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Interpreting Claims in Offender Profiles: The Role of Probability Phrases, Base-Rates and Perceived Dangerousness†

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SUMMARY

Offender profilers use verbal and numerical probability expressions to convey uncertainty surrounding claims made about offender's characteristics. No previous research has examined how these expressions might affect the recipient's interpretation of the information. Seventy participants completed an online questionnaire and results showed a diverse range of interpretations of these uncertainty expressions. Moreover, characteristic base-rates and dangerousness affected the perceived likelihood of the profiling claim, such that increased base-rates and perceived dangerousness resulted in an increased perception of the claim being likely. Perceived likelihoods also depended on the framing of characteristics as well as the framing of the claim itself. Finally, where claims involved presenting a characteristic qualified by a low probability these claims were interpreted as more likely than not to be present. These findings have practical implications for profilers and more general theoretical implications for the study of risk perception. Copyright © 2008 John Wiley & Sons, Ltd.

Traditionally, profiling has been defined as the process of predicting the likely socio-demographic characteristics of an offender based on the information available at the crime scene (Alison, Mclean, & Almond, 2007). In the last 10 years, however, a change of emphasis from the exclusive focus on the offender and his likely 'psychological profile' to a broader myriad of issues involved in investigating crime—such as interview strategies, DNA intelligence led screens, risk assessments and geographical profiling—has emerged. As a result, offender profilers are now more broadly referred to as 'Behavioural Investigative Advisors' (BIA). Despite this, BIA reports still typically contain claims about the likely characteristics of offenders; expressed with varying uncertainty qualifiers to indicate the extent to which the enquiry team can expect each claim to be true. Uncertainty

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qualifiers may encompass vague, verbal probability qualifiers such as *probably*, *possibly*, *unlikely*. For example, 'the offender is *probably* a male'. They can also include precise numerical expressions such as, 'There is a 60% chances that the offender will be white'. If a claim is not qualified by a verbal or a numerical uncertainty phrase, then the profiler is indicating to the enquiry team that the claim is certain. For example in the absence of any uncertainty qualifier, the statement, 'the offender will have previous convictions' might be understood as a statement of complete certainty.

To verify that profilers duly reported the uncertainty surrounding their claims, Collins and Alison (2002) content analysed 26 offender profiles constructed by a range of profilers, the majority of which were produced during the years 1996–2000. They identified 107 different verbal probability qualifiers, which they argued could be divided into two broad categories: a 'possible' low-probability category (i.e. characterising claims as having a low probability of being true) and a high-probability category (i.e. characterising claims as having a high probability of being true). However, 46% of the claims examined were not characterised by any uncertainty qualifier at all, suggesting that they may be perceived as statements of certainty (a situation which is extremely unlikely in any field of expert advice).

However in a contemporary study, Almond, Alison, and Porter (2007) examined 47 behavioural investigative advice reports produced by the National Policing Improvements Agency in the year 2005 and discovered that 18% of all the claims were unqualified. This more recent figure is comparatively lower than that observed by Collins and Alison (2002). Almond et al. (2007) coded the remaining claims as either verbal or numerical qualifying expressions, with the verbal probability expressions divided into the same two high/low categories previously identified by Collins and Alison (2002). Results revealed that 59% of these qualifiers could be coded as 'probable' and only 5% as 'possible'. The statistical terms were also categorised as either high or low probability qualifiers. Similar results emerged from this analysis: 16% of these qualifiers represented a probability higher than 50%, whilst only 2% represented a probability of less than 50%. So, overall, this line of research has shown that most claims presented within contemporary BIA reports were qualified by verbal probability expressions and were presented as highly probable statements of certainty.

The fact that probability expressions are now used in most profiling claims is reassuring, since investigators can more readily assess the significance of the inferences drawn from claims when they are qualified by varying levels of certainty. However, exactly how qualifiers affect the interpretation of the claims is currently unknown. There are some well-documented examples of disastrous errors caused by differential understanding and usage of verbal probabilities. For example, Karelitz and Budescu (2004) discussed the costly consequences of the different interpretation of the term *fair chance* by the U.S Joint Chief of Staff and the Central Intelligence Agency which led to the Bay of Pigs invasion in 1961. In a similar vein, if a Senior Investigating Officer (SIO) were to misinterpret the strength of an offender profiling claim, this could have serious consequences for the investigation. A misunderstanding about the likelihood of an offender having pre-convictions (and thus appearing in a Police National Computer record) could if unchecked, direct an enquiry down an unproductive route. For that reason, it is important that research considers how verbal and numerical probabilities affect uncertainty interpretations. This will give profilers and BIA's a better awareness of pertinent issues when constructing their reports and will help to minimise any misinterpretations between themselves and the SIO.

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There is a large body of decision-making literature that examines the interpretation of probability words and expressions. Several studies have revealed that, paradoxically, although people prefer to communicate uncertainties with verbal probability expressions they prefer to receive it with numerical probability expressions (Brun & Teigen, 1988; Erev & Cohen, 1990). Speakers' preference for verbal expressions is generally said to occur because words, as opposed to numbers, are thought to be better understood by those who receive the information. In contrast, decision-makers who receive uncertain information tend to think they will make more accurate inferences based on numerical information, although this belief is not necessarily correct (Erev & Cohen, 1990).

In the remainder of this introduction, the paper considers the research on verbal probabilities and uses this as a basis for predicting how verbal probabilities may affect the interpretation of profiling claims.

INTER-INDIVIDUAL VARIABILITY IN NUMERICAL INTERPRETATIONS OF PROBABILITY WORDS

When communicating uncertainty, the vocabulary people use to express states of uncertainty is rich and varied. In an effort to investigate the numerical meaning of verbal probabilities, Reagan, Mosteller, and Youtz (1989) found that over 282 different verbal probability expressions had been used in 37 studies of verbal uncertainty. As well as being numerous, verbal probabilities are also very vague (Brun & Teigen, 1988; Reagan et al., 1989; Teigen & Brun, 1995). Unsurprisingly, the most robust finding in studies of verbal uncertainty communication is the extremely high variability in individuals' interpretation of numerical probabilities conveyed within a verbal probability expression. Although people perceive the meaning of verbal probabilities consistently (individuals derive the same interpretation across multiple situations), there is a wide variation across different individuals in the interpretation of verbal probability expressions (Teigen & Brun, 1995).

Wallsten, Budescu, Rapoport, Zwick, and Forsyth (1986) argued that individuals' interpretations of verbal probability expressions are best understood in terms of membership functions. Memberships range from 0 for a numerical value that cannot be conveyed by the verbal probability to 1 for a numerical value that is typically conveyed by the verbal probability. Membership functions assign a degree of membership to all the values of the probability scale for any given probability expression. Membership functions thus describe how verbal probability expressions map on the different values of the numerical probability scale for different individuals. They specify the meaning of a particular verbal probability expression by defining (i) its range of possible numerical interpretations, (ii) the symmetry of the mapping and (iii) the probability value which has the highest membership value. For example, non-null membership values for the word *likely* spread from $p = .08$ to $p = 1$, indicating that *likely* could be interpreted to refer to almost any numerical probability value. On average, the maximum membership value (the membership function's *peak value*) for *likely* is assigned at a probability of .85 (Budescu, Karelitz, & Wallsten, 2003). This suggests that *likely* will be interpreted by most people as conveying an 85% probability. Whereas membership functions are generally quite stable for a given individual, they can vary greatly from an individual to another (Budescu & Wallsten, 1995). This line of research suggests that considerable variation in individuals' numerical interpretations might also be observed within the context of profiling claims.

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Therefore, we hypothesised that individuals' membership functions of verbal probability expressions qualifying profiling claims would be heterogeneous (Hypothesis 1).

PERCEIVED BEHAVIOURAL CHARACTERISTIC BASE-RATES WILL AFFECT NUMERICAL INTERPRETATIONS

In addition to high variability across different individuals' interpretations, several external factors, such as the outcome's base-rate as well as its seriousness have also been shown to have substantial effects on the numerical interpretation of verbal probabilities. Thus, the peak, spread and shape of probability words' membership functions also depends on the context within which any given claim arises (Budescu & Wallsten, 1995). Thus, a *likely* outcome can be thought to have different numerical probabilities of occurrence depending on its perceived base-rate probability. For example, compare the following two statements:

(1) It is *likely* that it will snow in Liverpool, England, next December.
(2) It is *likely* that it will snow in the Aspen ski resort, U.S., next December.

The word *likely* will receive different numerical interpretations depending on context. In interpreting the level of uncertainty communicated, individuals tend to combine the range of values which they feel are expressed by the word *likely* with contextual information about the base-rate of the outcome being predicted (in this case, the probability of snow in December in the two locations specified). Thus, when asked to give numerical interpretations for such outcomes, individuals typically assign higher numerical values to 'likely' when it qualifies a high base-rate outcome rather than a low base-rate outcome (Wallsten, Fillenbaum, & Cox, 1986; Weber & Hilton, 1990). In the example above, individuals would assign a higher numerical value to statement 2. Consequently, one might expect that a high base-rate offender characteristic would be assigned a higher numerical probability than a low base-rate characteristic, despite them being qualified by the same probability word (Hypothesis 2).

MORE DANGEROUS BEHAVIOURAL CHARACTERISTICS WILL BE PERCEIVED AS MORE LIKELY

As discussed previously the perceived severity of the outcome qualified is an additional contextual feature. Individuals tend to interpret a given probability word as more probable when it qualifies a severe outcome in a medical scenario (Bonnefon & Villejoubert, 2006; Weber & Hilton, 1990). Assuming the physician is polite and will try to 'sugar-coat' severe—hence threatening—news, individuals infer that the true numerical probability of the severe outcome is much higher than that usually communicated by the physician's probability qualifier (Bonnefon & Villejoubert, 2006). This 'severity effect' may also play a role in interpreting profiling claims because a severe outcome has potentially harmful consequences, the perceived dangerousness of an offender characteristic may, for example, also influence the numeric interpretation. This study consequently hypothesised that a dangerous offender characteristic statement would be assigned a higher numeric probability function than a harmless characteristic, even where qualified by the same probability word (Hypothesis 3).

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PERCEIVED LIKELIHOOD WILL DEPEND ON CHARACTERISTIC FRAMING

Probability words used to qualify an outcome can be assigned a variety of different numerical interpretations, depending on (i) individuals' personal membership functions for these words, (ii) on the outcome's base-rate or its severity. Furthermore, recent research suggests that the way an outcome is framed will also affect how likely it will be perceived.

Verbal probability qualifiers generate different perspectives on the perceived probability of an occurrence or non-occurrence (Moxey & Sanford, 2000; Teigen & Brun, 1995). Some probability words and expressions such as *probable* or *a small chance* are said to have a 'positive directionality'. This means that they focus our attention on a possible occurrence of the outcome characterised. Alternatively, when an outcome is qualified by a negative probability term such as *doubtful* or *not quite certain*, they focus our attention on non-occurrence.

A direct consequence of 'perspective effect' is that when an outcome is framed positively, individuals prefer using positive probability words to qualify uncertainty. For example, when a medical examination reveals positive reactions to *some* of the tests, individuals prefer to say, that it is *possible* the patient has the disease, thus representing a 'positive verbal probability'. Conversely, they will prefer to use a negative word and say, for example, that it is *uncertain* whether or not the patient has the disease when told that *not all* the tests showed positive reactions. A mirror pattern occurs when individuals are told of the quantities of tests showing negative results (Teigen & Brun, 2003).

Generally, systematic relationships between the directionality of a given probability expression and the shape and location of its membership function are observed. Thus, positive phrases are typically interpreted as conveying probabilities above .5, whereas negative phrases are typically interpreted as denoting probabilities below .5. The membership functions of positive probability expressions are, therefore, positively skewed with peak values above .50. In contrast membership functions of negative probability expressions are negatively skewed with peak values below .50 (Budescu et al., 2003).

Typically, profiling claims most often refer to behavioural characteristics that may or may not be true of the suspected offender. Thus, the perceived level of uncertainty associated with a given behavioural characteristic may depend on whether the characteristic is presented in a positive frame (i.e. *presence* of an offender characteristic) or in a negative frame (i.e. *absence* of an offender characteristic). The current paper hypothesises that the perceived level of uncertainty associated with a given probability word such as *likely* would be higher when this word qualifies a positively framed characteristic ('the offender *has* a history of sexually inappropriate behaviour') compared to when it qualified negatively ('the offender *does not have* a history of sexually inappropriate behaviour') (Hypothesis 4a). Similarly, probability words chosen to express a given numerical probability such as *80% probability* may convey a higher level of uncertainty when qualifying a positively framed characteristic rather than a negatively framed characteristic (Hypothesis 4b).

PERCEIVED LIKELIHOOD WILL DEPEND ON PROFILING CLAIM FRAMING

A given profiling claim may focus on the chances that a target attribute is true or will occur vs. the chances that the alternative target attribute is not true or will not occur. For example,

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a profiler could say that, 'it is *likely* that the offender *has* a short temper' (positive frame) or, 'it is *unlikely* that the offender *does not have* a short temper' (negative frame). Thus profiling claim framing entails both the framing of the behavioural characteristic and its associated probability. Research on the role of description framing has shown that when an alternative is described as offering a 90% chance of success, it will be more often endorsed than when it is described as offering a 10% chance of failure, even though the two descriptions are formally equivalent (Levin & Gaeth, 1988; Russo & Schomaker, 1989). Thus the numerical interpretation of a verbal uncertainty qualifier should be higher when inferred from a positively framed claim such as 'It is likely that *X*' rather than from a negatively framed claim such as 'It is unlikely that *X*' (Hypothesis 5a). Conversely, we expected that the probability word chosen to express the numerical probability of a claim would convey higher levels of uncertainty when it was inferred from a positively framed claim (e.g. there is a 70% probability that *X* is true) rather than from a negatively framed one (e.g. there is a 30% probability that *X* is not true) (Hypothesis 5b).

LOW-PROBABILITY CHARACTERISTICS WILL BE UNDERSTOOD AS CONFIRMATIONS

Although high numerical probabilities are typically expressed with positive probability words such as *very probable* and low probabilities, this is not always the case with negative words such as *very improbable*. An event with an 80% probability may be described as *not completely certain*, whilst an event with a 20% probability may be described as *possible*. In fact, low probabilities outcomes (10%-probability, 25% probability outcomes) are more often interpreted as asserting an outcome rather than denying it (Teigen & Brun, 1995). Moreover, Evans (1998) demonstrated the existence of a 'matching bias', defined as the tendency to only consider information whose lexical content matches that of the information presented in the propositional rule to be tested. We consequently hypothesised that where a behavioural characteristic is mentioned in a profiling claim; this would still be judged as more likely to represent the characteristic of the offender even when the claim that qualifies the characteristic is assigned a low numerical probability (Hypothesis 6).

EXPERIMENT

Profilers use probability phrases to indicate the level of uncertainty of any given claim. Previous research has shown that profilers use various verbal and numerical probabilities expressions to convey such uncertainties (Collins & Alison, 2002). However, there is currently no research examining how these terms can affect the interpretation of offender profiling claims. Based on existing literature on the interpretation of verbal probabilities, we formulated a number of hypotheses concerning the factors that will affect the interpretation of the uncertainty qualifying profiling claims. These hypotheses were tested using an online questionnaire.

Method

Participants

Seventy participants (20 men, 45 women, 5 did not specify their gender, mean age = 28.5 years, SD = 11.3 years) were recruited through postings on the University of

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Liverpool website and through forensic e-mail groups. The majority (75%) of participants were White British. Half were employed and 44% were still studying. Forty-one per cent had achieved a Post-Graduate Degree, 27% a Degree and 21% had achieved A-levels.

Design

All participants completed the same online questionnaire containing 48 questions presented in two sections. The first section presented a series of questions aimed at testing the effect of the different contextual factors we had identified on the numerical interpretations that could be assigned to probability words or on the choice of verbal probability words. The second section was aimed at assessing the variability in individuals' numerical interpretations of verbal probabilities using membership functions for a series of expressions qualifying different offender characteristics.

Materials and procedure

The first page of the questionnaire introduced the study as part of a larger project examining the content of offender profiles and behavioural investigative advice and the ways in which such advice is interpreted and used. Participants were reminded that their answers would remain confidential and anonymous. Before beginning the questionnaire, participants were asked to indicate that they consented to participate in the study and that they were aware that they could withdraw from the study at anytime.

The hypotheses were tested by displaying a series of statements presented as originating from a number of offender profiles that had been compiled to assist the police in their apprehension of an unknown suspect. Participants were asked to read each statement carefully and answer the associated question.

In order to examine the variation that exists across individuals' interpretation of verbal probability words (Hypothesis 1), we elicited membership functions for ten different words using the Multiple Stimuli Method (Budescu et al., 2003). So, after having read an offender profiling claim such as 'It is *very probable* that the offender will be male', participants were presented with 11 10-point Likert scales, corresponding to 11 levels of numerical probability (0%, 10%, up to 100% probability). For each of the probabilities presented (0%, 10%, etc.), participants were asked to indicate the extent to which the profiler could have had this probability in mind when making his claim. They reported their answer by selecting a number between 1 (absolutely not) and 10 (absolutely). Table 1 summarises the 10 probability phrases examined alongside the offender characteristic they qualified. The

Table 1. Offender profiling claims used to test for Hypothesis 1

Claim
1. It *suggests that* the offender will have previous sexual convictions
2. It is *very likely* that the offender will have a manual unskilled occupation
3. It is *uncertain* whether the offender will be employed
4. It is *likely* that the offender will be aged 50 years or older
5. It is *somewhat doubtful* that the offender will live in the local area
6. It is *possible* that the offender will not live in the local area
7. It is *very unlikely* that the offender will be married
8. It is *probable* that the offender will be single
9. It is *quite unlikely* that the offender will be aged less than 25 years old
10. It is *improbable* that the offender will have previous convictions

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Table 2. Claims presented to participants as a function of base-rate and dangerousness

Dimension manipulated	Probability phrase		
	...will probably be...	...is possibly...	...is likely to...
Base-rate			
High	...of White British origin	...of Christian faith	...have previous convictions
Low	...of Chinese origin	...of Pagan faith	...have previous convictions for fraud
Dangerousness			
High	...a sexual predator	...a psychopath	...kill again
Low	...a homosexual	...a postman	...return to the crime scene

selection of these terms was based on the most regularly used terms in the contemporary sample identified by Almond et al. (2007).

The effect of base-rates on the interpretation of the uncertainty associated with offender profiling claims (Hypothesis 2) was examined using three pairs of claims. The same probability phrase qualified either a high base-rate offender characteristic or a low base-rate characteristic. A similar manipulation was used to assess the effect of perceived dangerousness on the interpretation of the uncertainty associated with offender profiling claims (Hypothesis 3). Table 2 summarises the claims used for this section. For each of these claims participants were asked, 'What do you think the chances are that the offender [characteristic]? ___%'.

To evaluate the effect of characteristic framing on the level of probability assigned to a given probability word (Hypothesis 4a), we presented the following two pairs of claims where the same probability phrase qualified either a positively framed behavioural characteristic or a negatively framed characteristic (the words in brackets were presented in the claim using a negative frame):

(a) It is likely that the offender will (will not) have a history of sexually inappropriate behaviour.
(b) It is probable that the offender will (will not) be a loner.

In order to collect comparable judgements, participants were asked to evaluate the chances that the offender *did* present the target characteristic when it was positively framed, but they were asked to evaluate the chances that the offender *did not* present this characteristic when it was negatively framed.

We used a similar procedure to evaluate the effect of characteristic framing on the probability word used to convey a given level of numerical probability (Hypothesis 4b). However, we used the same numerical probability to qualify either a positively or a negatively framed characteristic and we asked participants to complete a sentence using their own preferred probability word. The two claims used were:

(c) There is an 80% probability that the offender will (will not) have a pre-conviction for violence.
(d) There is a 60% probability that the offender will (will not) live within one mile of the crime scene.

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As for the previous set of claims, to collect comparable judgements, participants were asked to choose a word to convey the probability that the offender *did* present the target characteristic for positively framed characteristics and a word to convey the probability that the offender *did not* present it for negatively framed ones.

The effect of claim framing on the numerical interpretation of verbal probabilities (Hypothesis 5a) was tested by presenting the following two claims qualified by opposite probability words *and* opposite characteristic framings:

(e) It is probable (rather improbable) that the offender will (will not) collect pornography.
(f) It is likely (rather unlikely) that the offender will (will not) be insecure with women.

In both cases, participants were asked to evaluate the chances that the offender presented the characteristic mentioned in the claim (e.g. the chances that the offender *would be* insecure with women). In a similar vein, the role of claim framing on the choice of verbal words to qualify a given numerical probability (Hypothesis 5b) was examined by presenting two identical claims qualified by complementary probability values and characteristics. The claims used were:

(g) There is a 70% probability (a 30% probability) that the offender will (will not) have a short temper and be quite aggressive.
(h) There is an 80% probability (a 20% probability) that the offender will (will not) have children.

Once again, in both cases, participants were asked to verbally express the chances that the offender would present the characteristic mentioned using their own preferred choice of words.

Finally, we wanted to examine whether suspects who presented a behavioural characteristic mentioned in a profiling claim would be judged more likely to be the offender even when the claim that qualified the characteristic yielded a low numerical probability (Hypothesis 6). To this end, we presented the following three different claims, which were either qualified with a low or a high probability:

(i) There is a 10% probability (a 75% probability) that the offender is a construction worker.
(j) There is a 25% probability (a 70% probability) that the offender is aged between 18 and 25 years.
(k) There is a 20% probability (a 80% probability) that the offender will be single.

Each claim was presented with the same summary information about the age, the marital status and the occupation of four suspects (see Table 3). In each case, participants were asked to rank order the suspects from the most likely to the least likely to have committed the offence.

Table 3. Summary suspect information presented to test for Hypothesis 6

Suspect no.	Age	Marital status	Occupation
1	28	Single	Unemployed
2	21	Co-habiting	Soldier
3	41	Divorced	Construction worker
4	44	Married	Lorry driver

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RESULTS

Inter-individual variability

We expected to observe considerable variability between individuals in their interpretation of verbal qualifying profiling claims (Hypothesis 1). Figure 1 presents the membership functions for each probability phrase used. The error bars (denoting the means standard deviations) further indicate the extent of the variability in interpretations dependent on the verbal probability term used. Table 4 presents the membership functions, mean peak, minimum and maximum values, together with standard deviations and coefficients of variation. There was little agreement amongst individuals concerning the numerical probability typically conveyed within a verbal probability phrase. This latter point is further illustrated by Figure 2, which represents histograms representing the distributions of the peak values assigned to any given word. These graphs reveal that phrases such as *it suggests* are especially ambiguous. The phrase is interpreted by some individuals as signifying a probability lower than 20%, whilst others interpret this as conveying a probability greater than 60% similar variations exist for *probable, unlikely* or *quite unlikely*, which are assigned peak values that encompass the whole scale of probabilities. Greater consensus was found for the phrases *somewhat doubtful* or *improbable*, which were interpreted as denoting probabilities lower than 20% by the majority of individuals. Similarly, *uncertain* or *possible* were generally understood as typically conveying a 50% or less probability. The phrases *likely* and *very likely* were generally understood to convey higher numerical values, ranging from 40% to 100% for *likely* and 60% to 100% for *very likely*.

The role of perceived base-rate and dangerousness of offender characteristics

Beyond inter-individual variability in the interpretation of verbal probability phrases, we also expected to demonstrate how contextual features, such as the perceived base-rate of a given offender profiling claim (Hypothesis 2) and the perceived dangerousness of the claim (Hypothesis 3) influence interpretation. Both hypotheses were tested using a 3 (probability word) $\times$ 2 (high vs. low base-rates/Dangerousness) within-subject Analysis of Variance (ANOVA). Figure 3 presents the mean probability judgements observed for each probability word (*probably*, *possibly* and *likely*) associated with (i) high and low base-rate levels, and (ii) high and low levels of dangerousness. The probability word used to qualify the claim had a significant effect on the numerical probability assigned to the claim; $M_{\text{probably}} = 57.96$, SE $= 2.12$; $M_{\text{possibly}} = 39.26$, SE $= 2.03$ and $M_{\text{likely}} = 61.86$, SE $= 1.79$; $F(2, 136) = 80.81$, MSE $= 249.18$, $\eta_p^2 = .54$, $p < .001$ for claims with differing base-rates; $M_{\text{probably}} = 60.54$, SE $= 1.98$; $M_{\text{possibly}} = 37.99$, SE $= 2.11$ and $M_{\text{likely}} = 66.59$, SE $= 1.70$; $F(2, 138) = 118.03$, MSE $= 269.55$, $\eta_p^2 = .63$, $p < .001$ for claims with differing dangerousness.

As anticipated in Hypothesis 2, numerical probability judgements were also influenced by the claims' perceived base-rates. High base-rate claims systematically led to higher mean probability judgements; $M_{\text{high}} = 57.08$, SE $= 1.56$; $M_{\text{low}} = 48.98$, SE $= 2.18$; $F(1, 68) = 19.25$, MSE $= 352.83$, $\eta_p^2 = .22$, $p < .001$. Similarly, and in line with Hypothesis 3, claims related to more dangerous behaviour characteristics were perceived as more likely than those related to more benign characteristics; $M_{\text{dangerous}} = 59.06$, $M_{\text{benign}} = 51.01$,

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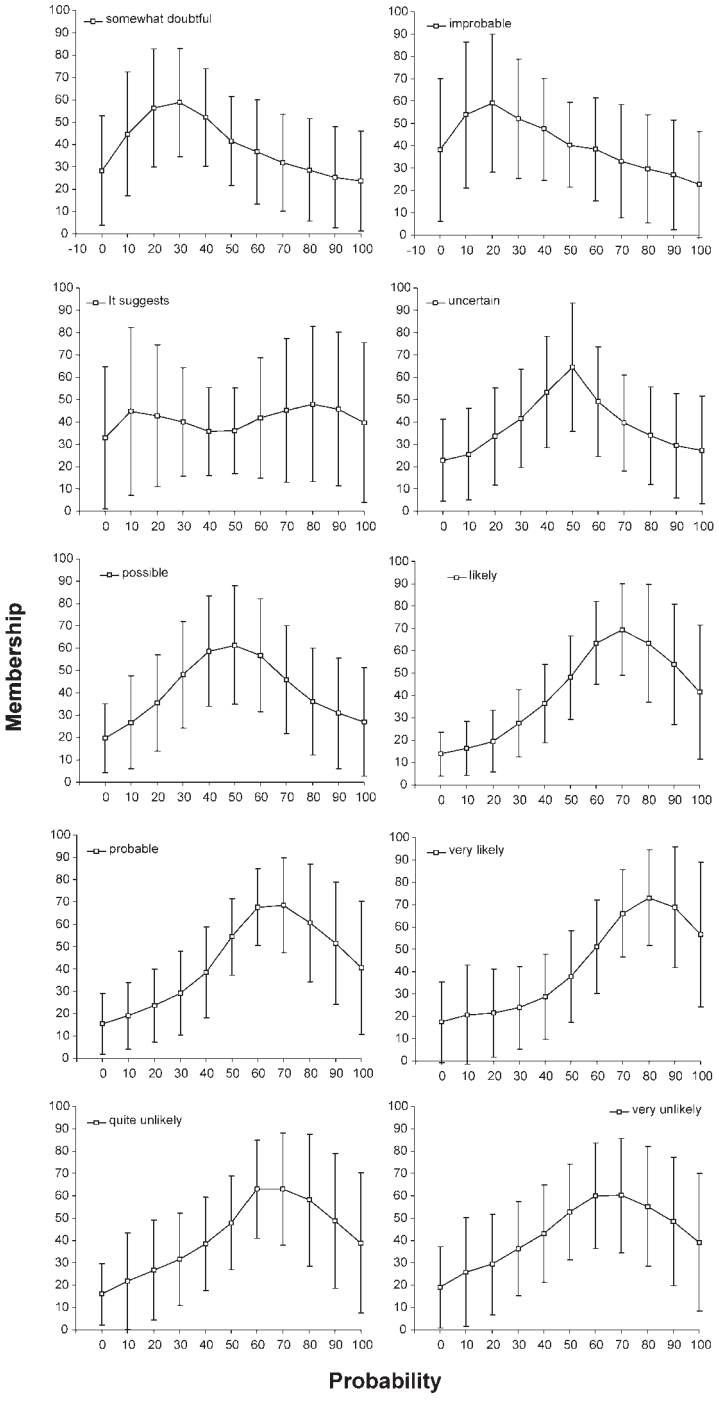

Figure 1. Membership functions for each of the ten probability words qualifying behavioural characteristics in offender profiling claims based on the judgements of all 69 subjects tested. Points represent the mean membership for a given probability. Vertical lines depict standard deviations from the means

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Table 4. Membership functions statistics for the probability words used to test for Hypothesis 1

		Peak			Min		Max		Skew	
Probability word	*N*	*M*	SD	Cv (%)	*M*	SD	*M*	SD	*M*	SD
Improbable (10)	62	33.1	31.5	95	10.5	16.5	78.5	22.5	0.26	0.52
Somewhat doubtful (5)	62	37.3	29.9	80	9.7	15.5	76.8	22.8	0.15	0.46
Uncertain (3)	64	41.9	26.4	63	14.8	15.6	83.8	20.5	0.03	0.35
Possible (6)	62	49.5	25.6	52	12.3	13.6	85.3	18.2	0.01	0.41
Suggests (1)	63	50.0	37.2	74	14.8	18.6	78.1	26.3	0.03	0.63
Very unlikely (7)	62	60.8	28.2	46	20.3	20.4	92.3	12.5	−0.12	0.46
Quite unlikely (9)	62	63.9	24.5	38	23.5	20.3	91.5	14.5	−0.16	0.42
Probable (8)	62	68.4	22.2	32	21.8	18.3	94.4	10.2	−0.22	0.41
Likely (4)	58	68.8	19.6	28	25.5	19.9	95.3	9.0	−0.20	0.40
Very likely (2)	64	73.3	26.5	36	29.1	22.3	95.3	13.8	−0.29	0.49

Notes: The words are sorted by their mean peak value. The numbers in brackets refer to the associated claim used as reported in Table 1.

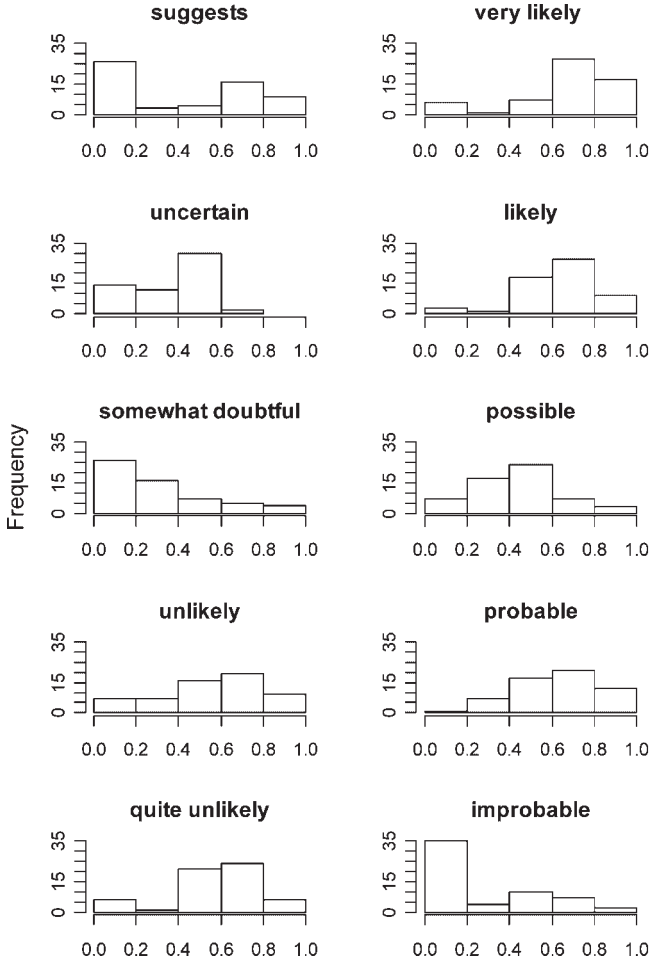

Figure 2. Histograms of the membership functions peak values for each of the 10 probability words qualifying behavioural characteristics in offender profiling claims

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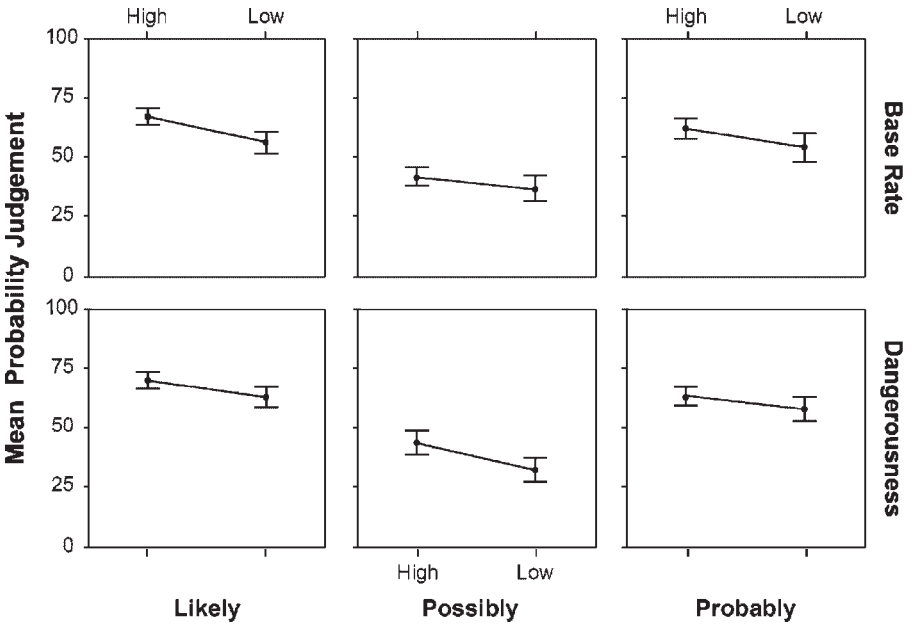

Figure 3. Mean probability judgements as a function of probability word, base-rate and dangerousness levels. Error bars depict confidence intervals around the means

$F(1, 69) = 19.25$, MSE $= 245.24$, $\eta_p^2 = .29$, $p < .001$. The interactions effects were not significant in either analyses; $ps > .15$.

The role of characteristic framing

We hypothesised that the perceived level of certainty associated with *likely* or *probable* would differ depending on whether these words qualified a positively framed characteristic (e.g. the offender *will* have a history of sexually inappropriate behaviour) compared to when it qualified a negatively framed one (e.g. the offender *will not* have. . .). The words *likely* and *probable* elicited similar numerical probability judgements; $F(1, 68) = 0.45$, MSE $= 230.24$, $\eta_p^2 = .01$, $p = .51$. In line with Hypothesis 4a, however, the valence of the behavioural characteristic had a significant effect on mean probability judgements. As expected, positively framed characteristics led to higher judgements than negatively framed ones; $M_{\text{positive}} = 62.34$, $M_{\text{negative}} = 54.36$, $F(1, 68) = 17.21$, MSE $= 255.63$, $\eta_p^2 = .20$, $p < .001$.

Similarly, we expected that probability words chosen to communicate a numerical probability associated with positively framed characteristic would convey greater certainty than those with a negatively framed characteristic (Hypothesis 4b). A total of 98 different probability expressions were elicited by the questions associated with claims (c), (d) and (g), (h) which were used to test for Hypotheses 4b and 5b, respectively (see the 'Method' section for a description of these claims). We presented the probability phrases elicited by our participants to a new set of 20 independent coders and asked them to provide the most typical probability value representative of the phrases listed. We then used the median probability value given for each word by the independent coders as proxy for the degree of

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Table 5. Wilcoxon-signed ranks test results for Hypotheses 4b and 5b

	Ranks							
	Positive			Negative			Ties	
Claims	*N*	*M*	$\sum$	*N*	*M*	$\sum$	*N*	*z*
Behavioural characteristic framing (Hypothesis 4b)								
(c)	32	18.97	59.00	40	14.75	607.00	23	−4.33**
(d)	15	19.03	285.50	16	13.16	210.50	28	−0.74
Claim framing (Hypothesis 5b)								
(g)	44	25.41	1118.00	3	3.33	10.00	11	−5.87**
(h)	49	28.70	1406.50	4	6.13	24.50	8	−6.13**

**$p < .001$.

certainty communicated by participants. The resulting scores were not normally distributed so we analysed these data with Wilcoxon-signed ranks tests. The tests results and summary statistics for Hypothesis 4b are presented in the first half of Table 5. As expected, the level of certainty communicated by words associated to positively framed characteristics was generally higher than that communicated by words associated with negatively framed characteristics. This trend, however, was only statistically significant for claim (c) 'There is an 80% probability that the offender will (will not) have a pre-conviction for violence'.

The role of profiling claim framing

Previous results revealed that the same probability word or probability value will convey different levels of certainty depending on whether it is associated with a positively framed characteristic or a negatively framed one. We also hypothesised that logically equivalent claims would be seen to convey different levels of certainty, depending on the valence of the frame used. In order to test Hypothesis 5a, we compared the perceived level of certainty based on positive claims (e.g. It is *probable* that the offender *will*. . .) to that associated with negative claims (e.g. It is *rather improbable* that the offender *will not*. . .). A printing error in the questionnaire prevented the use of statements (f) as the characteristic was framed positively in both claims. Hypothesis 5a was, however, confirmed by comparing judgements based on the positive framing of claim (e) to those based on its negative frame equivalent. Thus, the average probability that the offender collected pornography was judged higher by participants informed that it was *probable* that the offender *would* collect pornography (positively framed claim) compared to participants informed that it was *rather improbable* that the offender *would not* collect pornography (negatively framed claim); $M_{\text{positive}} = 62.77$, $\text{SD} = 19.53$, $M_{\text{negative}} = 47.99$, $\text{SD} = 29.40$, $t(68) = 4.15$, $d = 0.60$, $p < .001$.

Similarly, we hypothesised that probability words chosen to communicate a numerical probability associated with positively framed claim would convey more certainty than those chosen to communicate the same probability associated with a negatively framed claim (Hypothesis 5b). We used the same procedure used to test for Hypothesis 4b to analyse the degree of certainty communicated by probabilities phrases elicited. The tests results and summary statistics for Hypothesis 5b are presented in the second half of Table 5.

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As anticipated, probability words qualifying the same statement generally conveyed a higher level of certainty when based on positive rather than negative claims.

The impact of low-probability statistics on suspect identification

Our last hypothesis concerned the impact of matching behavioural characteristics on perceived likelihood of guilt. We expected that suspects who presented a behavioural characteristic mentioned in a profiling claim would be judged more likely to be the offender *even* when the claim qualified the characteristic with a low numerical probability (Hypothesis 6). To test this hypothesis we computed the proportion of positive identifications (i.e. identifications of a suspect as either most likely or second most likely to have committed the offence) depending on whether or not a suspect description contained a characteristic matching the offender's characteristic as well as the stated probability that the offender would present this characteristic. A total of 1649 identifications were available (4 suspects $\times$ 3 offender characteristics $\times$ 2 levels of probability for the offender characteristic $\times$ 70 subjects—missing data).

Overall, suspects who presented a matching characteristic were positively identified 77.3% ($N = 415$) of the time, whereas suspects who did not were positively identified 42.7% ($N = 1234$) of the time. The rate of positive identifications was thus significantly higher when suspects' descriptions matched a characteristic of the offender; $\chi^2(1, N = 1649) = 165.56$; $p < .001$. As expected, the stated probability of the offender presenting the named characteristic did not have an effect on positive identifications. Suspects were equally likely to be positively identified when the offender's characteristic was associated with a low probability or with a high probability; $\chi^2(1, N = 1649) = 0.005$; $p = .94$. There was, however, an interaction between the probability of the offender presenting a characteristic and whether or not a suspect's description matched this characteristic, as shown in Figure 4. Suspects were always more likely to be positively

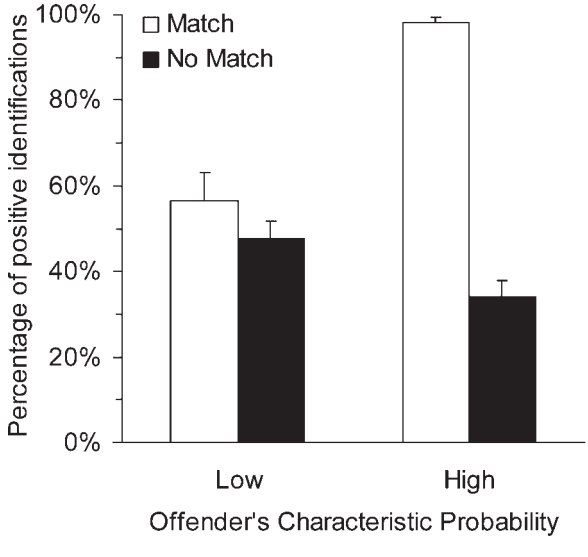

Figure 4. Percentage of positive identifications as a function of suspect–offender matching and offender's characteristic probability. Error bars depict confidence intervals around the percentages

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identified when they presented a matching characteristic with the offender but the effect of suspect–offender description matching was significantly more pronounced when the offender was said to be highly likely to present the matching characteristic. This result demonstrates that the matching bias is even stronger for high probability matching statements.

DISCUSSION

The aim of this research was to examine how probability expressions affect the interpretation of the information provided in offender profiles. Based on an online questionnaire we were able to demonstrate that uncertain claims about offenders are interpreted differently by different people. Our results showed that several uncertainty expressions led to considerable variation. Although participants generally agreed that phrases such as *improbable* or *somewhat doubtful* communicated very low probabilities, phrases such as *uncertain* or *possible* consistently were interpreted to communication probabilities at around chance level. Expressions such as *likely* and *very likely* clearly communicated higher probabilities above 50% chance, whereas other expressions, such as *it suggests* were found very ambiguous and were interpreted as denoting very low probabilities *or* very high probabilities. This interpretative diversity may induce an illusion of valid communication, which could result in misunderstandings between a Behavioural Investigative Advisor's intended meaning and the Senior Investigating Officer's (SIOs) interpretation (Budescu & Wallsten, 1985). Such opportunities for miscommunication have been shown to be higher for verbal opposed to numerical risk communication both experimentally (Budescu, Weinberg, & Wallsten, 1988) and in field (medical) settings (Bryant & Norman, 1980). However, relying on numerical probability estimates may not always be possible, especially in an arena, where there is a relative paucity of hard, scientific facts. Therefore, when uncertainty can only be characterised verbally, BIA's may wish to focus on the least ambiguous terms.

Our results also demonstrated how base-rates and perceived dangerousness influenced the way in which uncertain claims are interpreted. Thus, verbal probability expressions associated with a high base-rate claim led to higher subjective judgements of the probability of the claim being true compared to low base-rate claims. Similarly, extending upon the well-documented severity effect in medical contexts (Bonnefon & Villejoubert, 2006; Weber & Hilton, 1990), our research showed that more dangerous offender characteristics were perceived as more likely to occur. One strategy to counteract such effects might be to put greater emphasis on the uncertainty of a claim when it relates to a high base-rate or highly dangerous characteristic. For example, if a BIA concludes that it is *probable* that an offender may be a sexual predator (a dangerous characteristic), they could report that it is *possible* in order to prevent SIOs to overestimate the probability of such a claim being true. Conversely, one could temper the uncertainty associated with low base-rate claims or claims relating to a benign characteristic.

The results also confirmed that the framing of behavioural characteristics presented in profile claims also affected the perceived probability of occurrence. The same probability word was interpreted as denoting a lower level of uncertainty (i.e. a higher probability of occurring) when referring to the presence of a characteristic in an offender rather than its absence. This was also true for numerical probabilities: a given numerical level of uncertainty was communicated with probability expressions denoting less uncertainty

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when the numerical probability referred to the presence rather than the absence of a behavioural characteristic. Another framing effect was observed between logically equivalent claims either presented in a positive frame or in a negative frame. Thus, a claim presented in a positive frame (e.g. 'it is probable that the offender would collect pornography') led to higher subjective probabilities for the claim being true than when the same claim was presented in a negative frame (e.g. 'it is rather improbable that the offender would not collect pornography'). Once again, the same effect of claim framing was found when the original claim was qualified by a numerical probability: probability words qualifying a claim conveyed higher level of certainty when they were based of positive claims than when they were based on negative ones. From a general standpoint, these results both confirm and expand upon previous results by Teigen and Brun (2003), in which the interpretation of verbal probabilities depended on claim framing in general contexts and had not systematically distinguished the role of characteristic vs. claim framing on the uncertainty conveyed by a statement qualified by a probability phrase.

With regards to issues directly relevant to offender profiling, these results suggest that BIAs may need to consider what is the most appropriate way to frame behavioural characteristics (as either present or absent) or claims (as either true or not true) when reporting uncertain claims. Research has shown that where individuals are encouraged to engage in deeper processing of such information, they are less likely to draw biased interpretations of risk information in general (Kahneman, 2003; Natter & Berry, 2005). In particular, framing effects are reduced when recipients are encouraged to think about the claim in both a positive frame and its negative equivalent (Maule, 1989; Maule & Villejoubert, 2007). These results suggest that SIO's interpretations of BIA's profile claims will be less influenced by framing effects if such claims are presented both with positive and negative frames, thereby reducing interpretive error. Likewise, SIOs may consider reframing claims they read in the opposite frame in order to avoid being erroneously influenced by the way in which the claim is presented.

Finally, our results have shown that when prioritising suspects based on profile claims, suspects are more often classified as being either the most likely or the second most likely to have committed an offence if they present a characteristic that matches the offender characteristic in the profile claim. Such positive identifications were systematic when the claim was qualified by a high probability, although were still highly prevalent when the claim was qualified by a low probability. Individuals tend to rely on a similarity heuristic to make probability judgements (Kahneman & Frederick, 2002). It is therefore possible that individuals rely on such heuristics when they judge that the suspect who most resembles the offender was the most likely to have committed an offence. This is not necessarily an issue where the probability that the offender presents the characteristic is also high. However, where the characteristic in the behavioural claim is reported as having a low probability of occurrence, this could lead to erroneous prioritisation, where suspects presenting a matching characteristic are given too much priority.

Needless to say, a weakness of the study was the reliance on a non-police sample. However, previous studies in both lay samples and experts have revealed similar issues (Maule & Villejoubert, 2007). Thus, whilst important to test the transferability of such findings operationally, our results are probably indicative of general findings. Moreover, although advice concerning probable offender characteristics is rarely used in court, especially in the UK (Alison, Bennell, Mokros, & Ormerod, 2002), similar fact evidence in behavioural analysis has been used in the courts and is, therefore, actively listened to and read by members of the jury (Alison, West, & Goodwill, 2004). As such, our results yield

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interesting prospects for a greater appreciation of how such advice is interpreted beyond the remit of investigative experts. Indeed, other areas of advice also bear examination, including the interpretation of covert surveillance and other forms of law enforcement and military/security intelligence. Alison and Crego (2008), amongst many others have indicated how high stake decisions might be made based on uncertain information and how, in many cases, such uncertain information may come from external sources (e.g. from other agencies, expert advisor reports, source management and handlers etc.). An increased awareness of interpretative frameworks that may occur across this range of contexts, as well as research-informed advice on how such reports could be best constructed could prove invaluable.

CONCLUSION

The present research offered a comprehensive overview of ways in which uncertain profiling claims may be misinterpreted. As we mentioned in the introduction, research that is directly relevant to improve the quality of behavioural investigative advice is scarce. A major contribution of the present research was to extend results from previous research examining risk communication in medical and business settings to the domain of investigative advice. Raising awareness of these issues should assist in improving the quality of the provision of such advice and the interpretation and utilisation in operational contexts. Decision-makers who receive uncertain information tend to think they will make more accurate inferences based on numerical information, although this intuition is not necessarily correct (Erev & Cohen, 1990). Therefore, SIO's preferences for numerical information as well as the accuracy of their inference made on the basis of verbal and numerical information could be tested in future experiments.

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REFERENCES

Alison, L., & Crego, J. (2008). *Policing critical incidents: Leadership and critical incident management.* Devon: Willan Publishers.

Alison, L., Mclean, C., & Almond, L. (2007). Profiling suspects. In T. Newburn, T. Williamson, & A. Wright (Eds.), *Handbook of criminal investigation*. Devon, Cullumpton: Willan Publishers.

Alison, L., West, A., & Goodwill, A. (2004). The academic and the practitioner: Pragmatists' views of offender profiling. *Psychology, Public Policy and Law*, *10*, 71–101.

Alison, L., Bennell, C., Mokros, A., & Ormerod, D. (2002). The personality paradox in offender profiling: A theoretical review of the processes involved in deriving background characteristics from crime scene actions. *Psychology, Public Policy and Law*, *8*, 115–135.

Almond, L., Alison, L., & Porter, L. (2007). An evaluation and comparison of claims made in behavioural investigative advice reports compiled by the national policing improvements agency in the United Kingdom. *Journal of Investigative Psychology and Offender Profiling* (in press).

DOI: 10.1002/acp

Bonnefon, J. F., & Villejoubert, G. (2006). Tactful, or doubtful? Expectations of politeness explain the severity bias in the interpretation of probability phrases. *Psychological Science*, *17*, 747–751.
Brun, W., & Teigen, K. (1988). Verbal probabilities: Ambigious, context-dependent, or both? *Organizational Behavior and Human Decision Processes*, *41*, 390–404.
Bryant, G., & Norman, G. (1980). Expressions of probability: Words and numbers. *New England Journal of Medicine*, *302*, 411–427.
Budescu, D., & Wallsten, T. (1985). Consistency in interpretation of probabilistic phrases. *Organizational Behavior and Human Decision Processes*, *36*, 391–485.
Budescu, D. V., & Wallsten, T. S. (1995). Processing linguistic probabilities: General principles and empirical evidence. In J. Busemeyer, R. Hastie, & D. L. Medin (Eds.), *Decision making from a cognitive perspective*. New York: Academic Press.
Budescu, D., Karelitz, T., & Wallsten, T. (2003). Predicting the directionality of probability words from their membership functions. *Journal of Behavioral Decision Making*, *16*, 159–180.
Budescu, D., Weinberg, S., & Wallsten, T. (1988). Decisions based on numerically and verbally expressed uncertainties. *Journal of Experimental Psychology: Human Perception and Performance*, *14*, 281–294.
Collins, S., & Alison, L. (2002). How certain are offender profilers about the claims they make? Internal report for the National Crime and Operations Faculty, Hook, Bramshill, UK.
Erev, I., & Cohen, B. L. (1990). Verbal versus numerical probabilities: Efficiency, biases, and the preference paradox. *Organizational Behavior and Human Decision Processes*, *45*, 1–18.
Evans, J. St. B. T. (1998). Matching bias in conditional reasoning: Do we understand it after 25 years? *Thinking and Reasoning*, *4*, 45–82.
Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment*. Cambridge, UK: Cambridge University Press.
Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist*, *58*, 697–720.
Karelitz, T., & Budescu, D. (2004). You say ''probable'' and I say ''likely'': Improving interpersonal communication with verbal probability phrases. *Journal of Experimental Psychology: Applied*, *10*, 25–41.
Levin, I. P., & Gaeth, G. J. (1988). How consumers are affected by the framing of attribute information before and after consuming the product. *Journal of Consumer Research*, *15*, 374–378.
Maule, A. J. (1989). Positive and negative decision frames: A verbal protocol analysis of the Asian Disease problem of Tversky and Kahneman. In H. Montgomery, & O. Svenson (Eds.), *Process and structure in human decision making*. Chichester, UK: Wiley.
Maule, A. J., & Villejoubert, G. (2007). What lies beneath: Reframing framing effects. *Thinking and Reasoning*, *13*, 25–44.
Moxey, L. M., & Sanford, A. J. (2000). Communicating quantities: A review of psycholinguistic evidence of how expressions determine perspectives. *Applied Cognitive Psychology*, *14*, 237–255.
Natter, H. N., & Berry, D. C. (2005). Effects of active information processing on the understanding of risk information. *Applied Cognitive Psychology*, *19*, 123–135.
Reagan, R., Mosteller, F., & Youtz, C. (1989). Quantitative meanings of verbal probability expressions. *Journal of Applied Psychology*, *74*, 433–442.
Russo, J., & Schomaker, P. (1989). *Decision traps*. New York: Schuster & Simon.
Teigen, K., & Brun, W. (1995). Yes, but it is uncertain: Direction and communicative intention of verbal probabilistic terms. *Acta Psychologica*, *88*, 233–258.
Teigen, K., & Brun, W. (2003). Verbal probabilities: A question of frame? *Journal of Behavioural Decision Making*, *16*, 53–72.
Wallsten, T., Budescu, D., Rapoport, A., Zwick, R., & Forsyth, B. (1986). Measuring the vague meanings of probability terms. *Journal of Experimental Psychology: General*, *115*, 348–365.
Wallsten, T., Fillenbaum, S., & Cox, J. (1986). Base rate effects on the interpretation of probability and frequency expressions. *Journal of Memory and Language*, *25*, 571–587.
Weber, E., & Hilton, D. (1990). Contextual effects in the interpretation of probability words: Perceived base rate and severity of events. *Journal of Experimental Psychology: Human Perception and Performance*, *16*, 781–789.

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