Formation and Use of Covariation Assessments in the Real World

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SUMMARY

In this study we examined covariation assessments made using real-world information held by individual participants about an important preventive health behaviour: receiving an influenza vaccine (‘flu shot’). Four hundred and seventy-seven healthy adult participants completed a questionnaire, indicating both their personal experience and vicarious experience (knowledge of other people’s experiences) with the flu shot and the flu. Additionally, participants provided a covariation assessment by indicating how effective they thought the flu shot is in preventing the flu. We examined whether the experience information was related to the covariation assessment, and whether it in turn was related to the decision to receive a flu shot. Our results indicated that people use a simple intuitive strategy to combine their personal experience information. For vicarious experience information, we found evidence for use of a normative strategy, as well as simpler intuitive strategies. Consistent with our hypothesis, both types of experience information were associated with the effectiveness judgement, which was subsequently related to the decision to obtain a flu shot. Practical applications of these findings are discussed. Copyright © 2002 John Wiley & Sons, Ltd.

We are all regularly faced with situations in which we must judge the relationship between two events. For example, it is important to be able to assess that clouds predict rain, that studying results in good grades, and that symptoms indicate an illness. Such judgements are called covariation assessments (or contingency judgements). One important domain where these judgements are frequently made is in relation to preventive health measures. For example, people need to be able to judge whether following a healthy diet or exercising regularly will bring the health benefits desired. Such judgements can then form the basis of action (e.g. adopting or not adopting the diet or exercise plan).

A large body of research has explored how people form covariation assessments. In these previous studies, information about the predictor and the outcome has been presented by the experimenter to the participant. In contrast, in the current study covariation assessments were examined with regard to real-world information experienced by each individual participant. Specifically, we examined participants’ covariation assessments of the relationship between receiving an influenza vaccine (or ‘flu shot’) and preventing the flu. We also examined whether these covariation assessments were related to the action of accepting or declining a flu shot.

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1Although the examples provided, and the topic of this particular study, pertain specifically to causal assessments (a subset of covariation assessments), we retain the term ‘covariation assessment’ throughout this paper to avoid limiting the generalizability of our findings.

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COVARIATION ASSESSMENT STRATEGIES

Studies of covariation assessment typically focus on the relationship between two dichotomous variables. This allows the relationship between these variables to be depicted in a $2 \times 2$ contingency table. Figure 1 shows a contingency table applicable to the domain of preventive health behaviours (using the specific example of the flu shot). In traditional covariation assessment terms, engaging (or not engaging) in the preventive health behaviour is an input (or cause), and receiving (or not receiving) the effects of the health behaviour is an output (or effect). The four cells are labelled A, B, C, and D, denoting the four possible input/output combinations.

Research on covariation assessment has assessed how people use information on the relative frequencies of variable co-occurrences to form an overall assessment of covariation between the variables. One way to determine how people utilize the information from the four cells is to calculate the subjective weight assigned to each cell. A number of studies have used participants’ covariation judgements as the dependent variable in a regression that includes the frequencies in each of the cells as the four independent variables (e.g. Levin et al., 1993; Schustack and Sternberg, 1981; Wasserman et al., 1990). The results of these studies indicate that cell A tends to receive a higher weight than cell B, which is higher than cell C, which is higher than cell D. These regression weights are consistent with participants’ self-report that cell A is more important than B, which is more important than C, which is more important than D (Wasserman et al., 1990). Mandel and Lehman (1998) recently provided an explanation for this ordering of cell preferences by postulating that people use two previously identified hypothesis-testing techniques (Klayman and Ha, 1987). One is a positive-test strategy in which cell A is contrasted with either B or C to determine the relative frequency of the input given the output or the relative frequency of the output given the input. The second is a sufficiency-test strategy which favours comparisons involving cell B to those involving C.

In addition to determining the subjective weights assigned to the four cells, another method for determining how people form covariation assessments is to determine which integration strategy provides the best account of these judgments (Arkes and Harkness, 1983; Shaklee and Goldston, 1989; Shaklee and Hall, 1983; Shaklee and Mims, 1986; Shaklee and Paszek, 1985; Shaklee and Tucker, 1980; Shaklee and Wasserman, 1986;

![Figure 1. 2 × 2 contingency table for preventive health behaviours: flu shot example](image)

Receive effects of preventive health behaviour?

<table>
<thead>
<tr>
<th>Yes (do not get flu)</th>
<th>No (get flu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (get flu shot)</td>
<td>A</td>
</tr>
<tr>
<td>No (do not get flu shot)</td>
<td>C</td>
</tr>
</tbody>
</table>

Ward and Jenkins, 1965; Wasserman et al., 1990). In these studies, potential strategies for combining some or all of the cells are hypothesized. For example, the \( \Delta p \) rule is computed as follows: \( P(O|I) - P(O|\neg I) \) (the probability of the output given the input, minus the probability of the output given no input). Other simpler rules include the sum of the diagonals \( (A + D) - (B + C) \), the A–B rule, the A–C rule, and the cell A rule. (For reviews of possible strategies, see Allan, 1993; Kao and Wasserman, 1993; McKenzie, 1994.) Participants’ actual covariation judgements are correlated with the judgements that would result from the use of each rule. The rule that yields the highest correlation provides the best description of how the cell information is being combined. The results from these studies indicate that people use simple intuitive strategies – such as A–B, or sum of the diagonals – over more complex normative strategies – such as \( \Delta p \). Not all studies have agreed on what particular simple strategy is used most frequently, and strategy use can be influenced by task characteristics such as how the cell information is presented (Kao and Wasserman, 1993; Shanks, 1991). This research clearly indicates, however, that people frequently do not base their judgements on all four cells, even though all the cells are normatively relevant. In addition, when all four cells are used, they may not be combined in a normative fashion.

Despite their many differences, all the studies mentioned thus far have one commonality: participants have always been provided with the data appropriate to making a covariation assessment. For example, in some studies participants are presented with a series of cases, each one indicating whether the input and output were present, and the cases can be combined to form a \( 2 \times 2 \) table. In other studies, participants are provided with a \( 2 \times 2 \) table in which cell frequencies are indicated. Such studies offer several benefits for imputing the strategies that people use to make covariation assessments. First, multiple \( 2 \times 2 \) tables can be presented to each subject so that the regression and correlation analyses described previously can be conducted at the level of the subject. Second, because the experimenter determines the cell frequencies, \( 2 \times 2 \) tables can be constructed so as to distinguish precisely among possible strategies. For example, whereas judgements based on sum of diagonals are usually highly correlated with those based on \( \Delta p \) (McKenzie, 1994), \( 2 \times 2 \) tables can be designed specifically to distinguish between these two strategies (e.g. Shaklee and Mims, 1986; Shaklee and Tucker, 1980).

Studies in which the experimenter provides the cell frequencies also have disadvantages. Specifically, the external validity of this research can be brought into question. In the real world, collecting observations to place in the \( 2 \times 2 \) table is an important step (Crocker, 1981). Some researchers have attempted to address this external validity issue and simulate real-world covariation assessments in a laboratory setting, by providing information on a trial-by-trial basis, as opposed to in summary format (e.g. Kao and Wasserman, 1993; Ward and Jenkins, 1965). Such studies have found that less accurate covariation assessments are made under these real-world simulation conditions (i.e. less frequent use of normative strategies and greater use of simpler intuitive strategies). To our knowledge, no previous study has focused on covariation assessments based on real-world data possessed by each individual respondent.

**CURRENT STUDY**

The current study investigated covariation assessments in a real-world setting. Using a sample of healthy adults, we examined how participants used frequency information to
form assessments of the covariation between receiving a flu shot and avoiding the flu. In this case, the covariation assessments were judgements of the effectiveness of the flu shot in preventing the flu. To determine whether such covariation assessments were used as the basis for actual behaviour, we also examined the relationship between covariation assessments and the action of accepting or declining the free flu shot that was offered to all participants. Flu shot acceptance was selected as the preventive health behaviour of interest in this study because the flu shot has been shown to have considerable health-related and economic benefits for healthy adults (Grotto et al., 1998; Leighton et al., 1996; Nichol et al., 1995), and vaccination against the flu is an important contemporary health issue: ‘... from a societal perspective the clinical, public health, and economic benefits of influenza vaccination cannot be overstated’ (Patriarca, 1999). Flu shot acceptance can provide a test bed for determining whether covariation assessment can be used to understand health behaviour.

Crocker (1981) describes six steps involved in making real-world covariation judgments and elucidates the factors at each step that may influence judgements. These steps include deciding what data are relevant, sampling cases, classifying instances, estimating confirming and disconfirming cell frequencies, integrating the evidence to form a covariation assessment, and using the covariation assessment as the basis for action. When cell frequency information comes from real-world experience, errors can occur in sampling or classifying cases, or in estimating frequencies. Much of the previous laboratory-based covariation assessment research has focused on Crocker’s fifth step: integrating the evidence (i.e. applying an integration rule). Although our study also considers this fifth step, we also include Crocker’s final (sixth) step: using the covariation estimate to make decisions. Thus, we asked participants (1) to recall their previous experience with the flu and flu shot, listing frequencies of each cell that resulted from crossing flu shot receipt (or non-receipt) with experiencing the flu or not, (2) to judge the effectiveness of the flu shot in preventing the flu (a covariation judgement), and (3) to report whether they had received a flu shot during the previous flu season (action). We tested the hypothesis that cell frequencies are combined to form a covariation assessment which is then used as the basis for action. Consequently, combinations of cell frequencies should be directly related to covariation judgements and indirectly related to decisions. That is, the covariation judgement (perceived effectiveness) should act as a mediator of the association between experience information and the decision to receive a flu shot. This relationship is depicted in Figure 2. We tested this mediational model in the current study.

Our mediational hypothesis implies that the cell combination that provides the best account of covariation judgements should also provide the best account of the concomitant behavioural decision. Consequently, we examined the consistency between the strategies used to integrate the experience information in deriving an effectiveness judgement and the strategies used to integrate the experience information that best predicted the decision.

![Diagram of personal database, judgement, and decision model for current study](image-url)

Figure 2. Hypothesized personal database, judgement, and decision model for current study.
whether to obtain a flu shot. Principally, we were interested in whether people integrate their experience information in a normative or non-normative (intuitive) fashion when making a judgement and a related decision.

An additional aim of this study was to specify which particular strategy people tend to use in order to integrate their experience information. The current study diverged from past studies in the manner in which prospective strategies were examined. The studies reviewed previously have generally used a correlational method in which actual contingency judgements were correlated with predictions derived from each of several possible cell-combination rules. Because, in previous studies, each subject provided multiple judgements, such correlations were computed separately for each subject. In the current study, each subject provided a judgement of only one covariation relationship. Consequently, we conducted a correlational analysis at the level of the group, identifying the cell combination strategy that provided the best account of the group’s judgements. This group-level analysis has limitations because different individuals may use different strategies (for a discussion of this and other classification methods, see Busemeyer, 1991).

Another way in which the current study differed from previous studies was in the role of information received outside the study. Laboratory-based covariation assessment experiments are designed with the aim of excluding participants’ use of information extraneous to the contingency table presented in the study. For example, experimental stimuli are often used that discourage participants from applying prior expectations to the experimental judgments (see Alloy and Tabachnik, 1984). However, in the real world, judgements and decisions are invariably influenced by a wide variety of factors in addition to the cell frequencies. For example, participants may have expectations about the covariation relationship based on information other than event frequencies. Even inferences drawn from previously experienced cell frequencies may be subject to poor memory for those frequencies. Consequently, the correlation between real-world event frequencies and covariation judgements (or subsequent decisions) may not be particularly high. Thus, we expected participants’ judgements and decisions to be significantly related to the experienced frequency information, but that people would inevitably also be influenced by factors outside of personal or vicarious experience (as we define it).

A final difference between the current study and past studies is that we compared participants’ use of two types of cell frequency information: personal and vicarious. Personal experience information refers to the respondent’s own experience with accepting or declining the flu shot in past years and subsequently getting or not getting the flu. Vicarious experience information refers to the respondent’s knowledge of acquaintances who accepted or declined the vaccine and experienced or avoided the flu. Both of these types of experience information form ‘personal databases’ on which covariation judgements can be based. We compared how cell-combination strategies used on both databases could account for both covariation judgements and vaccination decisions.

In summary, the current study asked participants to recall frequencies of the events that make up two different $2 \times 2$ tables – one containing personal experience and the other containing vicarious experience. They also provided a covariation assessment in the form of a judgement about the effectiveness of the flu shot in preventing the flu. Finally, they indicated whether they had accepted a free flu shot in the past two months. We determined which combination of cell frequencies from both $2 \times 2$ tables was most closely related to effectiveness judgements and decision behaviour, and we tested the hypothesis that perceived effectiveness of the vaccine mediates the relationship between the frequencies of experienced events and the decision whether to obtain a flu shot.
METHOD

Participants/procedure
Faculty and staff of Rutgers University and the University of Medicine and Dentistry of New Jersey (UMDNJ) participated in this study. Every Fall, employees of both universities are offered a free flu shot at each of the campus health centres. In early December 1998, we distributed questionnaires to the mailboxes of 1649 campus employees. Prospective participants were asked to return their completed questionnaire via campus mail, in return for a one in ten chance of being selected at random to receive $50 (payments were mailed after the close of the study). Within six weeks of questionnaire distribution, 566 completed questionnaires had been returned, a response rate of 34%. Data from one participant was excluded due to a large amount of missing data. Responses from 88 participants (16%) were not included in the analyses because they reported not being aware that a free flu shot had been available to them (and thus could not make a decision about accepting it). Thus, data from the remaining 477 participants were used in the analyses. Of these 477 participants, 71% were Rutgers employees and 29% were UMDNJ employees. The average age was 41 (range 21 to 70), and 66% of participants were female. Participants indicated their ethnic/racial group membership as follows: White/Caucasian, 77%; African American/Black, 6%; Hispanic/Latino(a), 3%; Asian/Pacific Islander, 9%; Other (e.g. multi-ethnic), 6%.

Measures
Participants completed an 8-page questionnaire. The present study examines responses to the measures described below. The ordering of questions was the same for all participants (separated by additional questions pertaining to issues not examined here), with the flu vaccine acceptance question completed first, followed by the personal experience, vicarious experience, and perceived effectiveness questions.

Flu vaccine acceptance
One question assessed whether participants had received a flu vaccine during the Fall months preceding the study. Forty percent of participants had received a flu shot and 60% had not received one.

Personal experience
Four questions examined participants’ personal experience with the flu and the flu shot in terms of the number of years out of the previous 10 they had, and did not have a flu shot, and had, or did not have the flu (see the Appendix for exact questions). These personal experience questions essentially asked participants to complete a $2 \times 2$ contingency table, as shown in Figure 1. It is important to note that participants did not actually see or complete a contingency table; they provided us with the information pertinent to completing such a table. The units of this table for the personal experience items is number of years, and the question asked of participants is essentially: ‘In the past 10 years, how many years did each of these events happen to you?’

Vicarious experience
Four questions addressed participants’ vicarious experience with the flu and flu shot in terms of the number of people they knew who last year received, and did not receive a flu
shot, and who subsequently did, or did not have the flu (see the Appendix for exact questions). Again, this information can be depicted in a $2 \times 2$ contingency table (see Figure 1). The units of this table for these vicarious experience items is number of people, and the question asked of participants is essentially: ‘During the past year, how many people do you know who experienced each of these events?’

**Perceived effectiveness**

Three questions were used to assess perceived effectiveness of the vaccine. One question (previously used by Nichol et al., 1996) asked participants to agree or disagree with the following statement: ‘Flu shots almost always prevent the flu.’ A second question (used in our own prior research, Chapman and Coups, 1999) asked about the effectiveness of the flu shot in reducing a person’s chances of getting the flu. A 5-point Likert-type response scale, ranging from not at all to very, was used with this question. A final question asked participants to provide a relative frequency estimate of contracting the flu after having a flu shot: ‘Let us say that of 100 people who do not get a flu shot this winter, 50 actually get the flu. Of 100 similar people who do get a flu shot, how many do you think will get the flu?’

Moderate to high correlations were found among these three measures. The agree/disagree question was significantly correlated in the expected direction with both the 5-point response scale question and the frequency estimate question: $r = 0.50$ ($p < 0.001$), $r = -0.39$ ($p < 0.001$), respectively. The 5-point response scale question was also significantly correlated with the frequency question, $r = -0.48$, $p < 0.001$. Accordingly, we combined the responses to each of these three measures of perceived effectiveness to form a single composite measure. Scores on each of the three measures were first transformed into $z$ scores, and then a composite perceived effectiveness score was calculated for each respondent by taking the mean of these three $z$ scores. This composite $z$ score was used as our measure of perceived effectiveness for all analyses.\(^2\)

**RESULTS**

Note that when flu shot acceptance is used as a dependent variable in the regression analyses presented below, we use standard (least squares) multiple regression procedures. With a dichotomous dependent variable (such as flu shot acceptance), logistic regression analysis is the recommended statistical procedure. However, with one minor exception (see footnote 8), our results were not altered when using logistic regression analysis. Use of standard multiple regression for all analyses permits easier comparison of our regression results for perceived effectiveness and flu shot acceptance.

**Perceived effectiveness as a predictor of flu shot acceptance**

Previous research has found perceived effectiveness to be a consistent predictor of flu vaccine acceptance (for a review, see Chapman and Coups, 1999). Thus, we first sought to examine whether perceived effectiveness was a significant predictor of flu shot acceptance in our sample. To provide a conservative test, we examined whether perceived effectiveness

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\(^2\)We also conducted a principal axis factor analysis (with varimax rotation) of the three effectiveness questions. This yielded a one-factor solution that accounted for 64% of the variance. A measure created from the factor loadings on this factor was exactly the same as the composite $z$ score measure we created through simple averaging ($r = 1.00$).
was a significant predictor of flu shot acceptance, even after controlling for all other significant predictor variables. Accordingly, we conducted a regression analysis with the dependent variable of flu shot acceptance and the following predictor variables (for a detailed description of these additional variables, see Chapman and Coups, 1999): perceived effectiveness of the shot; being at risk for flu complications (due to chronic illness or being older than 65); perceived likelihood of getting the flu; perceived severity of flu, if one were to get it; perceived likelihood of a reaction to the flu shot; receiving the shot the prior year; age; being Hispanic. Even after controlling for all of these other significant predictors, perceived effectiveness was still significantly associated with flu shot acceptance: the more effective the shot was believed to be, the more likely one was to receive the shot.

Descriptive statistics for experience items

Personal experience
The mean number of times during the previous 10 years that people had experienced each of the four possible flu shot/flu events was as follows: flu shot/no flu (cell A) – 1.24 (SD = 2.33); flu shot/flu (cell B) – 0.15 (SD = 0.56); no flu shot/no flu (cell C) – 5.52 (SD = 3.67); no flu shot/flu (cell D) – 1.51 (SD = 2.06). The answers to these questions summed to exactly 10 years for 59% of the participants. Thirty-seven percent of participants gave responses that summed to less than 10 years; this was perfectly plausible, since people may not have been able to recall exactly which event happened to them in each of the previous 10 years. The answers of 4% of the participants summed to more than 10 years: since we could not know which of the four events had been incorrectly recalled, personal experience data for these people was not included when calculating the above means.

Vicarious experience
The mean number of people that each respondent knew had experienced each of the four possible flu shot/flu events was as follows: flu shot/no flu (cell A) – 1.83 (SD = 2.94); flu shot/flu (cell B) – 0.52 (SD = 0.97); no flu shot/no flu (cell C) – 2.96 (SD = 6.08); no flu shot/flu (cell D) – 1.31 (SD = 2.51).

Replacement of missing values for experience items
Since we intended to conduct regression analyses (see later), missing cell values for both personal and vicarious experience were replaced so that all 477 participants could be included in all analyses (7% of the personal and vicarious experience cell values were missing). The following replacement approach was used: if a respondent checked ‘yes’ to the first part of the question (see the Appendix), the mean from all other participants checking ‘yes’ was substituted for the missing value; missing values from participants who did not check ‘yes’ or ‘no’ were replaced with the mean from all participants. For personal experience, if the replacement of missing values caused the total of the four cells to exceed 10 years, all four cell values were normalized so that they summed to 10.

Individual cell associations with perceived effectiveness and flu shot acceptance

Personal experience
Regression analysis was used to examine each individual cell’s association with perceived effectiveness and flu shot acceptance (see Table 1). For the dependent variable of
perceived effectiveness, the regression analysis revealed that cells A and B had the highest regression coefficients, followed by cells C and D. For the dependent variable of flu shot acceptance, the regression analysis revealed that cells A and C were significantly associated with flu shot acceptance. Neither cell B nor cell D was significantly associated with flu shot acceptance.

Vicarious experience
The regression analyses described above were also conducted for vicarious experience information (see Table 1). For the dependent variable of perceived effectiveness, Cells A and B were the strongest predictors, followed by cell D. Cell C was not predictive of perceived effectiveness. For the dependent variable of flu shot acceptance, the best predictor was cell A, followed by cells C and B. Cell D was not associated with flu shot acceptance. The regression results for both personal and vicarious experience (for both perceived effectiveness and flu shot acceptance) are similar to, but not completely consistent with past studies that found the regression weight of cell A to be larger than B, which was larger than C, which was larger than D (e.g. Levin et al., 1993; Schustack and Sternberg, 1981; Wasserman et al., 1990).

Covariation strategies
We next assessed the use of a number of strategies that could be used to integrate the experience information. Specifically, we examined four types of strategy:

3We also examined use of a sum of diagonals strategy (|A + D|−|B + C|). However, it was excluded as it was indistinguishable from other strategies (we used a cutoff point of shared variance, i.e. $r^2 > 85\%$ for determining whether two strategies were distinguishable): for personal experience, the sum of diagonals was indistinguishable from $\Delta p$; for vicarious experience, the sum of diagonals was indistinguishable from A−C. The $\Delta p$ strategy was retained over the sum of diagonals strategy due to its theoretical significance as the normative strategy. The A−C strategy was retained on the basis of parsimony.
(1) **Positive hits.** This strategy entails considering the value of cell A only.

(2) **Strategies involving cells A and B.** Four strategies were examined that focus primarily (or exclusively) on cells A and B: (a) frequency strategy, computed as A–B; (b) ratio strategy, computed as A/B; (c) joint probability strategy, computed as (A−B)/(A + B + C + D); (d) conditional probability strategy, computed as A/(A + B).

(3) **Strategies involving cells A and C.** Four strategies were examined that focus primarily (or exclusively) on cells A and C (these are analogous to those shown above for cells A and B): (a) frequency strategy, computed as A–C; (b) ratio strategy, computed as A/C; (c) joint probability strategy, computed as (A−C)/(A + B + C + D); (d) conditional probability strategy, computed as A/(A + C).\(^4\)

(4) **Normative strategy.** Δₚ, computed as A/(A + B)−C/(C + D), was used as the normative strategy in this study.\(^5\) In this strategy, the probability that a specific output (or event) will occur is compared across the condition where the input is and is not present (A + B, and C + D, respectively).

Note that due to the presence of zeros in crucial cells for a number of participants, a constant (+1) was added to each of the four cells for each respondent before calculating the ratio, joint probability, conditional probability, and Δₚ strategies.\(^6\)

**Strategy associations with perceived effectiveness and flu shot acceptance**

In this section, the difference between two correlation coefficients is examined using a \(T_2\) test (\(T_2\) follows a \(t\)-distribution) as described by Williams (1959, cited by Steiger, 1980).

Since there were four different strategies that could be used to combine both the A and B cells, and the A and C cells, we first conducted analyses (separately for both personal and vicarious experience) to determine which of the four strategies (for both A and B, and A and C cells) was the best predictor of perceived effectiveness and flu shot receipt.

**Personal experience**

For the four possible A and B combination strategies, the correlation between conditional probability and perceived effectiveness was equal to or greater than the correlation between each of the remaining three strategies and perceived effectiveness. The correlation between conditional probability and flu shot receipt was greater than that for the remaining strategies. Accordingly, we chose to focus on the conditional probability strategy (A/[A + B]) as the strategy used to combine the A and B cells.

For the four A and C combination strategies, the frequency, joint probability, and conditional probability strategies were indistinguishable (see footnote 3). The correlation of each of these strategies with perceived effectiveness was the same as that for the ratio strategy. However, the correlation of the ratio strategy with flu shot receipt was lower than that for the other strategies. Accordingly, among the A and C frequency, joint probability, and conditional probability strategies we chose to focus on the frequency strategy (A−C) on the basis of parsimony.

\(^4\)We are grateful to an anonymous reviewer for suggesting examination of the joint and conditional probability rules.

\(^5\)There has been some question as to the normative status of the Δₚ strategy (Allan, 1980; Anderson and Sheu, 1995). McKenzie (1994) proposes the \(\phi\) coefficient as a more appropriate normative strategy. In this study, Δₚ and the \(\phi\) coefficient were indistinguishable (cf. McKenzie, 1994), with correlations of \(r = 0.99\) and 1.00 for personal and vicarious experience respectively. See also Mandel and Lehman (1998) for a discussion of the normative status of both Δₚ and the \(\phi\) coefficient.

\(^6\)Use of a constant 10 times larger or smaller had no effect on the results.
We first examined the correlations among the four strategies (cell A, A/[A + B], A–C, and Δp): they were all moderately to highly positively correlated with one another (see Table 2). Next we examined the correlations between each of the strategies and perceived effectiveness and flu shot acceptance. For perceived effectiveness, the A and B conditional probability strategy (A/[A + B]) showed the highest correlation (r = 0.40, p < 0.001), with the correlation for Δp being smaller (r = 0.21, p < 0.001). These two correlations were significantly different (T2 = 5.10, p < 0.001). Correlations between the strategies and flu shot acceptance were higher than those for perceived effectiveness. Again, the highest correlation was for the A and B conditional probability strategy (r = 0.57, p < 0.001), and the correlation for Δp was slightly smaller (r = 0.46, p < 0.001). These two correlations were significantly different (T2 = 3.32, p < 0.01). The A and A–C strategies had correlations with flu shot acceptance in between those for the A and B conditional probability and Δp strategies (rs = 0.54, 0.49, respectively, ps < 0.001).

Vicarious experience
As for personal experience, we first examined correlations of the four A and B combination strategies with perceived effectiveness and flu shot acceptance. The joint and conditional probability strategies were indistinguishable: the conditional probability strategy was thus favoured due to parsimony. The correlation between the conditional probability strategy and perceived effectiveness was higher than the correlations between perceived effectiveness and the remaining strategies. Additionally, its correlation with flu shot acceptance was equal to or greater than those for the other strategies. Thus, we focused on the conditional probability strategy as the strategy used to combine the A and B cells.

For the four A and C cell strategies, the ratio strategy (A/C) had correlations with perceived effectiveness and flu shot acceptance that were equal to or greater than those for the other strategies. Its correlations did not differ significantly from those for the conditional probability strategy. However, on the basis of parsimony, the ratio strategy was preferred over the conditional probability strategy.

First, we examined the intercorrelations for the vicarious experience cell-combination strategies (A, A/[A + B], A/C, and Δp): moderate positive correlations were found among the strategies (see Table 3). Examination of strategy associations with perceived effectiveness revealed that the A and B conditional probability strategy (A/[A + B]) showed the highest correlation (r = 0.40, p < 0.001), followed by the Δp strategy (r = 0.28, p < 0.001). The difference between these two correlations was significant (T2 = 3.14, p < 0.01). Both A and A/C were also significantly correlated with perceived effectiveness (rs = 0.20, 0.23, respectively, ps < 0.001). All the strategies showed significant

<table>
<thead>
<tr>
<th>Strategy</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A</td>
<td>–</td>
<td>0.83</td>
<td>0.77</td>
<td>0.61</td>
<td>0.33</td>
<td>0.54</td>
</tr>
<tr>
<td>2. A/[A + B]</td>
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<td>0.61</td>
<td>0.40</td>
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<tr>
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<td>0.19</td>
<td>0.49</td>
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<tr>
<td>4. Δp</td>
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<td>0.21</td>
<td>0.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Effectiveness</td>
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<td>0.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Flu shot acceptance</td>
<td>–</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note: N = 477. All correlations are significant at p < 0.001.
Table 3. Pearson correlation coefficients among judgement strategies, perceived effectiveness and flu shot acceptance for vicarious experience

<table>
<thead>
<tr>
<th>Strategy</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A</td>
<td>-</td>
<td>0.64</td>
<td>0.45</td>
<td>0.40</td>
<td>0.20</td>
<td>0.23</td>
</tr>
<tr>
<td>2. A/(A + B)</td>
<td></td>
<td>-</td>
<td>0.39</td>
<td>0.59</td>
<td>0.40</td>
<td>0.28</td>
</tr>
<tr>
<td>3. A – C</td>
<td></td>
<td></td>
<td>-</td>
<td>0.63</td>
<td>0.23</td>
<td>0.28</td>
</tr>
<tr>
<td>4. Δp</td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>0.28</td>
<td>0.31</td>
</tr>
<tr>
<td>5. Effectiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>0.37</td>
</tr>
<tr>
<td>6. Flu shot acceptance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

Note: N = 477. All correlations are significant at p < 0.001.

correlations (ranging from 0.23 to 0.31) with flu shot acceptance. None of these correlations were significantly different (although Δp’s correlations with both perceived effectiveness and flu shot acceptance were marginally greater than those for cell A).

Perceived effectiveness as a mediator of the association between experience and flu shot acceptance

Personal experience

Multiple regression analysis (as described by Baron and Kenny, 1986) was carried out to test the mediational model shown in Figure 2. We examined whether perceived effectiveness acted as a mediator of associations between personal experience and flu shot acceptance. Four strategies were examined to see if their association with flu shot acceptance was mediated by perceived effectiveness: A, A/(A + B), A – C, Δp. Since Δp is a normative strategy, we conducted our mediational analysis for the other three strategies while also examining Δp. This is a conservative test of our hypothesized model, and also gave Δp three opportunities to exhibit a mediational association with shot acceptance (once during the analysis for each of the remaining three strategies).

The first step of a mediational analysis involves examining whether the predictor variable is associated with the hypothesized mediator. Thus, a regression analysis was conducted with the dependent variable of perceived effectiveness and the independent variables of strategy A and Δp. Strategy A was a significant predictor of perceived effectiveness (β = 0.32, t = 5.83, p < 0.001), whereas Δp was not (β = 0.02, t = 0.38, p > 0.05). Since Δp did not predict perceived effectiveness after controlling for strategy A, perceived effectiveness did not act to mediate any association between Δp and flu shot acceptance. The second step of a mediational analysis specifies that the predictor variable should be associated with the outcome variable. Therefore, a regression analysis was carried out with the dependent variable of shot acceptance and strategies A and Δp as independent variables. The Δp strategy was a significant predictor of shot acceptance (β = 0.21, t = 4.46, p < 0.001). More importantly (since Δp was excluded from a mediational relationship in the prior step), the cell A strategy was also a significant predictor of shot acceptance (β = 0.41, t = 8.69, p < 0.001). The final step in establishing mediation requires that the mediator be associated with the outcome variable. Thus, a regression analysis was conducted with the dependent variable of shot acceptance and the independent variables of perceived effectiveness, strategy A and Δp. Perceived effectiveness was indeed a significant predictor of shot acceptance in this regression (β = 0.21, t = 5.51, p < 0.001). Strategy A was still a significant predictor in this regression analysis, but with a somewhat smaller effect size (β = 0.35, t = 7.23, p < 0.001). This result
indicates that perceived effectiveness acted as a partial (but not a full) mediator\textsuperscript{7} of the association between the cell A strategy and shot acceptance.

The results of the subsequent mediational analyses (for both personal and vicarious experience), as well as those described above, are summarized in Table 4. Note that perceived effectiveness was a significant predictor of flu shot acceptance for each set of mediational analyses. The above approach was repeated for the A and B conditional probability strategy (A/(A + B)). The results of the mediational analyses indicated that perceived effectiveness served to partially mediate the association between the A and B conditional probability strategy and flu shot acceptance. However, no such mediational relationship was found for the $\Delta p$ strategy.

Mediational analyses for the A–C (frequency) strategy revealed that perceived effectiveness did not act as a mediator for the association between A–C and flu shot acceptance.

### Table 4. Results of mediational analyses

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Mediator Effectiveness</th>
<th>Dependent variable Flu shot acceptance\textsuperscript{a}</th>
<th>Mediation status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$\beta_1$</td>
<td>$\beta_2$</td>
</tr>
<tr>
<td>Personal experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>A</td>
<td>0.32***</td>
<td>0.41***</td>
</tr>
<tr>
<td></td>
<td>$\Delta p$</td>
<td>0.02</td>
<td>–</td>
</tr>
<tr>
<td>2.</td>
<td>A/(A + B)</td>
<td>0.43***</td>
<td>0.46***</td>
</tr>
<tr>
<td></td>
<td>$\Delta p$</td>
<td>–0.05</td>
<td>–</td>
</tr>
<tr>
<td>3.</td>
<td>A–C</td>
<td>0.02</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>$\Delta p$</td>
<td>0.20\textsuperscript{b}</td>
<td>0.13</td>
</tr>
<tr>
<td>Vicarious experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>A</td>
<td>0.11*</td>
<td>0.13**</td>
</tr>
<tr>
<td></td>
<td>$\Delta p$</td>
<td>0.23***</td>
<td>0.26***</td>
</tr>
<tr>
<td>2.</td>
<td>A/(A + B)</td>
<td>0.37***</td>
<td>0.15**</td>
</tr>
<tr>
<td></td>
<td>$\Delta p$</td>
<td>0.06</td>
<td>–</td>
</tr>
<tr>
<td>3.</td>
<td>A/C</td>
<td>0.10</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>$\Delta p$</td>
<td>0.21***</td>
<td>0.23**</td>
</tr>
</tbody>
</table>

\textit{Note:} $N = 477$. Associations for cells marked by a dash are not reported, since a prior non-significant association precluded the possibility of a mediational relationship.

\textsuperscript{a}$\beta_1$ = standardized regression coefficient not controlling for effectiveness; $\beta_2$ = standardized regression coefficient controlling for effectiveness.

\textsuperscript{b}Although the results of the regressions presented here indicate that there is a partial mediational relationship, using logistic regression for the flu shot acceptance dependent variable showed that there was a full mediational relationship (see footnote 8).

\textsuperscript{p < 0.05, }\textsuperscript{** p < 0.01, }\textsuperscript{*** p < 0.001.}

\textsuperscript{7}Partial mediation is found when the predictor variable is still a significant predictor of the outcome variable after controlling for the mediator (and any other predictors). Full mediation occurs when controlling for the mediator causes the predictor variable to no longer be a significant predictor of the outcome variable.
Additionally, perceived effectiveness did not mediate the association between $\Delta p$ and flu shot acceptance.

Thus, the results of the mediational analyses indicated that perceived effectiveness acted to partially mediate the associations between flu shot acceptance and both strategy A and the A and B conditional probability strategy. Perceived effectiveness did not mediate any associations between shot acceptance and either strategy A–C or $\Delta p$. These results indicate that participants integrated their personal experience information into an effectiveness judgement using an intuitive (as opposed to a normative) strategy, and this effectiveness judgement in turn predicted their decision to receive (or not receive) a flu shot.

Vicarious experience

The same procedure as above was used to examine whether perceived effectiveness mediated associations between vicarious experience and flu shot acceptance (see Table 4). The four strategies examined were: A, A/(A + B), A/C, $\Delta p$. First we examined whether perceived effectiveness mediated the association between flu shot acceptance and the cell A and $\Delta p$ strategies. Results indicated that perceived effectiveness was a full mediator of the association between cell A and flu shot acceptance, and a partial mediator of the association between $\Delta p$ and flu shot acceptance. Interestingly, although A and $\Delta p$ had similar simple correlations with both perceived effectiveness and flu shot acceptance (see Table 3), when combined in a regression, $\Delta p$ was a stronger predictor of both variables. It is thus important to note that the fact that the $\Delta p$ strategy was only partially mediated whereas strategy A was fully mediated may simply reflect the fact that it is easier for the mediator to eliminate the small association of cell A with flu shot acceptance than the large association of $\Delta p$ with flu shot acceptance.

For the A and B conditional probability strategy, results showed that its association with flu shot acceptance was fully mediated by perceived effectiveness. However, perceived effectiveness did not mediate the association between $\Delta p$ and flu shot acceptance. For the A/C strategy, results indicated that perceived effectiveness did not mediate its association with flu shot acceptance. However, as found earlier with the cell A strategy, $\Delta p$’s association with flu shot acceptance was partially mediated by perceived effectiveness.

The results of these mediational analyses indicated that perceived effectiveness was a full mediator of the association between flu shot acceptance and both the cell A strategy and the A and B conditional probability strategy. Additionally, on two out of three possible occasions, perceived effectiveness partially mediated the association between $\Delta p$ and flu shot acceptance. As with personal experience, this provides evidence that participants combined their vicarious experience information into an effectiveness judgement, and this judgement was subsequently used (at least in part) in relation to the decision whether to receive (or not receive) a flu shot. Consistent with the findings for personal experience, there was evidence that participants may use an intuitive strategy to combine their vicarious experience information. However, contrary to the findings for personal experience, the association between cell A and flu shot acceptance was fully mediated by perceived effectiveness.

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8When this analysis was conducted using a logistic regression procedure for the flu shot acceptance dependent variable, the association between cell A and flu shot acceptance was fully mediated by perceived effectiveness. Accordingly, since logistic regression is the standard procedure for such a dichotomous dependent variable, we retain this conclusion. However, note that in the logistic regression analysis, controlling for perceived effectiveness only just caused A to be non-predictive of flu shot acceptance ($p = 0.06$); in the equivalent standard multiple regression presented here, A was only just predictive of flu shot acceptance ($p = 0.03$) when controlling for perceived effectiveness.
experience, there was also evidence that participants may use a normative strategy (Δp) for combining their vicarious experience information.

**DISCUSSION**

In the current study we examined the relationships among remembered cell frequencies in a 2 × 2 table, covariation assessments describing the relationship in that table, and a behavioural decision relevant to the covariation judgement. We found that cell frequency information gathered from real-world experience about receiving the flu shot and avoiding the flu was related to a covariation assessment of the effectiveness of the flu shot. The effectiveness judgement was in turn associated with the decision to accept a free flu shot. Combinations of the cell frequency information was itself related to the vaccination decision, but this relationship was at least in part mediated by the covariation judgements of vaccine effectiveness. These findings extend those of previous studies by including a decision that was related to both the original database information and to the covariation judgement. This design allowed us to examine whether the covariation judgement served to mediate any associations between integration strategies and the related decision. Such a mediational model has not previously been examined in covariation assessment research and is important because it indicates that covariation judgements are used to guide subsequent decisions. The results from our study support the conclusion that people use real-world experience to form covariation judgements and then base decisions on these covariation judgements.

An important question addressed by the current study was how the real-world experience was combined to form a covariation assessment. Was a normative strategy (such as Δp) used, or were simpler intuitive strategies favoured? We examined four strategies for their ability to account for covariation judgements at the group level. The answer to the question about strategy use differed for the personal and vicarious cell frequency information, with normative strategy use more apparent for the vicarious information.

**Personal and vicarious cell frequency information**

When participants considered their *personal* experience with the flu shot, it appears that they tended to follow an intuitive strategy when assessing both the effectiveness of the flu shot and when deciding whether to actually obtain a flu shot. Specifically, we found evidence for the use of a cell A strategy, as well as a cell A and B conditional probability strategy (i.e. A/[A + B]). Furthermore, results of the mediational analyses showed that effectiveness judgements were a partial mediator of the associations between acceptance of the flu shot and both of these strategies. The evidence thus indicated that participants did not combine their personal experience information concerning the flu shot and the flu in a normative fashion, but instead favoured simpler intuitive combination rules. An intuitive combination rule was used to derive a judgement as to the effectiveness of the flu shot, and this judgement in turn was related to the decision whether to receive a flu shot.

The results concerning *vicarious* experience were somewhat different. We found evidence for use of the normative Δp strategy, as well as simpler intuitive strategies. Additionally, mediational analyses indicated that perceived effectiveness mediated the association between both normative and intuitive strategies and receipt of the flu shot – for
strategy A, and the A and B conditional probability strategy, a full mediational relationship was found, whereas for $\Delta p$ a partial mediational relationship was found. The mediated relationship of the $\Delta p$ strategy and the flu shot decision indicates that participants tended to integrate their vicarious flu shot and flu information in a normative fashion. The fact that intuitive strategies also showed a mediated relationship indicates that information integration was not completely normative, however. A possible explanation for these results is that intuitive strategies may have been used by some participants while $\Delta p$ was used by others.

The results for the personal and vicarious databases differed in several respects. First, as just noted, participants apparently made some use of the normative $\Delta p$ strategy when combining vicarious information but not personal information. Second, the mediating role of effectiveness judgements was more apparent for the vicarious information than for personal information. In the analyses of personal experience information, the relationships between two of the intuitive strategies (cell A and A and B conditional probability) and the flu shot decision were only partially mediated by effectiveness judgements. In contrast, analyses of the vicarious information showed that the relationship between the same two intuitive strategies and the flu shot decision was fully mediated by effectiveness judgments. Furthermore, the $\Delta p$ relationship was also mediated by effectiveness judgements. Although this mediation was only partial, the size of the association between $\Delta p$ and the flu shot decision was reduced greatly when the analysis controlled for effectiveness judgements. Thus, it appears that vicarious information influences the flu shot decision by way of an effectiveness judgement, whereas personal information has an influence on the flu shot decision that is in part independent of a covariation judgement.

A final difference between the personal and vicarious results concerns the magnitude of the correlations between the cell frequency information and the decision to receive a flu shot. For the vicarious information, the correlations with perceived effectiveness were similar in size to those with vaccination decision (see Table 3); however, for personal experience, the correlations with receipt of the flu shot were appreciably higher than those with perceived effectiveness (see Table 2). It would appear that participants relied more closely on their personal experience information when deciding whether to receive a flu shot than when assessing the effectiveness of the flu shot.

These differences indicate that personal and vicarious databases are treated somewhat differently. Vicarious database information is treated in a more normative fashion, as indicated by the stronger evidence for $\Delta p$ and the larger mediating role of effectiveness judgements.

It is important to note that despite these differences, the personal and vicarious analyses had several important findings in common. In both cases, strategy A, as well as the A and B conditional probability strategy, predicted both effectiveness judgements and vaccination behaviour. The relationship between both of these strategies and the vaccination decision was at least partially mediated by effectiveness judgements in both cases. In addition, both the personal and vicarious analyses demonstrated consistency in that the cell-combination strategies that predicted effectiveness judgements also predicted behaviour.

**Comparison of current study to previous research**

The current study revealed the use of a cell A strategy for both the personal and vicarious databases. A number of previous studies have also identified use of this strategy (e.g.
Arkes and Harkness, 1983; Smedslund, 1963; Ward and Jenkins, 1965). In addition, we found evidence for use of the normative $\Delta p$ strategy in integrating vicarious experience. Past researchers have found that this normative strategy is sometimes used (e.g. Arkes and Harkness, 1983; Shaklee and Mims, 1986; Ward and Jenkins, 1965). Consistent with the results of previous studies (e.g. Schustack and Sternberg, 1981; Wasserman et al., 1990), we found that of the four cells, cell A (flu shot/no flu) was most closely associated with perceived effectiveness (and the related decision).

The correlations found in the current study between covariation assessments and cell frequencies and strategies were moderate compared to previous studies. (Typically, strategies have been found to have a correlation of 0.60 or more with covariation assessments.) In real-world covariation assessment, factors aside from personal or vicarious experience, such as advice from a healthcare provider, may play a role in determining effectiveness beliefs. Consequently, the moderate magnitude of correlations between the strategies and perceived effectiveness are not unexpected. In laboratory-based experimental studies, individuals are typically provided with all of the information available to make their judgement, and thus correlations between strategies and judgements are often very high.

Limitations

A number of limitations of this study need to be acknowledged. The use of a group-level correlational design meant that we were only able to specify which strategy gave the best account of the whole group’s judgement and decision. If multiple judgements per subject had been possible, it would be preferable to carry out such an analysis on an individual level. High correlations among a number of the strategies meant that we could not distinguish between some of them (see footnote 3). This problem can be avoided in laboratory experiments by presenting a carefully selected series of contingency tables (or information relevant to the tables) to participants. However, it was unavoidable in this study, since we were reliant on information reported by each individual respondent.

It should be noted that the time periods for the personal and vicarious experience information were not the same: the personal data was for a 10-year period, whereas the vicarious information was obtained using a one-year window. A 10-year time period was used for the personal information, since that is a reasonable time period to expect people to remember about. For vicarious experience, we attempted to ask about a time frame that would yield a similar number of mean observations to those for personal experience. Although we were fairly successful in ensuring that both types of experience database were of similar size, the discrepancy in time periods remains a possible confound when comparing the personal and vicarious experience results.

Finally, cell frequency estimates, covariation assessments, and decisions were all measured at the same time, with cell frequencies and decisions constituting retrospective judgements. Thus, although it seems plausible that cell frequencies were used to construct covariation judgements which in turn formed the basis of a subsequent decision, we cannot be sure of this causal ordering. It is possible, for example, that cell frequencies were reported so as to support existing beliefs about vaccine effectiveness. Furthermore, the question order was not counterbalanced. Thus, it is possible that answers to earlier questions may have influenced later responses.
Applications

The present results provide some reason for optimism about people’s ability to integrate real-world experience to form a covariation judgement and then use that judgement as the basis for a decision such as whether to engage in a preventive health behaviour. Use of the normative $\Delta p$ strategy was most evident when considering vicarious experience. These results suggest that when confronted with accurate frequency information about the relationship between a predictor and an outcome, decision makers will be able to use that information appropriately to guide decisions. Consequently, behaviours such as vaccine acceptance could be encouraged by exposing decision makers to accurate frequency information about the effectiveness of those actions.

Influenza vaccination provides a particularly convenient opportunity for decision makers to collect both personal and vicarious information. The decision to be vaccinated occurs annually, so that across several years a database of personal or vicarious behaviour can be amassed. Perhaps more importantly, the outcome of the decision (getting or avoiding the flu) is apparent within a few months’ time. Because vaccination often takes place at a public location (e.g. a workplace clinic) and because people feel free to talk about their vaccination status, it is easy to collect information about the experiences of others.

Other health behaviours do not provide such opportunities for collecting frequency information. Decisions about some health behaviours (e.g. pneumococcal vaccination) occur infrequently, limiting the size of a personal database. Decisions that occur much more frequently (e.g. taking medication, exercise, diet) often have consequences that occur very far in the future or that occur rarely in personal or vicarious experience (e.g. lack of seatbelt use leading to injuries). These factors make it difficult to amass a personal database. Finally, some health behaviours (e.g. condom use) are private, making vicarious databases difficult to acquire. When decision makers are not able to collect real-world experience about covariation relationships, they may not be able to form accurate covariation judgements or reach appropriate decisions. In these cases, personal and vicarious experience may need to be supplemented with public databases such as those from epidemiological studies. Future research is needed to address this issue empirically.

Although many preventive health behaviours present difficulties in constructing personal databases, other health- and non-health-related behaviours do readily afford access to personal information about covariation relationships. Examples include the relationship between taking cold remedies and reduction in symptoms, the effect of studying on exam scores, and the association between travel time and travel routes.

CONCLUSIONS

In this study, reports of real-world event frequencies comprising a $2 \times 2$ table were associated with covariation assessments of relationship expressed in the $2 \times 2$ table. Participants appeared to combine the frequency information using simple strategies such as $A$ or $A/(A + B)$, although for vicariously experienced event frequencies, use of the normative $\Delta p$ strategy was also apparent. Of primary interest, cell-combination strategies were also associated with a decision relevant to the covariation relationship, and this association was mediated by covariation assessments. This pattern of results supports the
idea that real-world event frequencies are used to form covariation assessments which are then used as the basis for relevant decisions.

ACKNOWLEDGEMENTS

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REFERENCES


**APPENDIX: PERSONAL AND VICARIOUS EXPERIENCE QUESTIONS**

**Personal experience**

In the last 10 years, was there a year when you **had** a flu shot but **got the flu** that year anyway?

☐ Yes ☐ No

If Yes, how many years has this happened in the last 10 years? __________

The above question format was then repeated three times with the following variations:

‘... **had** ... **did not get the flu** ...’

‘... **did not have** ... **got the flu** ...’

‘... **did not have** ... **did not get the flu** ...’

**Vicarious experience**

The following questions concern your knowledge of **other people’s experiences** with the flu shot and flu. Please only include people for whom you **definitely know** whether they got a flu shot last year.
Do you know anyone who definitely had a flu shot last year and still got the flu?

☐ Yes    ☐ No

If Yes, how many people like this do you know?_________

The above question format was then repeated three times with the following variations (the word ‘still’ was omitted from each of them):
‘... had ... did not get the flu’
‘... did not have ... did get the flu’
‘... did not have ... did not get the flu’