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Abstract

This book is a detailed semantic analysis of FQs (fuzzy quantifiers) that extends the discussion of meaning beyond what has previously been investigated, by moving from rule-based analysis of meaning to an exploration of the fuzzy nature of meaning. Original contributions of this book are: exploring the far-reaching implications of fuzzy set theory and the theories of compositionality and motivation to the study of FQs and contributing to an unconventional but better understanding of this important trend in linguistic research. This work will be of interest to those who are interested in linguistics, cognitive science, logic, and psychology alike.

Author's biographical note:

Dr. Grace Qiao Zhang received a Ph.D. degree from the Department of Linguistics, University of Edinburgh in 1996. She is now a senior lecturer in the School of Asian Studies, University of Auckland, New Zealand. She has published a number of books and papers in the research areas of fuzzy semantics, fuzzy linguistics and Chinese linguistics.

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Preface

The aim of this book is to discuss the semantics of FQs (fuzzy quantifiers), formal semantics in particular. The approach used is fuzzy semantic based on fuzzy set theory i.e. I explore primarily the denotational meaning of FQs represented by membership functions. Empirical data from both Chinese and English is used for illustration.

A distinguishing characteristic of the semantics of FQs like *about 200 students* and *many students* as opposed to other sorts of quantifiers like *every student* and *no students*, is that they have fuzzy meaning boundaries. There is considerable evidence to suggest that the doctrine that a proposition is either true or false has a limited application in natural languages, which raises a serious question towards any linguistic theories that are based on a binary assumption. In other words, the number of elements in a domain that must satisfy a predicate is not precisely given by an FQ and so a proposition containing one may be more or less true depending on how closely numbers of elements approximate to a given norm.

The most significant conclusion drawn here is that FQs are compositional in that FQs of the same type function in the same way to generate a constant semantic pattern. It is argued that although basic membership functions are subject to modification depending on context, they vary only with certain limits (i.e. FQs are motivated---neither completely predicated nor completely arbitrary), which does not deny compositionality in any way. A distinctive combination of compositionality and motivation of FQs makes my formal semantic framework of FQs unique in the way that although some specific values, such as a norm, have to be determined pragmatically, semantic and inferential patterns are systematic and predictable.

A number of interdisciplinary implications, such as semantic, general linguistic, logic and psychological, are discussed. The study here seems to be a somewhat troublesome but potentially important area for developing theories (and machines) capable of dealing with, and accounting for, natural languages.

This book is a revised version of my PhD thesis completed at the Department of Linguistics, University of Edinburgh (UK) in 1996. Since then, parts of my thesis have been published in sections of two books and three journal articles (see the References for detail).

For all the constant guidance, encouragement and stimulating discussions of my PhD thesis, the basis of this book, given me in the past years, I am immensely indebted to my PhD supervisors, Ronnie Cann and James R. Hurford. They gave

generously of their time and ideas, made numerous suggestions on improvements to my PhD thesis that have been incorporated into the final version. Ronnie Cann, especially, has carefully read every section of each earlier draft, and contributed tremendously to shape and reshape the final draft of my PhD thesis; for that I am most thankful to him.

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I am extremely grateful to the Dalian Municipal Government whose sponsorship enables the publication of this book. For the completion of my. PhD, I acknowledge the financial assistance provided by a Van Dunlop Scholarship from the University of Edinburgh (Faculty of Arts Scholarship Fund) and the ORS Awards Scheme during 1989--1992. Subsequently, I have been given financial assistance from the President's Fund of the Edinburgh Association of University Women and the Great Britain-China Educational Trust in London.

Finally, I owe much of my happy life to my parents--- Shimin Zhang and Lanyin Zhang---and all the love they give me. I thank my husband Zhigang Guan with my whole heart for his love, patience, and support; and our daughter Anne Xiaoqiao Guan for understanding that this book has taken so much of my time.

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Chapter 1 Introduction

Suppose this might happen in real life. While preparing a party, Mary asked John to buy *about 20 beers* and *a few apples*. John had to decide exactly how many beers and apples he would buy. In a shop he hesitated for a while then bought 18 beers and five apples. Once Mary saw the things John bought she seemed satisfied. Although this is a hypothetical example of communication with words like *a few* and *about 20*, in fact this kind of communication happens very often in our everyday life. If we closely examine our language, most expressions have a *fuzzy*[1] boundary. For instance, an essay could be *not bad*, a girl may be *rather pretty*, a pile of papers might be *20 or so*, and someone may have *many* friends. This kind of expression enables us to speak about a far greater variety of topics than those precise numbers would allow. The questions that arise are: what kind of linguistic theory lies behind it, and particularly what kind of formal interpretation can we come up with?

For many years it seems to have been taken for granted that propositions, at least declarative propositions, are either true or false. However, it is found that the conventional two-valued logic approach cannot accurately represent natural languages; not even three or four-valued logic can do the job properly (see McCawley (1981) for further discussion). The reason is that there are propositions denoted by sentences in natural languages that are true (or false) up to a point, i.e. neither completely true, nor completely false. For instance, in the sentence *Mary is about 20 years old*, the expression *about 20 years old* has an uncertain meaning boundary. Accordingly, its truth value could be a matter of degree. This cannot be handled by any conventional theories. Although both three-valued and four-valued logics seemingly have an undefined value to represent the degree of truth, all they do is just conflate any value which is not all-or-none type into a general category without any further structured exploration.

As an illustration, according to conventional truth conditional semantics, the sentence *Mary is about 20 years old* is true if and only if there is an individual called Mary and she is about 20 years old. This allows a biconditional statement---*u* satisfies the formula *about n(x)* iff *u* is in the set of *about n*. It leaves *about n* as an unanalysed primitive, and does little to capture the meaning of it. As Klein (1980) points out, the treatment utilizes a semantic metalanguage in which fuzzy expressions occur, and presupposes the notion of fuzziness. This kind of treatment is not particularly informative or useful. We need an account which can define expressions like *about n* adequately. FST (Fuzzy Set Theory, Zadeh 1965) can do a better job in that it captures degrees of truth, which will be demonstrated in Chapters 5, 6 and 7 below.

The study of FQs here concentrates on semantics, with little account of syntax and phonology. The

[1] Sainsbury (1991) argues that it is inappropriate to say that some concept has a fuzzy boundary, because the term *boundary* must be understood as a precise one, otherwise there is no boundary at all. Therefore, Sainsbury suggests using *boundariless*. Nevertheless, it seems to me that something with a fuzzy boundary is not the same as something without a boundary at all. Take *about 20 years old* as an example; there is uncertainty about its boundary or there is disagreement towards the precise boundary of the concept. That is, whether or not 16 or 26 is within the boundary is undetermined. However, this does not mean that the concept is boundariless, because we would not agree if one says that a one-month old baby is within the boundary of *about 20 years old*.

reason is that the very issue of FQs' semantics is so complex that it is more than enough to deal with for a book of limited length. It would be wiser to tackle one aspect of FQs adequately than to touch on several aspects superficially. However, a further study of FQs interfacing phonology, semantics and syntax would be of benefit.

In terms of organisation of the book, the presentation is in four parts. In the first part (Chapters 1 & 2) I shall give a general discussion of the issues involved such as terminology, approach and methodology, causal factors of fuzziness, and a review of previous work. Following that, the second part (Chapters 3 & 4) is a discussion of the semantics of FQs. Chapter 3 is an empirical study. Chapter 4 is a discussion of pragmatic effects and compositionality of FQs. In the third part (Chapters 5, 6& 7), a formal semantic account of FQs is proposed in which FQs are treated as fuzzy operators. The fourth part (Chapter 8) contains interdisciplinary implications and conclusions. The four parts are logically arranged. Part one provides background knowledge. Part two discusses the semantics of FQs from different aspects. Part three provides a formal framework. Finally, implications and conclusions are drawn up.

1.1. Survey of the fundamental notions

Two notions need to be clarified at the outset: *fuzzy* and *FQ*.

1.1.1. Fuzzy

How can the membership of the set of *twentyish* be defined (putting aside contextual factors: the membership of *twentyish* for a person's age and for a medical measurement could be different)? In other words, how old does one have to be to be *twentyish*? 15? 16? 17? 18? 19? 20? 21? 22? 23? 24? 25? Obviously, any attempt to fix a single answer will be impossible. Expressions like this are considered as *fuzzy* ones to which an application of a particular referent or state of affairs is not a clear-cut case.

Furthermore, such a sentence as *Mary is twentyish* may very often be neither true, nor false, nor nonsensical; but only true to a degree. For instance, if Mary is exactly 20 years old, the sentence might be 100% true. If Mary is 15 years old, the sentence might be 60% true. If Mary is 40 years old, then the sentence might be totally false. The reason is that the membership of *twentyish* is fuzzy, i.e. some elements in the domain neither definitely belong to the set nor definitely do not belong to it.

It is imperative that the concept *fuzzy* used in this discussion has nothing to do with the negative part of its literal meaning, like *misuse*, *mistaken*, or *not well defined*. In fact, the term *fuzzy* is a technical term, and has a precise definition throughout the discussion. However, it appears that the term *fuzzy* sometimes confuses people. Accordingly, it has been suggested that the term *continuous* could replace the term *fuzzy*. For example, *fuzzy logic* could be called *continuous logic*. It seems that whatever it is called makes little difference, as long as we keep it well defined

Fuzziness occurs in two layers with respect to two types of language users (individual and group). The individual type means that an FQ is defined in correspondence with an individual's view. Fuzziness occurs on an individual level, when an individual, Mary for instance, is unsure about the boundary of *a twentyish man*. The group type, on the other hand, means that an FQ is defined corresponding to the views of a group of people. An FQ may be viewed as non-fuzzy at the individual level, but not necessarily at a group level. For instance, Mary may say that an interval for *a twentyish man* is from 15 to 25; John might insist that it is from 16 to 24. What follows is that at an individual level the expression is not fuzzy at all, because Mary and John are individually certain about it. If we examine it at a group level the expression could be viewed as a fuzzy one, since Mary's and John's responses are different and they may not reach a unified decision.

It is empirically proven that fuzziness at an individual level is less than that at a group level. For example, Wallsten *et al* (1986a) conclude that the membership function of fuzzy terms is useful and reliable for individuals, rather than the group (see Section 2.2 for the details). The data in Chapter 3 also showed that there was indeed a discrepancy among the subjects in terms of intervals they designated for FQs.

1.1.2. Fuzzy quantifier

The quantifiers [2] that are most often referred to are *all, a, the, any,* and *some.* These are called *logical quantifiers,* because their meanings are not context-dependent. What I intend to explore here is another kind of quantifier, known as *FQs,* which is context-driven. The generic term FQ covers a collection of quantifiers whose representative elements are: *several, many, few, a few, about 10, approximately 5, nearly 10, 10 or so, 10-odd* and *3 or 5.*

An FQ is defined here as a quantifier which has no clear-cut meaning boundary in terms of what precisely the number should be. What is special about an FQ is that it generates, in an approximate fashion, a set of numbers. For instance, when John says that Mary is *20 or so,* he means to say that Mary's age is within a permissible latitude (i.e. a possible interval which is appropriate for an FQ) allowed by *20 or so.* We may say that *20 or so* is certainly less than *2,000 or so,* or *There are many students in the hall* logically entails *There are several students in the hall.* However, we are less sure about the precise boundaries of *many* and *20 or so.*

FQs have the property of being context-dependent. For instance, *many* may be interpreted differently in the following two sentences: *Many people are in my room* and *Many people are in Tian An'men Square.* Due to the different sizes of *my room* and *Tian An'men Square, many* would be interpreted as having a narrower interval in the former than in the latter (see Section 4.1.2 for further discussion). We term quantifiers like *many* as non-standard quantifiers or non-logical quantifiers in the sense that they are context-dependent, as opposed to so-called logical quantifiers (e.g. *all, a, the*). They are also called natural language quantifiers (e.g. Moxey and Sanford, 1993b). It should be noted that FQs are typical natural language quantifiers rather than atypical, since there are many more FQs in natural languages than so-called logic quantifiers.

There are four concepts, fuzziness-vagueness-generality-ambiguity, that are different in many ways. As suggested in my paper (1998d), generality, vagueness, and fuzziness are under-determined, and ambiguity is over-determined. It is claimed in the paper that fuzziness differs from generality, vagueness, and ambiguity in that it is not simply a result of a one-to-many relationship between a general meaning and its specifications; nor a list of possible related interpretations derived from a vague expression; nor a list of unrelated meanings denoted by an ambiguous expression. Fuzziness is inherent in the sense that it has no clear-cut referential boundary, and is not resolvable with resort to context, as opposed to generality, vagueness, and ambiguity, which may be contextually eliminated. See Zhang (1998d) for a detailed discussion.

1.2. Types of FQs

The types of FQs are examined in terms of the way they are constructed. There are three types of FQs which will be discussed in this work.

1.2.1. The three types

Table 1.1: Types

Type I: few, a few, many, a lot
Type II: about n, n or m, n-ish, nearly n, n or so, n-odd
Type III (semi-FQs): fewer than n, more than n, at least n.

(*n* and *m* indicate numerals.)

[2] In this book, the term *quantifier* is used as defined in Barwise and Cooper (1981), where a quantifier is a noun phrase: determiner + noun. However, for the convenience of exposition, I may leave the noun out from time to time.

In terms of Type I FQs, more can be listed: *not quite all, nearly all, most, very many, an awful lot, a majority, a comfortable majority, quite a lot, quite a few, several, not a lot, not many, only a few, hardly any, very few.* I will only investigate a proportion of these FQs listed. FQs in Type I do not have numerals like *n* and *m* which occur in Types II and III. For example, in *about 20*, *20* is a number required for FQs in Types II and III. The number could be a single number like *20* in *about 20*, or two numbers like *20* and *30* in *20 or 30.*

In terms of the semantics of the three types, most of the FQs in Type I are proportional, except FQs like *several* and *a few* (at least, the two have less sense of proportion). FQs in the other two types are cardinal. Generally speaking, proportional FQs are semantically more complex than cardinal FQs. That is because a cardinal FQ decides whether a set has certain properties based on the number of entities in the set. However, a proportional FQ also has to consider the relation between the sets involved. For instance, we may interpret *about 20 students left* by just checking how many students left. With *Many students left*, we also need to decide whether or not the set of students who left, compared to some norm in a given context, is a significant number. The interpretation of proportional FQs requires more than just checking some straightforward numbers in a relevant set. I will elaborate on this throughout the following discussion.

In terms of construction, some FQs of Type I have only one element (besides the common noun), like *many*. On the other hand, FQs in Types II and III must have more than one element: approximator (e.g. *about*) + numeral (e.g. 200) (see Section 1.2.2 for a definition of *approximator*). Approximators have to appear with numerals to result in approximations. It is clear that this constraint applies equally to all the approximators that fall into Types II and III, such as *nearly, or so, odd* and *more than*. However, FQs in Type I do not have the form of approximator + numeral, a form that FQs in Types II and III must have.

A difference between Type III and the rest is that the former may, in a mathematical sense, have a clear-cut boundary. For instance, we may say that *more than 20* has a precise interval: from *20* to *positive infinity*. However, in ordinary language *more than 20* would be understood as an FQ having a fuzzy interval, just like any other FQs. That is the reason I consider FQs of Type III as semi-FQs, which will be discussed fully in Section 3.2.3.

1.2.2. Adaptor and fuzzifier

Approximators[3] are of two types: adaptors and fuzzifiers. An adaptor operates on an item to modify it to a certain extent, and is exemplified by *sort of*[4] and *very*. On the other hand, a fuzzifier operates on an item resulting in a fuzzy expression, and is exemplified by *about* and *or so.*

What differentiates an adaptor from a fuzzifier is that an adaptor operates on an item which is a fuzzy expression. All it does is alter the meaning of the fuzzy expression to a certain degree. For example, the adaptor *very* in *very many* may alter the original fuzzy meaning of *many* to a certain degree, i.e. intensifying it. A fuzzifier, however, operates on an item which is a non-fuzzy expression. What a fuzzifier does is create a fuzzy meaning. Thus, the fuzzifier *about* combines with an exact number *200* to result in an FQ denoted by *about 200*, i.e. *about* makes the meaning boundary of *about 200* fuzzy. In other words, adaptors can only make a quantity change while fuzzifiers can make a quality change. Most approximators, such as *very, about,* are function words---words without contentive elements. They do not denote entities, i.e. they do not denote individuals (e.g. the word *table* denotes a class of individuals) or events (e.g. the word *festival* denotes a class of events).

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[3]Approximators are also termed as *approximatives* in Moxey and Sanford (1993b) and Wierzbicka (1986). For instance, for *about 20*, *20* is the numeral, and *about* is the approximative.

[4]I would draw attention to a subtle difference between the two readings of *sort of*: *sort of* (*kind of*) and *sort of* (*somewhat* or *to a modest extent*). For instance, *a sort of bird* means a kind of bird, whereas *sort of a bird* means somewhat a bird. In this book, *sort of* is used consistently to mean *somewhat* or *to a modest extent.*

Usually, an approximator has only one function, either as an adaptor or a fuzzifier. However, there is at least one exceptional approximator: *-ish*, which has a dual function. For instance, if *–ish* combines with a non-fuzzy expression like in *twentyish*, it acts as a fuzzifier; whereas it could also modify a fuzzy expression like *reddish*, in which it acts as an adaptor.

Fuzzifiers tend to appear with numbers. Anywhere that a number occurs, a fuzzifier can be added to the number and result in an FQ, except where *exactly* or something like that is used. For instance, *I have been in Britain for about four years* can still be acceptable and meaningful without the fuzzifier *about*. It is in this sense that I term *about* and the like as fuzzifiers which bring a fuzzy reading to expressions and propositions which would otherwise usually be precise[5].

Adaptors rarely combine with an FQ formed by a fuzzifier. For example, we do not say *sort of about 200*, where *sort of* is an adaptor and *about* is a fuzzifier. One thing both adaptors and fuzzifiers have in common is their effect on the truth values of the propositions associated with them. For instance, the truth value of the proposition *198 is 200* would be false; *198 is about 200* may be true. Also, the truth value of *Steam is a gas* would be different from the truth value of *Steam is sort of gas.* Jim Miller (personal communication) points out that the latter assertion places the steam on the periphery of the set of gas, whereas the former assertion leaves it open how central steam is in the set. As Prince *et al* (1980) suggest, the addition of an approximator to a proposition *Pi* results in the formation of a proposition *Pj*, where $i \neq j$.

My definitions here are in the same vein as in Prince *et al*(1980). They define an approximator as affecting the propositional content, either by *adapting* a term to a non-prototypical situation (e.g. *sort of a bird*) or by indicating that some term is a *rounded-off* representation of some figure (e.g. *about 20*). In their terms approximators differ from what they called shields, which affect the degree and type of speaker-commitment that is inferred by implicating that the speaker is uncertain because she/he speaks from knowledge or beliefs acquired via *plausible reasoning* or that she/he has no direct knowledge but is *attributing* the belief to a particular other. Prince *et al*'s idea is illustrated as:

Hedge: Approximator + Shield
Approximator: Adaptor (*sort of, somewhat, a little*, etc) + Rounder (*approximately, about, essentially*, etc)
Shield: Plausibility (*I think, probably, seem to*, etc) + Attribution (*according to her, estimates, presumably*, etc)

It is claimed by Prince *et al* that approximators affect the truth condition of the propositions associated with them. Adaptors and rounders all implicate non-prototypicalness. In contrast, shields do not affect the truth condition of the propositions associated with them. Thus, the truth value of *A robin is a bird* and *I guess/according to Mary a robin is a bird* shall be the same. The only effect of the latter is that the speaker implicates that she/he is not fully or personally committed in the usual or *unmarked* way to the belief that the relevant state of affairs actually pertains. Shields are not my interest here---we will concentrate on approximators.

1.3. Causal factors for fuzziness

In this section the matter of where fuzziness comes from will be discussed. Through the discussion the nature of the semantic imprecision of FQs will be revealed. It is expected that clarification of this will deepen our discussion of the semantics of FQs.

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[5]It is noted that even exact numbers may be understood as fuzzy. For example, often the sentence *I have been in Britain for 4 years* may well mean no more than *I have been in Britain for about 4 years*, i.e. the fuzzifier is unstated in the former sentence but implied by the context or understood by people.

Ullmann (1962: 118) delineates the following causal factors of fuzziness:

1. Generic character of words;
2. Meaning is never homogeneous (i.e. it is context-bound);
3. Lack of clear-cut boundaries in the non-linguistic world;
4. Lack of familiarity with what the words stand for.

He explains (1) as words referring to "not single items but classes of things or events bound together by some common elements". For instance, the word *bird* generates a set of objects where "to have feathers" could be considered as a common element. But, the objects in the set differ in some other aspects, and we do not have a precise concept to represent them. This is seen as a conflict between language, thought and the world, which will be discussed in Section 1.3.1.

Factor (2) shows that interpretation of meaning is context-dependent; Ullmann's implication is, as Channell (1983) points out, that ultimately exact interpretations will appear. In fact, this might not necessarily be the case for fuzziness. For instance, it is suspected that the meaning of *There are about 10 people in the classroom* may not be precise no matter what kind of context it is put into.

Factor (3) says that fuzziness is caused by the real world. Contrary to this, it is claimed in Section 1.3.1 below that fuzziness is not a characteristic of reality. Factor (4) says that the reason for the existence of fuzziness is that we are unfamiliar with what the words stand for. A word could be unfamiliar to a child, a foreigner, or even a native adult speaker. If we do not know what a word stands for then we do not know its meaning. However, this is not a causal factor for fuzziness defined in this work. I define *fuzzy* as a technical term; it means an expression has no clear-cut meaning boundary. For example, we may be absolutely sure about the meaning (definitional meaning, to be precise) of *city*, but we are less sure whether or not a particular place qualifies as a city. This kind of fuzziness differs from a situation where a particular person happens to not know what the word *city* means at all. So, factor (4) does not seem to be a causal factor, as far as the definition of fuzziness in my terms is concerned. Next, we shall discuss a number of causal factors for fuzziness.

1.3.1. A language concept

This section explores the issue of fuzziness as a language concept rather than a property of reality. It is argued that fuzziness exists because thought, language, and the world do not allow definitive mappings, since they consist of entities of different types.

Locke---the 17th century philosopher of language and mind, author of the Essay Concerning Human Understanding---did not believe that language is divine and natural. He claimed that people, who sort and dominate objects by the sensible qualities which they find in them, create language. Lack of a universal understanding of the world leads to a lack of accurate and sharp criteria for defining the denotation of expressions (e.g. *twentyish*). That is, fuzziness seems to emanate from people's minds. More specifically, fuzziness is caused by human indecisiveness in applying a linguistic item to some element of a domain.

Locke devised in Book Three of the Essay an account of meaning which he called *semantic individualism*. That is, the interpretation and understanding of meaning depend on each individual. Moreover, meaning varies in different situations. Locke claimed that each individual understands words in his own particular way, owing to the impenetrable subjectivity of ideas to which words are tied. Fuzziness is indeed associated with subjectivity, since comprehension of the same expression depends greatly upon our backgrounds, world knowledge and experience. For example, answers to the question *Is Mary beautiful?* may differ according to people's

varying aesthetic criteria; our differing tastes enhance different aspects of a meal.

Taking Locke's semantic individualism as a basis, it appears that because each individual has his own understanding of meaning, semantic imprecision inevitably occurs. Furthermore, even with one individual there might also be inconsistencies in interpretations as a result of having no clear-cut criteria in defining fuzzy expressions.

Goocher (1965) provides empirical evidence which suggests that people's inferential activities indeed cause fuzziness in terms of interpretation of expressions like *often* and *seldom*. Take *going dancing* as an example; those who disliked and had little experience of the activity tended to give higher frequency quantifiers than those who enjoyed and had more experience of it. For the former, going dancing once a week might be *often*, but it might be *seldom* as far as the latter is concerned [6].

However, there is a view claiming that fuzziness is a characteristic of reality. For instance, Ullmann (1962) says that one of the four causal factors for fuzziness is "lack of clear-cut boundaries in the non-linguistic world." An example is *sea water*. Generally speaking, *sea water* means the salt water in the sea. However, the sea water in the natural world is usually mixed up with rain water and water of other kinds. Thus, the distinction of sea water is difficult to make in practice. Objective fuzziness is even adopted as the basis of an ancient fable. Once, Aesop's drunken master made an unrealistic promise that he would drink up all the sea water. When he sobered up, he turned to Aesop for help. The suggestion given by Aesop was to quibble that what the master had promised was to drink unadulterated sea water, but the water in the sea was actually not pure. Aesop took advantage of the fuzziness of *sea water* to save his master from embarrassment by confronting people who were waiting by the seashore.

I do not agree with the assumption that the fuzziness of *sea water* comes from the fact that sea water itself is fuzzy. Sea water itself, like anything else in the world, is just physical stuff. It is neither fuzzy nor precise, it just exists in the world. The fuzziness of the expression is caused by the fact that people are not capable of defining it a precise denotation, at least in ordinary language. That is, the fuzziness of *sea water* is caused by providing no sharp criterion for defining the concept. Similarly, we can say that the expression of *a tall man* is fuzzy, but not that the man himself is fuzzy just because we are not sure whether he is tall or not.

Opposing the view that there are fuzzy objects in the world is the view that the world is precise. Tye (1990) disagrees with the view that the world is precise, as do I. However, I do not incline to believe his view that there are fuzzy concrete objects in the world. Tye is in favour of Ullmann's idea mentioned above. The example Tye gives is Mount Everest. He thinks that there is no line which sharply divides the matter composing Everest from the matter outside it. Therefore, Everest's boundary, in Tye's view, is fuzzy, i.e. Mount Everest is a fuzzy object. He says: "Let us hold that something *x* is a borderline of *F* just in case *x* is such that there is no determinate fact of the matter about whether *x* is an *F*". (1990: 535-536)

How could we know that a concrete object has borderline parts? Tye does not elaborate on this. Is it somehow that the object itself illustrates it? We have little evidence to say so. A reasonable explanation seems to be that only human beings can set up some criteria by which those concrete objects are classified and accommodated. Consider Mount Everest again. The reason for its physical boundaries not being precise is, as Tye says, that there is no line which sharply divides the matter composing Everest from the matter outside it. Then, Tye draws his conclusion that Mount Everest itself is fuzzy. However, it is obvious that Mount Everest itself cannot possibly draw any line---precise or fuzzy. It is we, as human beings, who give criteria to the concept of *Mount*

[6] Newstead (1988: 59) comments that it is possible that this finding is a special case of an effect of the expected frequency, since those who like the activity or indulge in it regularly might have a higher expected frequency for such an event. For more discussion on the role of expectation of language users, see Section 2.4 and Section 4.1.2.

Everest. Mount Everest is fuzzy because we cannot reach an agreement on its denotation, but Mount Everest itself is just something which unconsciously exists in the world.

Another example is *rainbow*. Although using a kind of non-ordinary language, physicists may somehow be able to identify the denotation of *rainbow*; in ordinary language, it is fuzzy. In terms of the visual colour spectrum we cannot decide precisely where the edge of a rainbow is, i.e. there are bands, but no bounds. It again appears that the object in the world being called *rainbow* is neither fuzzy nor precise, just something in the sky. When people try to identify the edge of it, they may not come to an agreement. So, it is the expression of *rainbow* that is fuzzy, rather than the object itself. My view is shared by Russell (1923), Black (1937), Fodor (1977), Fine (1975), Danell (1978), and Schmidt (1974). They all agree that fuzziness is a phenomenon of language, not of reality. Moreover, even if our perception of something (e.g. *rainbow*) in the world were absolutely accurate, language communication of such information could not be (see the next section for the details).

To sum up, it is claimed that fuzziness is a property of language and human inferential activity, but not a property of concrete objects in the real world. Fuzziness is due to the fact that there is no precise correspondence, i.e. a mismatch, among human thought, language and the real world; they are different in various aspects. As far as linguistics is concerned we say that the denotation of an expression is fuzzy, and is a matter of linguistic categorisation. Cognitive property may be significant in the way the world is structured by humans, but fuzziness (in denotation) is essentially a linguistic concept.

1.3.2. Lack of need for preciseness

In this section, we discuss the lack of need for preciseness in language. Consider the sentence, *Mary is twentyish*, which has a fuzzy meaning. In communication, there may be no need to make the sentence precise after all. That is, this fuzzy sentence may just serve our communicational purpose well; a precise sentence is simply not required. Another example is Mount Everest. It is true that there is no sharp criterion to decide where to draw a line which divides the matter composing Mount Everest from the matter outside it. Nevertheless, the fact is that there is usually no need to do so in day-to-day conversation anyway.

This factor is compatible with Grice's (1975) conversational principles. He outlines *cooperative principles* which see certain *maxims* followed in conversational situations:

Maxim of Relevance: Do not say something that is not relevant.
Maxim of Quantity: Do not say more than you need to say. (1.1)

In the case of fuzziness, the two maxims play a key role; in particular, the Maxim of Quantity, i.e. people should not say more than they need to say.

Then, the question is how people communicate with each other appropriately if Locke's account of *semantic individuality* (see Section 1.3.1 for more details) is the case. In other words, how can an individual elicit a common meaning which can be understood by other people? On this point, Locke presented an account of *secret reference*. What he meant by this is that there is a presupposition of meaning among people, by which they can understand each other up to a point. Locke thought that each individual has a private language that might make absolutely adequate communication difficult, but it does not mean that people cannot communicate at all. Language users have a common *secret reference* that makes communication in an approximate fashion possible.

Empirically, Locke's *secret reference* account is verified in our tests. It was found that there was a high agreement on typical members of an FQ. For instance, in Channell's (1983) test, most subjects agreed that 15 was in the meaning boundary of *about 15 people*, i.e. 15 was considered as a prototype. The test results showed that the fuzziness tended to emerge in a peripheral