-Isolation During the COVID-19 Pandemic. *Psychology & Health*. Published Online, 19 November 2020. https://doi.org/10.1080/08870446.2020.1849701

Using Decision Aids to Support Self-Isolation During the COVID-19 Pandemic

Peter D. Lunn[a,b,*], Shane Timmons[a,c], Hannah Julienne[a], Cameron A. Belton[a], Martina Barjaková[a], Ciarán Lavin[a] & Féidhlim P. McGowan[b]

[a]*Economic and Social Research Institute (ESRI), Dublin, Ireland;* [b]*Department of Economics, Trinity College Dublin, Ireland;* [c]*Department of Psychology, Trinity College Dublin, Ireland.*

*corresponding author: Economic and Social Research Institute (ESRI), Whitaker Square, Sir John Rogerson's Quay, Dublin, Ireland. pete.lunn@esri.ie

Using Decision Aids to Support Self-Isolation During the COVID-19 Pandemic

Objective: Self-isolation is a vital element of efforts to contain COVID-19. We set out to test whether decision aids can support self-isolation. **Design:** We conducted a pre-registered online experiment with a nationally representative sample (n=500). Three stages tested: (i) whether decision trees help people to decide whether they need to self-isolate; (ii) whether an online planning tool increases people's confidence in their ability to self-isolate; and (iii) whether infographics help people to absorb advice on managing a household in which someone must self-isolate. **Main Outcome Measures:** (i) Accuracy of matching symptom patterns to a response scale for the need to self-isolate; (ii) self-reported confidence in coping with self-isolation; (iii) objective tests of recall and comprehension. **Results:** Decision trees improved decisions about when self-isolation was necessary, although participants systematically underestimated the need to self-isolate with less common COVID-19 symptoms (e.g. sore throat, fatigue). The online planning tool increased confidence about coping with self-isolation only among adults aged under 40. Infographics improved recall and comprehension of how to manage self-isolation. **Conclusion:** Decision aids can be used to support self-isolation during COVID-19. The study also demonstrates how even an emergency public health response can benefit from rapid experimental pre-testing of interventions.

Keywords: COVID-19; decision aids; self-isolation; pre-testing

Introduction

Self-isolation is an established public health measure for combatting infectious disease (Day et al., 2006) and an essential aspect of the preparedness, readiness and response actions to COVID-19 recommended by the World Health Organisation (2020a). The logic is simple: if individuals who think they might have the coronavirus avoid contact with others, further spread of the disease is less likely. Self-isolation will remain vital as countries ease social distancing measures while trying to control infection.

Although the logic of self-isolation as a public health measure is straightforward, the psychology of self-isolation is less so. This paper focuses on three elements. The first is the initial decision to undertake self-isolation. Individuals must assess a situation against public health guidelines and reach the appropriate conclusion about the need to self-isolate. The second is coping with the negative psychological consequences of self-isolation (Brooks et al., 2020). These two factors potentially interact. Individuals who feel unable to cope with self-isolation may be less inclined to self-isolate in marginal cases (e.g. when unsure of the strength of symptoms). Lastly, self-isolation requires household management. To reduce transmission risk, households containing a self-isolating individual need to absorb, comprehend and follow guidance on sleeping arrangements, bathrooms, eating, waste management, and so on.

The present study was motivated by the idea that work in psychology and broader behavioural science literature could assist people in these different psychological aspects of self-isolation. Specifically, we focus on decision aids – interventions or tools designed to improve decision making. Using the established scientific literature, we developed and tested three bespoke decision aids for rapid potential deployment in public health communications. We used an online, multi-stage experiment to test whether the decision aids helped people to decide when an individual needs to self-isolate, to be more confident about the prospect of self-isolation, and to learn requirements for managing a household where an individual self-isolates. A representative sample of 500 adults in Ireland were randomly assigned to view or interact with either the decision aids or control material. The latter consisted of prevailing public health advice on Ireland's main public health website (www.hse.ie) or in a public health advice booklet delivered to every house in the country (hereafter, "the booklet"). The specific hypotheses are shown in Table 1 and were pre-registered with the Open Science Framework (pre-registration). All bar H1b were directional hypotheses.

Each hypothesis in Table 1 was informed by extant literature, consisting of psychological theory and previous empirical findings. None depended on any specifics of the prevailing public health advice available in Ireland at the time. Hence, while it was useful for policymakers to test the specific materials, the study was designed to generate broader evidence in relation to decision aids and associated psychological mechanisms. The main contribution is to test the effectiveness of these decision aids in the context of a large-scale emergency response. Our findings may be useful for designing other specific behavioural interventions, both during the coronavirus pandemic and in relation to other challenges in the domain public health and perhaps beyond.

Deciding when to self-isolate requires individuals to weigh up multiple factors, over and above judgements about the presence or absence of specific symptoms. When information must be integrated from multiple inputs, heuristic tools can promote good decision making (Gigerenzer & Gaissmaier, 2011). These include “fast-and-frugal trees”: decision trees with n sequential questions and n+1 exits; one at each question and two at the final question (Martignon et al., 2003). Fast-and-frugal trees represent decisions in an intuitive and memorable way, lending themselves to graphical representations, such as flowcharts, which can assist learning and comprehension (Mayer, 2002; Butcher, 2006; McCrudden et al., 2007). Fast-and-frugal trees have been used successfully in multiple settings, including emergency medicine (Green & Mehr, 1997).

In common with circumstances in which fast-and-frugal trees have proved effective, the decision to self-isolate may impose a significant cognitive load, given the dispersal of guidance across sources, the volume of information, and the potential for ambiguity (e.g. What constitutes a symptom? Who counts as a close contact?). We therefore hypothesised that fast-and-frugal trees would help people to decide whether an individual needs to self-isolate (Hypothesis 1a), with possible differences between a simple (two-level) and more complex (four-level) tree (Hypothesis 1b). In the study, we randomised participants to view the relevant prevailing public health advice, a two-level decision tree, or a four-level decision tree. We then tested judgements as to whether individuals with different patterns of symptoms needed to self-isolate.

If anticipation of the unpleasantness of the experience deters people from self-isolation, feeling well-prepared may assist (Lunn et al., 2020). Planning can help people to cope with lifestyle changes and facilitate compliance with health guidance (Sniehotta, 2009). Planning practicalities, such as how to obtain essential supplies, may familiarise individuals with self-isolation and overcome some anxiety through "mere exposure" to the process (Lee, 2001). Plans can be made more effective by linking a conditional antecedent (e.g. "If I need to self-isolate…") to a specific intention (e.g. "I will ask my neighbour to pick up supplies and leave them at my door"). Such "implementation intentions" can bridge the intention-action gap in a range of domains, including health (Gollwitzer, 1999; Hagger & Luszczynska, 2014). Hence, we hypothesised that prompting individuals to create a personalised plan for self-isolation would increase confidence in their ability to cope and reduce the perceived difficulty (Hypothesis 2a).

In addition to the practicalities, loss of routine can be difficult (Brooks et al., 2020). Disruption to time structure can reduce mental wellbeing, as occurs following unemployment (Martella & Maass, 2000). Maintaining time structure and daily routine has mental health benefits more generally (Bond & Feather, 1988). Similarly, routines can help people to cope in "isolated and controlled extreme" (ICE) environments, as can setting achievable goals, undertaking hobbies, engaging remotely with social networks and exercising (Palinkas, 2003; Smith et al., 2017). The WHO recommends that people self-isolating during COVID-19 should keep a routine, engage social networks remotely, and maintain healthy behaviours (World Health Organisation, 2020b).

Given these findings, we hypothesised that making a plan and, further, developing a routine would increase individuals' confidence that they could cope with self-isolation (Hypotheses 2b and 2c). We developed an online planning tool, which asked a series of prompted questions about how individuals could self-isolate within their household. To construct an additional routine, we adapted the "day reconstruction method" – a diary task that helps people to organise and recall events from the previous day (Kahneman et al., 2004). We used a similar approach to help people to structure a day of self-isolation, which we refer to as "day preconstruction". Participants were randomised to engage with the prevailing public health advice on coping with self-isolation, the planning tool, or the planning tool plus the routine. We measured confidence in coping, willingness to extend a period of self-isolation if needed (Briscese et al., 2020), and perceived difficulty of specific aspects of self-isolation.

Managing a household in which an individual self-isolates is similar to managing a patient at home following a medical procedure. A list of behaviours must be understood, recalled and acted upon. However, patients typically cannot recall a substantial amount of relevant information, with recollections being sensitive to format (Hoek et al., 2019). Verbal communication is recalled less than written information or, better still, video. The visual form of information matters generally. Bullet points are absorbed more easily than paragraph text for public health communication (Lagassé et al., 2011) and consent documents (Jefford & Moore, 2008), but may be insufficient to improve recall (Wogalter & Shaver, 2001), unless simplified further via themes (Duvall Antonacopoulos & Serin, 2015) or reduced text content (Jolly et al., 1995). Categorisation of medical information can improve memory performance (Kessles, 2003), helped by specifying clear categories in advance to the recipient (Ley, 1979). Similarly, topic headings can improve memory for text (Lorch et al., 1993). Where video is not an option, visual cues can be introduced via “infographics”, which combine imagery and minimal text. Simple pictures can increase attention, recall, comprehension and adherence to medical guidance (Houts et al., 2006, Bunge et al., 2010) and cartoon illustrations alongside text can increase recall of information in patient leaflets (Delp & Jones, 1996; Austin et al., 1995; Sojourner & Wogalter, 1998).

Given this evidence, we hypothesised that categorising information on how to manage a household in which someone is self-isolating into themed, bulleted infographics would assist recall and comprehension (Hypothesis 3). Participants were randomised to view either the ten-point list used in the booklet or equivalent infographics. They then completed an objective test of recall and comprehension.

Materials and Methods

The study was undertaken for the Behavioural Change Subgroup of the National Public Health Emergency Team in Ireland, to inform public health communications. It was approved according to the Economic and Social Research Institute’s policy for the conduct of ethical research. Data was collected during the first week of April 2020.

At that time, everyone in Ireland had been urged to stay at home, except for a few specified reasons, such as essential work, caring for others, essential shopping, and exercise. Public health guidelines stated that an individual experiencing any symptoms of COVID-19 should self-isolate completely. Meanwhile, anyone in close contact with a confirmed case of COVID-19, or living with someone displaying symptoms, should remain at home as much as possible and leave only to exercise or shop for essentials if absolutely necessary. These guidelines were covered extensively in the media and promoted via multiple government communication channels, as well as via the booklet.

Participants

Five-hundred participants were recruited by invite from a market research agency panel to be broadly nationally representative by gender, age and working status. All gave informed consent to participate. Socio-demographic characteristics are summarised in Supplementary Material. Participants were paid €8.50 for completing the 25-minute study, programmed using Gorilla Experiment Builder (Anwyl-Irvine et al., 2020).

Procedure

The study was multi-stage, with hypotheses tested sequentially on the same participants. Randomisation was conducted independently at each stage. The study was carefully designed to avoid the possibility that assignment to conditions in earlier stages would affect responses to later stages, although this was double-checked during data analysis.

Stage 1: Decision trees

Participants were randomised to view one of three online pages:

- Control: The page displayed advice from Ireland's Health Service Executive (HSE) webpage about restricted movements and self-isolation, together with the symptom table provided in the booklet.
- Simple tree: The page displayed a simple, 2-level fast-and-frugal tree, designed to aid decisions about self-isolation and restricting movements.
- Complex tree: The page displayed a more complex, 4-level fast-and-frugal tree, designed to aid decisions about self-isolation and restricting movements.

For illustration, Figure 1 displays the complex tree (the simple tree and control page are shown in Supplementary Material). All materials throughout the study employed this black and yellow branding – a feature of the Irish public health response to COVID-19.

This stage had a before-and-after design. Participants responded to ten short scenarios ("vignettes"), organised into two sets of five, each describing an individual trying to decide whether they needed to self-isolate. For example:

> Jack has been unwell the last few days. He has a dry cough and feels like he has a fever, although he doesn't have a thermometer so can't check. He's feeling a little bit better today though, and thinks he's on the mend.

An initial set of five vignettes required participants to respond based on background knowledge and understanding of public health guidelines. The intervention page was then shown, followed by another set of five, during which participants could click back to the advice page. These checks were recorded. The sets shown pre- and post-intervention were counterbalanced and within each set the order was randomised.

Vignettes were carefully written based on contemporaneous public health advice. Each set conformed to a natural ranking: (i) Subject has "primary" symptoms of COVID-19 (fever, dry cough); (ii) Subject has other flu-like symptoms (e.g. sore throat, headache, fatigue, aches and pains); (iii) Subject has had close contact with a confirmed case or lives with someone displaying primary symptoms; (iv) Subject has had potential close contact with a suspected case or lives with someone with a potential symptom; (v) Subject does not need to self-isolate. Some extraneous information was also present. Both sets of vignettes are reproduced in full in Supplementary Material.

Participants responded on a scale (1 = "Doesn't need to self-isolate" to 7 = "Definitely needs to self-isolate"). After each set, they were asked how confident they were in their judgements (1 = "Not at all confident" to 7 = "Very confident"). The primary outcome of interest was whether responses matched prevailing public health advice, especially in relation to the two scenarios in which complete self-isolation was needed (primary COVID-19 symptoms, other flu-like symptoms).

Stage 2: Planning Tools

Participants were randomly assigned to one of three conditions: control, plan, "plan + routine". Participants in the control condition saw an information page from the booklet about keeping well during self-isolation. Participants in the other two conditions interacted with an online tool. All pages are available in Supplementary Material.

In the plan condition, participants were told that the next stage would involve creating a plan they could follow should they need to self-isolate. They were asked questions about their living situation, including which room they could sleep in, how they could obtain groceries, and who they could stay in contact with and how (e.g. via phone calls or social media). Responses were used to create a personalised plan, which was added to the information page shown to control participants.

Participants in the "plan + routine" condition completed the same plan, but then the online tool engaged them also in the day preconstruction task. They were told that "coping with self-isolation can be made a bit easier by keeping some structure in your day, particularly when you feel well enough." They were asked to think about things they might plan to do to structure their day if they needed to self-isolate. They were given advice about what these might be, including sticking to a regular sleep pattern, getting some light exercise, being mobile, getting fresh air, staying in contact with others (via phone or social media), undertaking hobbies, and targeting small goals they might want to achieve. Next, participants were asked to imagine that they needed to self-isolate and to think about the kinds of things they would plan to do tomorrow. Instructions were adapted from the day reconstruction booklet (Kahneman et al., 2004). They were told to think of tomorrow as a series of episodes split into three parts: morning (waking up until lunch); afternoon (lunch until evening meal); evening (evening meal until sleep). They were shown a list of tasks or activities they might do during each episode. Participants could choose from the list or type in another activity. They were also asked to put the tasks in the order they might do them. Finally, participants were shown a summary of their personalised plan and day schedule.

After reading the information or engaging with the online tool, participants rated the helpfulness of the information (1 = "not at all" to 7 = "extremely"), and how likely they would be to direct someone who needed to self-isolate to it (1 = "highly unlikely" to 7 = "highly likely"). These measures were presented as ostensibly the only measures of interest regarding the plans. However, the primary outcome variables were elicited in a subsequent set of questions. Participants were told that we were interested in their views on self-isolation more generally. They were asked to imagine they needed to self-isolate from now and asked how confident they felt in their ability to cope (1 = "not at all" to 7 = "extremely"). We also asked how likely they thought they would be to continue to comply if their isolation period had to be extended beyond the expected 14 days (1 = "highly unlikely" to 7 = "highly likely"). Intentions to comply decrease when the isolation period is lengthened beyond what is expected (Briscese et al., 2020), but participants who feel better able to cope should be less likely to decrease their intentions to comply. Finally, participants were asked how difficult they thought they would find five specific issues taken from Barari et al. (2020): lack of freedom, boredom, lack of fresh air, lack of exercise, loneliness (1 = "not at all difficult" to 7 = "extremely difficult"). The five responses were combined into a composite score for ease of coping.

Stage 3: Infographics

Continuing the theme from Stage 2, participants were asked to imagine that they were about to self-isolate. They were shown guidelines on how to self-isolate properly and encouraged to read them in detail, but not informed about subsequent tasks. Half the participants were randomised to view the guidelines as presented in the booklet – a one-to-ten numbered list across three pages, each with a short paragraph. The other half saw three infographics categorised into advice themes: "personal", "interacting with other people", "household management". The information was identical, but presented as bullet points next to cartoon images (Figure 2). All pages are shown in Supplementary Material. Participants could scroll between pages with no time limit.

Three tasks followed. The first simply asked how easy they thought they would find it to follow the guidelines (1 = "very difficult" to 7 = "very easy"). The second tested recall. Participants were shown pairs of guidelines and had to identify whether one (and if so which), both or neither guideline was in the official guidelines. Twenty guidelines (ten official, ten distractors) were presented in ten pairs, with combinations and orders randomised. The third task tested comprehension. Participants responded to multiple choice questions (MCQs) about the guidelines, for example:

> If symptoms worsen but it is not an emergency, what should you do?
> A. Call 999 or 112
> B. Call GP [correct answer]
> C. Call the test centre and arrange a test
> D. Wait 14 days

Participants responded to six MCQs, with questions and response options randomised. The full set of MCQs is provided in Supplementary Material.

Statistical Analyses

Data analysis was undertaken in Stata 15. It was anticipated that outcome variables in all stages were unlikely to be normally distributed. This was confirmed by standard tests (Shapiro-Wilk, skew). Bivariate analysis was by standard non-parametric tests (Wilcoxon signed-rank, Wilcoxon-Mann-Whitney) for equal distributions. Since differential responses by socio-demographic group were possible and the sample sufficiently large for analysis by subgroup, multivariate analysis of ordered response categories was conducted by ordinal logistic regression (OLR), following transformation of dependent variables to ensure adequate cell sizes (details in Supplementary Material). Data and analysis code can be found at data link.

Results

Stage 1

Before examining responses by condition, we consider the overall pattern of responses to the five scenarios (Figure 3), which constitutes an unexpected but notable result. At baseline, for scenarios in which individuals had primary COVID-19 symptoms (dry cough, fever), the mean response was 6.11 (sd = 1.58), with 66% of respondents assigning the maximum of 7 and 88% assigning a 5 or higher. Thus, public health messages about the primary symptoms had been absorbed by a large majority. However, respondents were unsure about scenarios in which individuals had other flu-like symptoms (e.g. aches and pains, sore throat, fatigue, headache). Pre-intervention, the mean response was exactly at the midpoint of 4.00, with wide dispersion (sd = 2.12). Only 49% responded with a 5 or higher, despite prevailing public health guidelines that people with these symptoms should self-isolate. Post-intervention these responses increased (pooling across conditions, Wilcoxon signed rank, two-tailed, p = .002), although the increase was modest and dispersion persisted (mean = 4.38, sd = 2.28). Participants gave higher responses to scenarios in which the individual was asymptomatic but had been in close contact with a confirmed case or someone with primary symptoms, or even with a suspected or potential case. In these latter situations, guidance was for individuals restrict movements but, in contrast to having flu-like symptoms, to self-isolate fully only if they go on to develop symptoms. This pattern did not change post-intervention. We consider explanations for these departures from the guidance in the Discussion. Responses to the scenario in which the individual had no relevant symptoms were lower than for the other four scenarios and scores reduced post-intervention (Wilcoxon signed-rank, two-tailed, $p = .007$).

Responses to the two scenarios requiring full self-isolation varied by condition. Figure 4 shows proportions of participants by condition who responded with a 7 for the scenario with primary symptoms and a 5 or higher for the scenario with other flu-like symptoms. (The pattern is not sensitive to precise cut-off points). Post-intervention, the proportion of individuals who assigned a 7 to the primary symptom scenarios increased only in the complex tree condition. For the scenarios with other flu-like symptoms, post-intervention responses increased in all conditions, but most strongly in the complex tree condition. Note, however, that despite randomisation into conditions, we recorded pre-intervention differences by condition. These were short of statistical significance for the primary symptoms scenario, but pre-intervention responses to the other flu-like symptoms were significantly higher in the complex tree condition, including after controlling for socio-demographic background characteristics (Supplementary Material). Randomisation apparently assigned more cautious individuals to the complex tree condition. Fortunately, having recorded responses both pre- and post-intervention, we could control for this in our analysis at the individual level.

Table 2 presents regression models that test for significant differences in post-intervention responses, controlling for pre-intervention responses via two variables: responses to the equivalent pre-intervention scenario and the individual's mean response to the other four pre-intervention scenarios. We control also for differences between the counterbalanced sets of scenarios (Set A versus Set B). Models 1-3 are binary logistic regressions, where the dependent variable is whether the participant responded with a 7 to the primary symptoms scenario. Models 4-6 are OLR models for responses to the scenario involving other flu-like symptoms. All models pass standard specification tests and further robustness checks (Supplementary Material).

Relative to the control condition, viewing the complex decision tree significantly increased the likelihood that participants decided that self-isolation was required. Controlling for multiple background characteristics (gender, age, educational attainment) did not alter this finding. However, in the scenario with primary symptoms there was an interaction with educational attainment (measured by whether the participant held a degree). Model 3 reveals that the decision trees altered the decisions of the 65% of the sample who were not degree holders, with no impact on those who were – the coefficient on the interaction term cancels the main effect. For scenarios involving other flu-like symptoms, both decision trees increased the likelihood of deciding that self-isolation was needed, although the effect was only borderline statistically significant for the simple tree and the interaction with educational attainment was short of statistical significance.

Overall, these models confirm an improvement in decisions after viewing decision trees (Hypothesis H1a), driven by participants without degree-level education. However, the models fall short of confirming Hypothesis H1b. Across all six models, while point estimates are consistently higher for the complex tree, differences between coefficients for the simple versus complex tree are short of statistical significance (two-tailed, $p > .1$). In addition, Table 2 reveals that males were less likely to identify these scenarios as requiring self-isolation and that older people were less likely to do so for the scenario involving other flu-like symptoms.

Comparing confidence ratings pre- and post-intervention, participants who viewed the control intervention experienced a marginal decrease in confidence. Those who viewed either decision tree experienced increases (Mann-Whitney-Wilcoxon, two-tailed: control versus simple, $p = .005$; control versus complex, $p = .07$). Participants who viewed the simple decision tree were less likely to click back to the page when making decisions (Control 38%, Simple 25%, Complex 41%; two-tailed, $\chi2(2) = 9.50$, $p = .009$), perhaps because they felt that they had absorbed the information.

Stage 2

The main responses in Stage 2, on coping with self-isolation, were collected after participants rated intervention materials for helpfulness and whether they would recommend them. Mean confidence ratings were 5.80 (sd = 1.42), 5.99 (1.29) and 6.00 (1.38) for the control, plan and "plan + routine" conditions respectively. The difference between the control and treatment conditions (pooled) was marginally statistically significant (Mann-Whitney-Wilcoxon, one-tailed, $p = .06$). Mean responses to the question about extending the period of self-isolation were 6.21 (1.48), 6.17 (1.41), and 6.17 (1.25), with no significant differences. Correlations between ratings for specific aspects of self-isolation (lack of freedom, boredom, lack of fresh air, lack of exercise, loneliness) ranged from 0.28-0.66 and were combined into an "ease of coping" score by standardising and computing individual-level means. Differences between control and treatment conditions were not significant. Overall, there was insufficient support for Hypothesis H2a – the planning tools did not generally increase confidence in coping.

However, all three outcomes varied strongly with age and there was an interaction between age and condition. Table 3 shows OLR models for confidence, willingness to extend a self-isolation period, and ease of coping (further details in Supplementary Material). To further examine Hypothesis H2a, the plan and "plan + routine" conditions are pooled. Although the interaction with age was not a pre-registered hypothesis, it is consistent across all three dependent variables (and further robustness checks are in Supplementary Material). The pattern has three distinct aspects. First, older people, particularly the over 60s, were significantly more confident about coping with self-isolation. Second, the planning interventions were positive for younger adults (under 40). Third, the planning interventions were not effective for older adults. These relationships are illustrated in Figure 5, which displays mean confidence scores by condition and age. In the control condition, under-40s were less confident about coping, but the planning tools increased their scores to match those of older adults. The pattern for the two other outcome variables is similar (Supplementary Material). Hence, there was support for Hypothesis H2a among adults under 40.

To test Hypothesis H2b, the models were re-estimated separating the treatment conditions (Supplement 2). Both coefficients were consistently positive, marginally and strongly statistically significant for confidence (plan, $\beta = .581$ (.384), $z = 1.51$, one-tailed, $p = .07$; "plan + routine", $\beta = 1.204$ (.400), $z = 3.01$, one-tailed, $p = .002$), non-significant for extending the period of self-isolation, and marginally significant in the "plan + routine" condition for ease of coping ($\beta = .536$ (.386), $z = 1.39$, one-tailed, $p = .08$). However, the pattern of interactions again suggested that both tools were effective only among the under-40s. Overall, therefore, the results indicate modest support for Hypothesis H2b among younger adults. With respect to Hypothesis H2c, differences between conditions were generally short of statistical significance, but there was a marginally significant negative effect of the “plan + routine” condition on the over 60s (Supplementary Material), suggesting that among this initially more confident group the tool may even have backfired. Participants’ views about the helpfulness of the treatments supported this. They favoured the plan without the routine (Mann-Whitney-Wilcoxon, plan versus control, $p = .04$; plan versus “plan + routine”, $p < .001$) but were less likely to recommend the “plan + routine” condition (Mann-Whitney-Wilcoxon, “plan + routine” versus control, $p < .001$; plan versus “plan + routine”, $p < .001$).

Stage 3

In Stage 3, on managing self-isolation, while the main outcomes of interest were scores out of ten for recall and scores out of six for comprehension, participants initially rated how easy they found the information to follow. Mean scores for the three outcomes are shown in Figure 6, in which the vertical axes cover one standard deviation across participants to indicate effect size. There was no significant difference by condition in perceptions of how easy the advice was to follow. However, participants in the infographic condition produced higher scores than those in the control condition for recall and comprehension (Mann-Whitney-Wilcoxon, one-tailed, $p = .02$ and $p = .001$ respectively). The results therefore confirm Hypothesis H3.

Table 4 presents OLR models for recall and comprehension, allowing some further analysis by subgroup. Consistent with the bivariate scores, the infographics had a consistently positive impact on recall and comprehension. Recall was better among participants who held a degree. Comprehension was better among older adults, perhaps reflecting experience in managing a household. The pattern of interactions suggests that the infographics had differential effects by gender and educational attainment. Models 11 and 13 indicate that the infographics were more help to women. Model 11 suggests that they may also have been more helpful for participants without a degree.

Discussion

This three-stage study tested whether decision trees improve the decision to self-isolate, whether online planning tools increase confidence in coping with self-isolation, and whether infographics improve recall and comprehension of information about how to self-isolate. In all three stages, the interventions generated some statistically significant, positive outcomes. Overall, therefore, the study provides evidence that decision aids can be used to support self-isolation during the COVID-19 pandemic.

As described at the outset, while the present study constituted a useful test of materials that were specific to time and place, the primary contribution is to show the effectiveness of these types of decision aids in the context of an emergency response. Thus, while specific elements of the communication materials tested here have changed as public health advice in Ireland has evolved, the evidence generated in relation to the underlying principles and techniques endures and is relevant elsewhere. This final section addresses three further issues: individual differences, the absolute level of performance in recognising the need to self-isolate, and the benefits of pre-testing.

The results of all three stages displayed individual differences, with commonalities and contrasts. In Stages 1 and 3, decision trees and infographics were more effective for participants with lower educational attainment. Decision aids that seek to simplify and organise information may be particularly beneficial for people with no college education. Such findings are important with respect to concerns that COVID-19 may have disproportionate effects on those in lower socio-economic groups, both within and between nations (Ahmed et al., 2020; van Dorn et al., 2020). In Stages 2 and 3, older adults (over 40s) had greater confidence in their ability to cope with self-isolation and better understanding of how to run a household in which an individual self-isolates. Planning tools were beneficial to younger adults' confidence in coping with self-isolation. A danger is that younger adults who do not feel confident about coping with self-isolation, either psychologically or practically, will be slower to self-isolate when they should. Our findings show that public health authorities can design and test communication materials with this target population in mind.

We set out to test communication materials informed by previous psychological studies and, given this, outcome variables were designed for relative comparison between conditions. However, one absolute outcome requires specific mention. Participants were equivocal about self-isolation with flu-like symptoms other than the primary COVID-19 symptoms. The two scenarios tested involved an individual described as "tired, achy all over and has a blocked nose" and another who was "feeling achy, has a sore throat and is generally a bit under the weather". A substantial proportion of participants thought these individuals had less reason to self-isolate than people who were asymptomatic but had been in contact with someone with primary symptoms. These responses straightforwardly contravene public health guidance. There are several possible potential explanations. There was media discussion at the time regarding criteria for obtaining a COVID-19 test, which distinguished more strongly between primary and other flu-like symptoms. This may have caused confusion, but does not explain why participants were more inclined to say that asymptomatic people who had been in contact with confirmed or suspected cases had greater need to self-isolate. An alternative possibility is that learning a narrative for how the virus could have been contracted increases the subjective probability of having it. Or, more simply, familiarity with cold and flu-like symptoms might lead people to underestimate the link to COVID-19. Whatever the explanation, or combination of explanations, individuals' own internal models for contracting COVID-19 distorted public health advice and reduced perceived need to self-isolate. Although this study took place relatively early in the pandemic, Ireland had already experienced extensive media coverage of COVID-19 symptoms and widespread advice on the need to self-isolate if experiencing any flu-like symptoms. It is therefore possible that internal models of the likelihood of contracting the disease overrode that public heath advice and may have continued to do so. Given the ongoing importance of self-isolation in efforts to fight the virus, studies that investigate this question at later stages in the pandemic would be helpful.

The preceding argument highlights a hazard when trying to deploy behavioural science as a rapid response to the pandemic. On the one hand, this study demonstrates rapid deployment of an experiment to test and improve relevant public health communications. It shows the advantage of proper experimental testing over standard marketing research, since participants' subjective opinions about the usefulness of the interventions did not match objective measures of decisions or capabilities post-intervention. On the other hand, the results reveal shortcomings in our understanding of relevant psychological mechanisms during an unprecedented pandemic. Ideally, applied behavioural science involves a careful diagnosis to guide the design of interventions that can then be pre-tested (Lunn, 2019). Yet pressures of time, driven by the need for rapid intervention, may make this impossible. Moreover, it is possible that relevant psychological mechanisms change over time, altering the effectiveness of interventions.

Nevertheless, this study demonstrates that rapid behavioural testing of public health communications can be undertaken online even in what are, from a policy perspective, emergency circumstances. Findings from this study have been incorporated into Department of Health communications campaigns in Ireland (and indeed elsewhere). They add to previous literature on the effectiveness of decision aids by demonstrating the potential value of such interventions in a widespread public health crisis. Given the possibility of further waves of Covid-19, or of other pandemics, applied psychological science can strengthen empirical foundations for public health advice.

References

Ahmed, F., Ahmed, N. E., Pissarides, C., & Stiglitz, J. (2020). Why inequality could spread COVID-19. *The Lancet Public Health*, 5(5), e240. https://doi.org/10.1016/S2468-2667(20)30085-2

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, 52(1), 388-407. https://doi.org/10.3758/s13428-019-01237-x

Austin, P. E., Matlack, R., Dunn, K. A., Kosler, C., & Brown, C.K. (1995). Discharge instructions: Do illustrations help our patients understand them? *Annals of Emergency Medicine*, 25, 317–20. https://doi.org/10.1016/s0196-0644(95)70286-5

Barari, S., Caria, S., Davola, A., Falco, P., Fiorin, S., Hensel, L., ... & Ledda, A. (2020). Evaluating COVID-19 Public Health Messaging in Italy: Self-Reported Compliance and Growing Mental Health Concerns. Working Paper.

Bond, M. J., & Feather, N. T. (1988). Some correlates of structure and purpose in the use of time. *Journal of Personality and Social Psychology*, 55(2), 321-329. https://doi.org/10.1037/0022-3514.55.2.321

Briscese, G., Lacetera, N., Macis, M., & Tonin, M. (2020). *Compliance with COVID-19 Social-Distancing Measures in Italy: The Role of Expectations and Duration*. National Bureau of Economic Research Working Paper No. 26916. https://doi.org/10.3386/w26916

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The Lancet*, 395(10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8

Bunge, M., Mühlhauser, I., & Steckelberg, A. (2010). What constitutes evidence-based patient information? Overview of discussed criteria. *Patient Education and Counseling*, 78(3), 316-328. https://doi.org/10.1016/j.pec.2009.10.029

Butcher, K. R. (2006). Learning from text with diagrams: Promoting mental model development and inference generation. *Journal of Educational Psychology*, 98, 182-197. https://doi.org/10.1037/0022-0663.98.1.182

Day, T., Park, A., Madras, N., Gumel, A., & Wu, J. (2006). When Is Quarantine a Useful Control Strategy for Emerging Infectious Diseases? *American Journal of Epidemiology,* 163(5), 479–485. https://doi.org/10.1093/aje/kwj056

Delp, C., & Jones, J. (1996). Communicating information to patients: The use of cartoon illustrations to improve comprehension of instructions. *Academic Emergency Medicine*, 3, 264–70. https://doi.org/10.1111/j.1553-2712.1996.tb03431.x

Duvall Antonacopoulos, N. M., & Serin, R. C. (2015). Comprehension of Online Informed Consents: Can It Be Improved? *Ethics & Behavior*, 26(3), 177–193. https://doi.org/10.1080/10508422.2014.1000458

Gollwitzer, P. M. (1999). Implementation intentions: strong effects of simple plans. American psychologist, 54(7), 493. https://doi.org/10.1037/0003-066X.54.7.493

Green, L., & Mehr, D. R. (1997). What alters physicians' decisions to admit to the coronary care unit? *Journal of Family Practice*, 45, 219-226.

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. Applied Psychology: Health and Well-Being, 6(1), 1-47. https://doi.org/10.1111/aphw.12017

Hoek, A. E., Anker, S. C. P., van Beeck, E. F., Burdorf, A., Rood, P. P. M., & Haagsma, J. A. (2019). Patient discharge instructions in the emergency department and their effects on comprehension and recall of discharge instructions: A systematic review and meta-analysis. Annals of Emergency Medicine. https://doi.org/10.1016/j.annemergmed.2019.06.008

Houts, P. S., Doak, C. C., Doak, L. G., & Loscalzo, M. J. (2006). The role of pictures in improving health communication: A review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*, 61(2), 173–190. https://doi.org/10.1016/j.pec.2005.05.004

Jefford, M., & Moore, R. (2008). Improvement of informed consent and the quality of consent documents. *The Lancet Oncology*, 9(5), 485–493. https://doi.org/10.1016/s1470-2045(08)70128-1

Jolly, B. T., Scott, J. L., & Sanford, S. M. (1995). Simplification of emergency department discharge instructions improves patient comprehension. *Annals of Emergency Medicine*, 26(4), 443–446. https://doi.org/10.1016/s0196-0644(95)70112-5

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N. & Stone, A. A. (2004). A survey method for characterizing daily life experience: The day reconstruction method. *Science*, 306(5702), 1776-1780. https://doi.org/10.1126/science.1103572

Kessels, R. P. C. (2003). Patients' memory for medical information. *Journal of the Royal Society of Medicine*, 96(5), 219–222. https://doi.org/10.1177/014107680309600504

Lagassé, L. P., Rimal, R. N., Smith, K. C., Storey, J. D., Rhoades, E., Barnett, D. J., ... & Links, J. (2011). How accessible was information about H1N1 flu? Literacy assessments of CDC guidance documents for different audiences. *PloS one*, 6(10). https://doi.org/10.1371/journal.pone.0023583

Lee, A. Y. (2001). The mere exposure effect: An uncertainty reduction explanation revisited. Personality and Social Psychology Bulletin, 27(10), 1255-1266. https://doi.org/10.1177/01461672012710002

Ley, P. (1979). Memory for medical information. *British Journal of Social and Clinical Psychology*, 18(2), 245–255. https://doi.org/10.1111/j.2044-8260.1979.tb00333.x

Lorch, R. F., Lorch, E. P., & Inman, W. E. (1993). Effects of signaling topic structure on text recall. *Journal of Educational Psychology*, 85(2), 281–290. https://doi.org/10.1037/0022-0663.85.2.281

Lunn, P. D. (2019). Nudger beware: Diagnosis precedes remedy. *Journal of Behavioral Economics for Policy,* 3(S), 23-26.

Lunn, P. D., Belton, C. A., Lavin, C., McGowan, F. P., Timmons, S., & Robertson, D. A. (2020). Using Behavioral Science to help fight the Coronavirus. Journal of Behavioral Public Administration, 3(1). https://doi.org/10.30636/jbpa.31.147

Martella, D., & Maass, A. (2000). Unemployment and life satisfaction: The moderating role of time structure and collectivism 1. *Journal of Applied Social Psychology*, 30(5), 1095-1108. https://doi.org/10.1111/j.1559-1816.2000.tb02512.x

Martignon, L., Vitouch, O., Takezawa, M., & Forster, M. R. (2003). Naive and yet enlightened: From natural frequencies to fast and frugal decision trees. In Thinking: Psychological perspective on reasoning, judgment, and decision making (eds. Hardman, D. & Macchi, L.), pp. 189-211. John Wiley and Sons.

Mayer, R. E. (2002). Multimedia learning. *Psychology of Learning and Motivation*, 41, 85-139. https://doi.org/10.1016/S0079-7421(02)80005-6

McCrudden, M. T., Schraw, G., Lehman, S., & Poliquin, A. (2007). The effect of causal diagrams on text learning. Contemporary Educational Psychology, 32, 367-388. https://doi.org/10.1016/j.cedpsych.2005.11.002

Palinkas, L. A. (2003). The psychology of isolated and confined environments: Understanding human behavior in Antarctica. *American Psychologist*, 58(5), 353-363.

Smith, N., Kinnafick, F., & Saunders, B. (2017). Coping strategies used during an extreme Antarctic expedition. *Journal of Human Performance in Extreme Environments*, 13(1), 1. https://doi.org/10.7771/2327-2937.1078

Sniehotta, F. F. (2009). Towards a theory of intentional behaviour change: Plans, planning, and self-regulation. *British Journal of Health Psychology*, 14(2), 261-273. https://doi.org/10.1348/135910708X389042

Sojourner, R. J., & Wogalter, M.S. (1998). The influence of pictorials on the comprehension and recall of pharmaceutical safety and warning information. *International Journal of Cognitive Ergonomics*, 2, 93–106. https://doi.org/10.1177/009286159703100340

van Dorn, A., Cooney, R. E., & Sabin, M. L. (2020). COVID-19 exacerbating inequalities in the US. *The Lancet*, 395(10232), 1243-1244. https://doi.org/10.1016/S0140-6736(20)30893-X

Wogalter, M. S., & Shaver, E. F. (2001). Evaluation of List vs. Paragraph Text Format on Search Time for Warning Symptoms. In Bittner, A.C., & Champney, P.C (Eds.), *Advances in Occupational Ergonomics and Safety Volume 4* (pp. 434-438). IOS Press.

World Health Organisation (2020a, updated 24 June 2020). Critical preparedness, readiness and response actions for COVID-19. WHO. https://www.who.int/publications/i/item/critical-preparedness-readiness-and-response-actions-for-covid-19

World Health Organisation (2020b, 30 June 2020). Mental health and psychosocial considerations during the COVID-19 outbreak. WHO. https://apps.who.int/iris/handle/10665/331490

Table 1. Study hypotheses.

Hypothesis 1a	Decisions to self-isolate will be improved by providing individuals with a fast-and-frugal decision tree, compared to reading prevailing public health advice in text and tables.
Hypothesis 1b	A simple (2-level) tree will differ in effectiveness compared to a more complex (4-level) tree.
Hypothesis 2a	Individuals who complete a plan (with or without a routine) will be more confident in their ability to cope with self-isolation and perceive it as less difficult than individuals who read only the prevailing public health advice.
Hypothesis 2b	Both constructing a plan, or the plan with a routine, will increase confidence in ability to cope with self-isolation and reduce its perceived difficulty relative to prevailing public health advice.
Hypothesis 2c	A plan with a routine will have an additive effect, above constructing only a plan, on all measures.
Hypothesis 3	Recall and comprehension of current public health information describing how to manage self-isolation will be improved by providing it in the form of infographics.

Table 2. Logistic and ordered logistic regression models for Stage 1 responses to scenarios involving primary and other flu-like symptoms respectively.

	Primary symptoms Logit (Response = 7)			Other flu-like symptoms (Ordered logit)		
	(1)	(2)	(3)	(4)	(5)	(6)
Condition (Ref=Control)						
Simple tree	**.289**	**.294**	**.661*****	**.241**	**.309***	**.385***
	(.251)	**(.255)**	**(.311)**	**(.208)**	**(.209)**	**(.256)**
Complex tree	**.677*****	**.619****	**1.051*****	**.535*****	**.518*****	**.782*****
	(.265)	**(.269)**	**(.346)**	**(.215)**	**(.217)**	**(.280)**
Pre-intervention responses						
Matching scenario	1.177***	1.173***	1.189***	.225***	.207***	.207***
	(.227)	(.230)	(.232)	(.047)	(.047)	(.047)
Other scenarios	-.025	-.027	-.017	.098	.073	.073
	(.098)	(.101)	(.102)	(.084)	(.084)	(.084)
Scenario Set B	.829***	.829***	.817***	-.399**	-.379**	-.379**
	(.214)	(.216)	(.217)	(.178)	(.179)	(.179)
Male		-.397	-.413*		-.482***	-.482***
		(.214)	(.216)		(.174)	(.174)
Age Ref=(18-39)						
40-59		.209	.240		-.291	-.291
		(.280)	(.216)		(.226)	(.226)
60+		.342	.383		-.521**	-.521**
		(.278)	(.280)		(.224)	(.224)
Degree		.431*	1.234***		.067	.355
		(.239)	(.418)		(.191)	(.325)
Education interaction						
Simple tree * Degree			**-1.152****			**-.204**
			(.557)			**(.447)**
Complex tree * Degree			**-1.120****			**-.651**
			(.564)			**(440)**
Constant	-.801*	-.911	-1.233**			
	(.470)	(.559)	(.581)			
Log likelihood	-263.37	-259.61	-256.64	-787.76	-781.05	-779.89
n	437	437	437	437	437	437

*** p < .01; ** p < .05; * p < .10 (one-tailed in the first two rows only, consistent with the directional main hypothesis).

Table 3. Ordered logistic regression (OLR) models for confidence in coping with self-isolation, willingness to extend self-isolation, and ease of coping with specific aspects.

	Confidence (7)	Extended period (8)	Ease of Coping (9)
Plan	**.878*** **	**.292**	**.480***
	(.338)	**(.352)**	**(.336)**
Male	.377**	-.047	.147
	(.172)	(.186)	(.166)
Degree	-.069	.083	.052
	(.194)	(.209)	(.183)
Age Ref=(18-39)			
40-59	.342	.202	.930**
	(.383)	(.415)	(.384)
60+	.964***	1.464***	.971***
	(.376)	(.463)	(.373)
Age interaction			
Plan * 40-59	**-.601**	**-.403**	**-.737**
	(.455)	**(.482)**	**(.449)**
Plan * 60+	**-1.084****	**-.1.414*****	**-.756***
	(.454)	**(.533)**	**(.445)**
Log likelihood	-586.04	-492.98	-649.36
n	472	472	472

*** p < .01; ** p < .05; * p < .10 (one-tailed in the first row only).

Table 4. Ordered logistic regression (OLR) models for scores for recall and comprehension (MCQs).

	Recall		Comprehension	
	(10)	(11)	(12)	(13)
Infographics	**.365****	**1.053*****	**.420*****	**.792*****
	(.168)	**(.267)**	**(.162)**	**(.257)**
Male	-.201	.286	.001	.295
	(.167)	(.241)	(.161)	(.229)
Age Ref=(18-39)				
40-59	.189	.231	.653***	.670***
	(.222)	(.223)	(.211)	(.212)
60+	.132	.146	.482**	.475**
	(.215)	(.216)	(.209)	(.209)
Degree	.379**	.723***	.195	.330
	(.187)	(.187)	(.180)	(.246)
Interactions				
Infographics * Male		**-.935*****		**-.581***
		(.337)		**(.325)**
Infographics * Degree		**-.638***		**-.241**
		(.356)		**(.341)**
Log likelihood	-791.18	-785.62	-670.20	-668.34
n	446	446	446	446

*** p < .01; ** p < .05; * p < .10 (one-tailed in first row only).

Figure 1. Four-level decision tree. The decision over whether self-isolation is needed is broken down into a set of sequential questions that can be depicted visually.

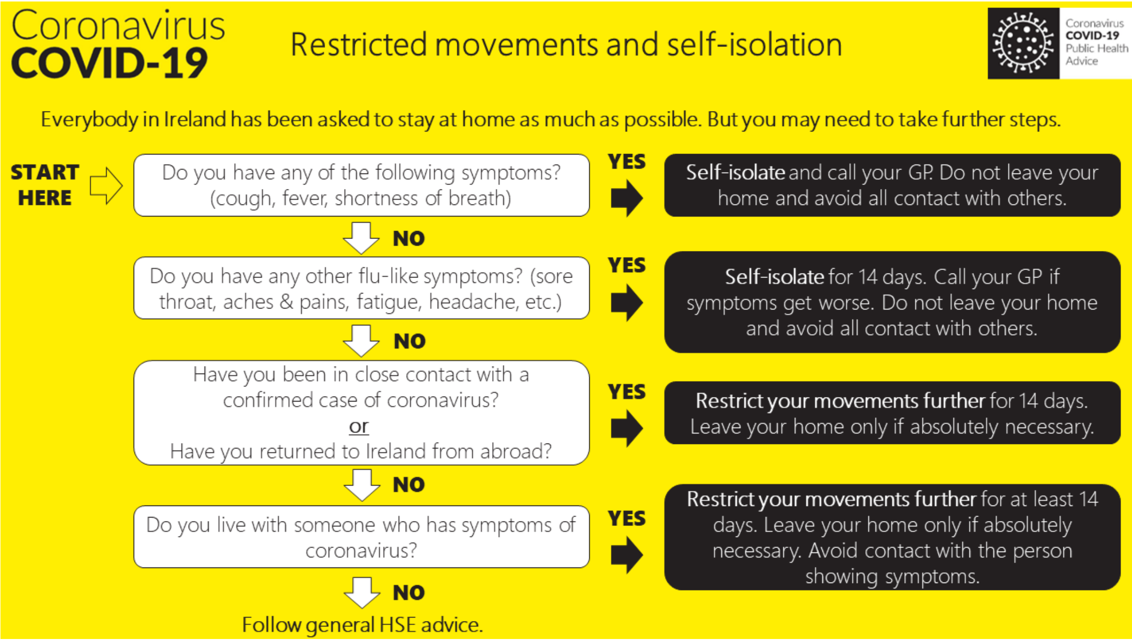

Figure 2. Example infographic. The information on how to self-isolate is categorised, arranged into bullet points and accompanied by cartoon-style graphics.

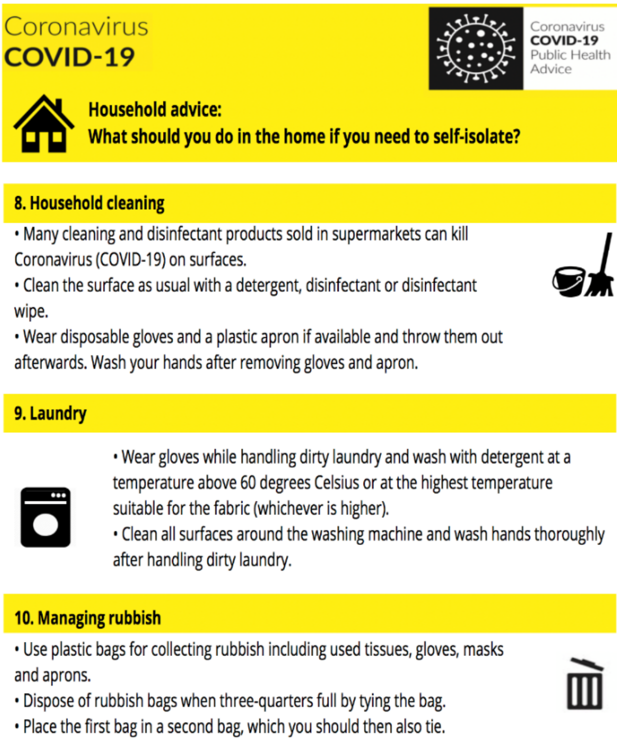

Figure 3. Assessments of the need to self-isolate. Mean scores by type of symptoms and contact history, pre- and post-intervention. Error bars = 95% CI.

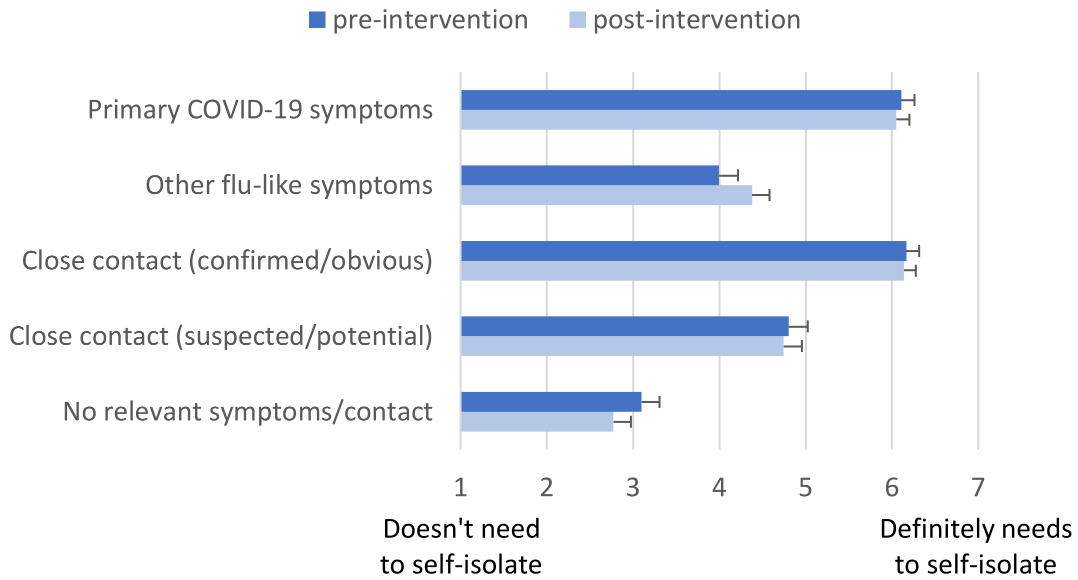

Figure 4. Assessed need for self-isolation if symptomatic. Proportions giving responses of 7 for primary symptoms and of 5 or higher for other flu-like symptoms, pre- and post-intervention, by condition. Error bars = 95% CI.

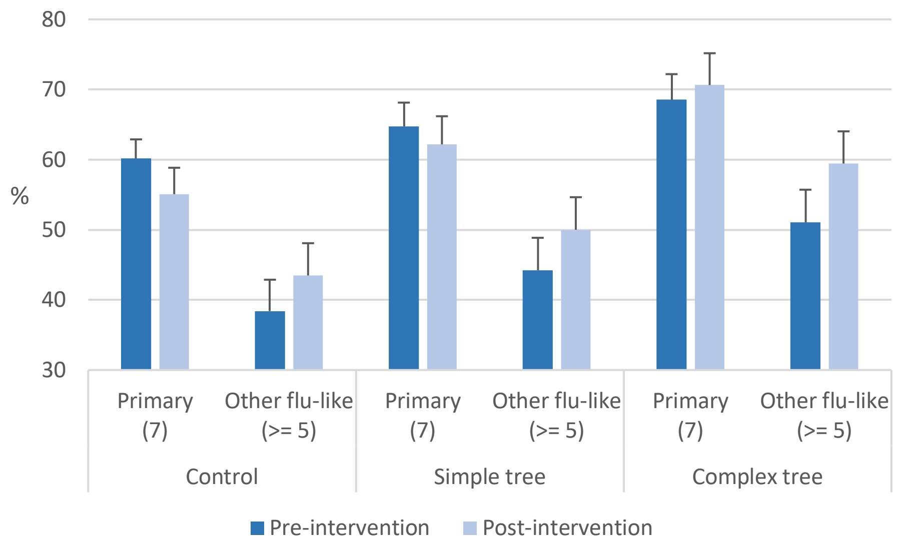

Figure 5. Confidence in coping with self-isolation. Mean confidence scores show an interaction between experimental condition and age. Error bars = 95% CI.

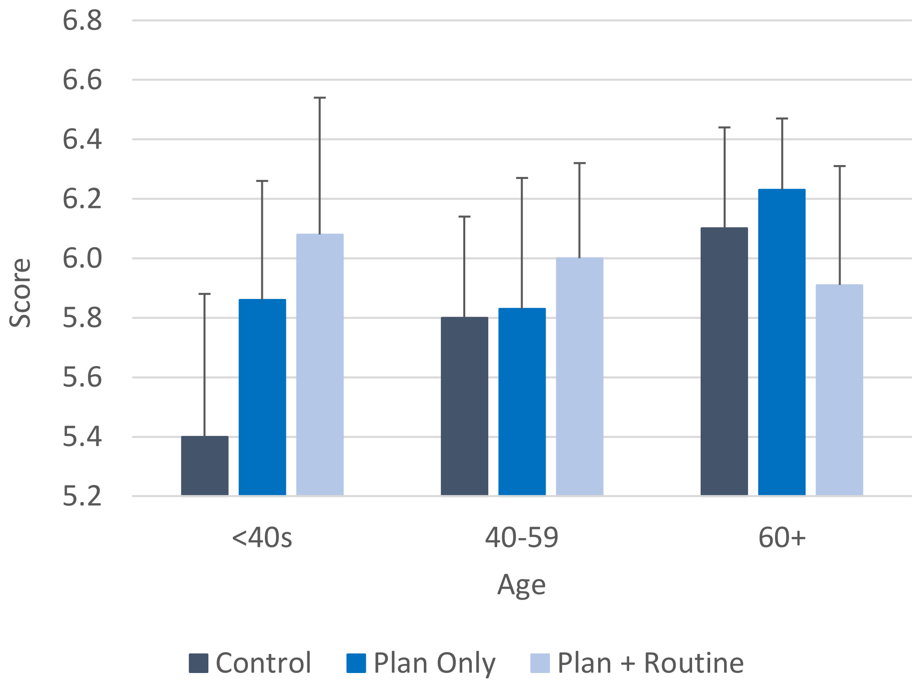

Figure 6. Responses to materials on managing self-isolation. Mean scores for easiness to follow (out of 7), recall questions (number correct out of 10) and multiple-choice comprehension questions (number correct out of 6), by condition. Error bars = 95% CI.