*Technical Report CMU-EPP-1990-03-02, Department of Engineering and* Public Policy, Carnegie Mellon University, Pittsburgh, PA, May 1989

# Verbal Uncertainty Expressions: Literature Review

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May 20, 1989

**Abstract**

This paper summarizes findings of a literature review on verbal uncertainty expressions. There have been several studies in this field in the last twenty years. The main motivation behind these studies is that using verbal expressions is preferred by humans in certain situations and may be practically applied in decision making. It is postulated to reflect better non-numerical nature of the data, avoid the misleading impression of precision by being implicitly vague, and be easier for people to deal with.

Two major findings of this research are that people are internally consistent in their use of these expressions and that there is a great between-subject variability. The probabilistic meaning of the phrases is also shown to be highly context sensitive, with an asymmetry and a large overlap between different phrases. Variability of verbal expressions is severly underestimated by people using them and verbal communication poses the danger of considerable misunderstandings. On the other hand, there exist phrases that most of the people agree upon and a careful choice of a small vocabulary is able to facilitate precise communication. Appendix gives a list of all verbal uncertainty phrases encountered in the literature.

## Introduction

The concept of subjective probability, mapping of person's belief onto the real number between 0 (event believed to be impossible) and 1 (event believed to occur with certainty), plays a major role in any modern theory of decision making. However, on various grounds, people often resist expressing their opinions numerically, preferring instead to use non-numerical terms, like *probable*, *chances are*, *almost certain*, etc.

*This work was supported in part by the National Science Foundation under grant IRI–8807061

There are several reasons why such preference might exist. First of all, the real world information, on which the described data is based, is often not sufficiently precise to be translated into numerical statements and linguistic terms are reflecting better its non-numerical nature. Second, numerical descriptions carry a misleading precision: they suggest that the probability of the event in question is measurable, while it is often not the case. Experts feel that it is not ethical to produce precise numerical judgments while the uncertainty itself is of a vague form. Consumers of the information, decision makers, are argued to be poorly served when provided with forecasts that are more precise than warranted by the available information [4]. Further, experts may feel less threatened by a possible verification of their predictions when giving a verbal estimation. Also, recipients of the probability estimations may feel that it is more understandable and easier to digest when it is given in a more "natural", verbal rather than numerical form. Probability concepts were formally developed around three centuries ago, while language expressions for different degrees of uncertainty existed in many languages long before then [20].

Research on verbal uncertainty expressions is relatively young. Important work in this field has been done only in the last two decades. Studies have concentrated on the possible applications of verbal uncertainty expressions in communication between individuals (experts and decision makers) and between automated decision support systems and their users (eliciting uncertain knowledge and explaining the results). The main question that researchers have been trying to answer is: *Do the verbal uncertainty phrases have a reasonably precise, communicable probabilistic meaning?* This paper is intended to summarize the most important findings of this research and make suggestions for its possible further directions.

## Experimental methods

Most of the empirical work on uncertainty expressions has focused on investigation if a verbal phrase carries a probabilistic meaning, i.e. if there is a numerical probability or a range of probabilities corresponding to that phrase. An equally important issue is if that numerical equivalent is stable and consistent both within and between subjects.

The simplest setting involves asking the subjects directly what they understand by a given verbal expression or what expression they associate with a given numerical probability.

Phrases can be studied in isolation from any real life context or within a context. In context free experiments, it is understandable that the subjects may disagree in their interpretations of the phrases, because each subject may provide a different semantic contexts in his or her mind. "In context" tasks bring the danger that the subject's deep involvement with the events described may cause correlation of his or her personal opinion on the topic with the probability terms used, encouraging personal statements rather than independent meanings of uncertainty expressions. Further, if the context is not defined with sufficient precision, the subjects may add their own interpretation, resulting possibly in a high between-subject

variability.

An entire class of experiments is concerned with a practical use of different phrases in decision making and a performance comparison with use of numerical or graphical representation. Experiments can be conducted in real life settings, with subjects selected among experts, whose everyday job is to estimate probabilities, or in laboratory conditions. In the latter case, the subjects are requested to make bets on events, whose probability has been described verbally. To test effectiveness of verbal communication, the game can be enhanced by dividing the roles into "expert" and "decision maker", the first estimating the probability of an event and communicating it verbally, and the second using this information to bet on the event. Performance and consistency of verbal communication can be compared against the performance and consistency of numerical communication.

# Major findings

## Preference for verbal expression

It emerges from the existing literature that the verbal information processing is preferred by people and is more efficient for some tasks and in some environments, while numerical is more efficient in others. It has been found that people rely more heavily on verbal information when the data are not easily quantifiable, and more heavily on numerical information when it is available. Zimmer [21] found that bank clerks making numerical predictions of future currency exchange rates relied on variables that are usually stated numerically (e.g. GNP) in deriving their predictions. Clerks making verbal predictions employed both these and qualitative variables, such as the stability of the government. The performance of the second group was found to be better and its superiority was suggested to be the result of using a broader knowledge base.

Budescu, Weinberg, and Wallsten [6] found that their subjects preferred verbal expressions to numerical when dealing with lotteries involving gains. In lotteries involving losses, the subjects preferred numerical estimations.

It has also been observed that people tend to prefer to output their uncertainty in verbal form, but generally prefer to receive information in numerical form [16]. Brun and Teigen [2] demonstrated that physicians (general practitioners) prefer to express probabilities verbally, while mothers of small children prefer to receive numerical estimations about their children's health risks.

Zimmer [21] suggested that forcing people to give numerical estimates causes them to operate in a mode that requires more mental effort and is therefore more difficult to use. This, however, has not been confirmed in a study done by Budescu, Weinberg, and Wallsten [6]. There have been no significant differences in response time for the three methods of communication: numerical, graphical, and verbal.

### Richness of the uncertainty vocabulary

It is generally agreed upon that although each individual uses a relatively small set of phrases, there is a considerable amount of various verbal uncertainty expressions actively used by people. For example, in an experiment where the subjects were free to generate their own verbal expressions to describe probabilities, a surprising richness of the probability vocabulary was found. Although each subject used on the average 13 phrases, the total number of different phrases generated by 20 subjects was 111 [6].

There are several types of verbal uncertainty expressions. Some of them describe probability directly, but other phrases have a distinctly frequentistic rather than probabilistic meaning (e.g. *usually*, *rare*, *seldom*), some are logical relations (e.g. *consistent with*, *is compatible with*, *effectively excludes*), utility considerations (e.g. *best bet*), etc. A list of 178 phrases found in the literature is included in the Appendix.

### High between-subject variability

The overwhelming result of all studies has been that there is great between-subject variability in the numerical values assigned to probability terms [3] [12]. This result has been replicated even with subjects selected among experts using verbal descriptions in their work [1] . Some phrases, like *possible*, *probable*, or *predictable* were assigned values between 0.01 and 0.99 [12]. The ranks given by different subjects to verbal phrases have been found to differ, although subsets of suitably spaced phrases were ranked similarly by most people [3] [10]. High between-subject differences were attributed to individual differences in language usage and to context effects. Beyth-Marom [1] found that between-subject variability was higher within specific contexts than in context free settings.

Study of between-subject consistency in the medical field, performed by Kong, Barnett, and Mosteller [11], indicated an encouraging degree of agreement - the median values assigned to different phrases by physicians, medical students, and other professionals were almost the same. The variation in the probability equivalents observed among the results of different studies indicate the need for codification of expressions before they can be used in clinical settings. Other studies (e.g. by Beyth-Marom [1]) showed less consistent results.

### Influence of the context

Numerical probability equivalents for verbal phrases have been observed to be context sensitive. Context influences mainly the assignment of values, but it does not substantially influence the order of phrases.

An appealing example of context effect is given by Lichtenstein and Newman [12]. There is a large difference in numerical probability equivalent of the word *likely* in the following two sentences presented to English subjects: *The Labor Party is likely to win the next election*

and *We are likely to have a fine Summer* (in England!).

Wallsten, Fillenbaum, and Cox [19] demonstrated that interpretation of verbal uncertainty expressions depends on perceived base rate of the event being described.

### Within-subject consistency

Within subject variability is not minor, but it is considerably less than between-subject variability. Meanings of probability phrases to individuals, although vague, have been observed to be stable within particular contexts [16]. Subjects have been found to have a stable rank ordering of different phrases over time [3].

### Fuzziness

All studies to date agree that there is an enormous overlap among terms. The study performed by Lichtenstein and Newman [12] indicated an overlap of 0.2 even between terms like *likely* and *unlikely*. In some cases, the overlap reached 0.98! Careful selection of several words, sufficiently "apart" of each other eliminates this overlap greatly [1].

Some of the verbal expressions (e.g. *always*, *toss-up*, *never*) turn out to be interpreted very consistently among subjects. Budescu, Weinberg, and Wallsten [6] call them anchor phrases.

Lichtenstein and Newman [12] found that the probability equivalents for verbally symmetric phrases, e.g. *quite likely* and *quite unlikely*, show asymmetry.

Adverbs attached to phrases shift the phrase into higher or lower probability range. Lichtenstein and Newman [12] found the following sequence typical: *very* > *quite* > no adverb > *rather* > *fairly* > *somewhat* .

Beyth-Marom [1] and later Budescu and Wallsten [3] suggested that because of cognitive limitations seven distinct probability categories are the most humans can handle efficiently. It is arguable that it is this level of resolution that explains why verbal uncertainty expressions, with all their fuzziness, provide a satisfactory medium for communication of uncertainty.

### Other findings

It turns out that the variability (i.e. low consistency) of verbal expressions is severely underestimated by the judges themselves. Whenever a person outputs a phrase, he or she thinks that it is more precise and more extreme (i.e. farther from 0.5) than it really is.

The number of alternatives available has been observed to have a significant influence on the meaning given to the verbal phrases [14].

## Related work

Wallsten, Budescu, Rapoport, Zwick, and Forsyth [18] proposed a theory of how the numerical correspondence of verbal expressions is being selected. According to this theory, an individual when required to act on the basis of a linguistic uncertainty, selects a single probability from a set of probability values, that are sufficiently well described by the phrase. This set is essentially a membership function, similar to the functions proposed by Zadeh in Fuzzy Set Theory. Probability values described by the phrase depend on the task. Membership functions vary between subjects. Furthermore, each function has a task specific threshold. The higher the threshold, the narrower probability interval the phrase describes. To the degree that people perceive the context similarly, their interpretation of the phrase is affected similarly. The threshold value reduces the full range of vagueness to a smaller interval, that is believed by the subject to be most consistent with the communication.

Elsaesser proposed a list of relative probability comparison phrases that could be used in explanation engines of decision support systems [8].

## Open questions

An area that still needs exploration is how the verbal uncertainty expressions are processed, i.e. how will a phrase expressing person's belief change when new evidence (also expressed verbally) is presented. If verbal expression is closer to the cognitive representation of uncertainty than numerical, would people follow the normative rules of probability calculus better than when using numbers?

It would be interesting to combine the findings of the research on verbal uncertainty expressions with the research on human reasoning under uncertainty, where very often numerical probabilities were applied. An interesting question is if the biases that subjects demonstrated in those experiments would also appear when verbal expressions were used and, if yes, if their magnitude would be preserved.

Wallsten, Fillenbaum, and Cox [19] found that subjects reacted in their interpretation of verbal uncertainty expressions to the perceived base rate of the event. This result was different than the results of a large number of other experiments (see for example Tversky and Kahneman [15]) in which subjects (using numerical probabilities) were shown to be insensitive to base rates. This result is quite puzzling and certainly needs further investigation.

One of the most interesting studies on verbal uncertainty expressions involved a real decision making setting [6]. It has shown that using verbal expressions is not as inferior to numerical estimations as one would expect. Especially those subjects who chose verbal form as preferred form of communication, did just as good as those who chose numerical or graphical form. In another study, Zimmer [21] asked bank tellers to predict the exchange rate between US Dollar and German Mark one month ahead. One group was asked to make a verbal prediction (this is what his subjects usually did in their work) and the other group

was asked to give numerical estimates in terms of percentage of change. The first (verbal) group was found to be more correct and more internally consistent. Further experiments involving studies of human communication in real (decision making) settings may provide the most interesting ideas and should in my opinion be given a high priority.

## Conclusion

From the findings summarized in this paper, it is clear that verbal uncertainty expressions are not too good means of communication. Differences in interpretation of phrases between the communicating and receiving side may lead to confusion in usual communication, while giving the illusion of mutual understanding. There is a lot of anecdotal evidence supporting this. Also, Brun and Teigen [2] demonstrate this in an experiment involving physicians (general practitioners) and parents of small children. Use of numbers rather than verbal phrases eliminates this confusion.

On the other hand, it has also been observed that not all phrases are equally vague. Meaning of a small number of anchor terms is generally agreed upon and some expressions preserve between-subject ordinal relationships. One could select a reduced set of phrases whose ordinal properties are generally agreed upon and which could be used with little or no confusion. Alternatively, this subset may evolve naturally in communication. One could argue that such a serious restriction of the vocabulary would reduce discriminating power. Cognitive psychologists generally agree upon that humans cannot handle, discriminate or reliably transmit information containing too many categories. Discriminative power of the full vocabulary may be illusory. Use of verbal expressions instead of numbers in some situations allows to avoid incorrect impression of precision and implies a vagueness associated with lack of information and with subjective judgment.

Study of the area of verbal uncertainty expressions is an important direction towards understanding the cognitive representation of uncertainty.

The results of studies of verbal uncertainty expressions are still too modest to be of a practical importance. Recent work allows for some optimism. Experiments in decision making settings prove that there are situations in which verbal expressions are not inferior to numerical and graphical forms of communication.

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## Appendix: Verbal Phrases

*Letter denotes class:*

*C - comparative expressions*
*E - expectation,*
*F - frequentistic,*
*L - logical,*
*U - utility considerations*

a reasonable hope
a very real possibility
according to chance
almost always (F)
almost certain
almost impossible
almost never (F)
always (F)
as likely as not
barely possible
best bet (U)
better than even
can't rule out entirely
cannot be excluded (L)
certain
chance association
chances are
chances are not great
characteristically
classic (?)
close to certain
common (F)
commonly (F)
compatible with (L)
conceivable
consistent with (L)
consistently (L)
definite
definitely
definitely not
doubtful
effectively excludes (L)
equally likely
even odds
exceptionally
expected (E)
extremely likely
extremely unlikely
faintly possible
fair chance (E)
fairly likely
fairly unlikely
feasible
few (F)
fighting chance
frequent (F)
frequently (F)
good chance (E)
good hope (E)
great chances
half the time (F)
high chance
high probability
highly improbable
highly probable
highly unlikely
hopefully
impossible
improbable
inconceivable
inconclusive
indeed
indefinite
infrequently (F)
it could be
it may
it seems
it seems to me
less than even
less than half the time (F)
likely
low chance
low probability
many (F)
may
meaningful chance (E)

moderate probability
moderate risk
more often than not (F)
most likely (C)
nearly certain
necessary
never (F)
non-negligible chance
normally (?)
not certain
not conceivable
not definite
not feasible
not improbable
not inevitable
not infrequently (F)
not likely
not much chance
not necessary
not possible
not probable
not quite even
not unreasonable
not unreasonable
not very likely
not very probable
occasionally (F)
odds on
often (F)
on occasion (F)
on the contrary
one can expect
one must consider
one should assume
pathognomonic (?)
perhaps
periodically (F)
poor chance
positive
possible
possibly
practically all (F)
practically none (F)
predictable
pretty good chance
probable
quite likely
quite possible
quite probable
quite unlikely
rare (F)
rarely (F)
rather improbable
rather likely
rather probable
rather unlikely
reasonable chance
reasonable to assume
reasonably likely
remote possibility
seldom (F)
several (F)
significant chance
slight chance
slight odds against
slight odds in favor
slightly less than half the time (F)
slightly more than half the time (F)
small chances
small doubt
some chance
sometimes (F)
somewhat likely
somewhat unlikely
suggests
supports
suppose
sure
there is a chance
think
toss-up
typically associated (F)
uncertain
uncommon (F)
unfeasible
unlikely

unnecessary
unpredictable
usually (F)
usually not (F)
very good chances
very high chance
very improbable
very likely
very low chance
very often (F)
very poor chance
very possible
very probable
very probably
very unlikely
virtually always (F)