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# A Model-Theoretic Approach to A-Not-A Questions

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## 1. Introduction

To form an A-not-A question for a simple declarative sentence like

(1) Zhangsan pao
Zhangsan run
'Zhangsan runs.'

what one needs to do is copy the verb *pao* (run) and place the negative *bu* between the two verb forms.

(2) Zhangsan pao bu pao?
Zhangsan run-not-run
'Does Zhangsan run or not run?'

Of concern to me in this paper is that the A-not-A question exhibits an intriguing, but hitherto unnoticed, property, viz., unlike a Y/N question, it cannot take a quantified NP in subject position. This paper is organized as follows: In section 2, I will first present the facts and then propose a model-theoretic analysis for them along the lines of Higginbotham (1993). In section 3, I will consider an

[1] This is part of a longer paper presented at both the 21st Penn Linguistics Colloquium and the 16th West Coast Conference on Formal Linguistics. The issue addressed here is more general in that the A-not-A question is not only incompatible with a quantifier in subject position, but also incompatible with such quantifying elements as modal adverbs, frequency adverbs and focus particles. For a fuller discussion of the phenomena, see (Wu, 1997). I am deeply indebted to Norbert Hornstein for his help and guidance at every stage of preparing this article, without which it would not have come into existence in the first place. I would also like to express my thanks to Juan Uriagereka whose comments provoked me to think more carefully about some of the issues. Finally, I would like to thank the participants of the two conferences for their valuable comments and suggestions.

apparent counterexample: an "A-not-A question" formed by reduplicating the copula instead of a main verb (henceforth B-not-B questions) is not subject to the above restriction. I will show that the B-not-B question and the Y/N question are of the same semantic type, and then provide an explanation for why they can be exempt from the above restriction.

## 2. A Model-Theoretical Analysis

In this section, I will first present the relevant facts and then take a quick look at how referential NPs differ from quantified NPs in terms of interpretation. I will further propose a semantic analysis of the A-not-A question along the lines of Higginbotham (1993) and Karttunen (1977). Finally, I will give a model-theoretic account of how the above restriction follows.

### 2.1. Facts

(3) a. ?meigeren dou pao bu pao?
   everyone all run-not-run
   'Does everyone run or not run?'
b. *you ren pao bu pao?
   someone run-not-run
   'Does someone run or not run?'
c. *mei you ren pao bu pao?
   no body run-not-run
   'Does nobody run or not run?'

(3a) in which the universal quantifier occupies the subject position is deviant, if not totally unacceptable. (I conjecture that this is because *meigeren* (everyone) is ambiguous between being a quantifier and a group-denoting NP, an issue I will return to in later discussion.) (3b,c), where the existential quantifier and its negative counterpart take the respective subject position, are completely unacceptable.

Note that the corresponding Y/N questions are perfectly acceptable. The question, then, is where this restriction comes from and why the same restriction does not apply to the Y/N question, to which I will turn in what follows.

### 2.1. Referential NPs Vs. Quantified NPs

On the model-theoretic view, to know the meaning of a sentence is to know what this sentence denotes, i.e., in what state of affairs this sentence can be true. To know the denotation of a sentence, one also has to know the denotations of its components. A simple sentence like *John runs*, for example, is made up of two components *John* and *run*. What does *John* denote and what does *run* denote? We can take *John* to denote an entity, some kind of thing, and *run* a set of things that run. To evaluate the truth-value of this sentence, we verify whether *John* is in the set of things that run. If it is, the sentence is true; otherwise it is false. A proper name like *John* is assigned a type $< e >$.

A very important insight, originating with Frege, is that a quantified expression, unlike a proper name, does not denote an entity. Rather, it denotes a set of sets. To evaluate the truth-value of a quantified sentence like *Everyone runs*, we need to verify each member in the people set to see if he or she is in the set of things that run until we exhaust every member in the set. If it turns out that every member of the people set is in the set of things that run, the sentence is true; otherwise it is false. In other words, we verify whether the people set is a subset of the runner set. In (4) Y denotes a set of people and X a set of runners and the sentence is true iff Y is a subset of X; otherwise it is false.

(4) EVERY (Y) (X) iff $Y \subseteq X$

To evaluate the truth value of an existentially quantified sentence like *Someone runs*, we verify each member of the people set to see if there is at least one member in the set of things that run. (5) is its verification procedure.

(5) SOME (Y) (X) iff $Y \cap X \neq 0$

Y denotes a set of people and X a set of runners. The sentence is true iff the intersection of Y and X is not empty. In other words, the sentence is true iff there is at least one member in Y that is in X; otherwise it is false.

To evaluate the truth value of a sentence involving a negative existential quantifier like *No one runs*, we go through each member of the people set to see if there is any in the set of things that run. (6) is its verification procedure.

(6) NO (Y) (X) iff $Y \cap X = 0$

Y denotes a set of people and X a set of runners. The sentence is true iff the intersection of Y and X is empty, that is, if no member of Y is in X; otherwise it is false.

So, unlike a referential NP, a quantified NP denotes a function from a VP denotation to a sentence denotation, namely, a set of sets; thus, it is assigned a type <<e,t>,t>. This distinction, as we will see, plays a crucial role in the proposed analysis of the restriction under discussion.

### 2.2. Where Does this Restriction Come From?

To see where this restriction comes from, let us first look at the semantic structure of an A-not-A question. Following Higginbotham's (1993) treatment of questions, I propose that an A-not-A question is a partition of the possible states of affairs into two mutually exclusive but jointly exhaustive cells, according to which the simple A-not-A question in (2) will have the partition in (7).

(7) {{Zhangsan pao} | {Zhangsan bu pao}}
Zhangsan runs Zhangsan does not run

To answer an A-not-A question we pick one of the cells as true and reject the other as false. In a sense, we make a choice between two complementary cells. To capture this in formal terms we may give the following logical form to (2) by employing Karttunen's analysis of questions.

(8) {P| E(c) (P=^ c ((Zhangsan → (pao / bu-pao)) & true (P))}

(8) is a set of true propositions such that there is a choice function **c** that applies to the output of mapping *Zhangsan* onto the predicate set *pao* (run) and its complement set *bu-pao* (not run).

An A-not-A question like (2) is well-formed because its subject is a referential NP, which, as noted above, denotes an entity, and mapping an entity onto the predicate sets as such gives us exactly two mutually exclusive and jointly exhaustive cells. The two cells represented in (7), for example, are mutually exclusive in that only one of them can be true, and they are also jointly exhaustive in that together they cover all the possible states of affairs. In other words, there is no third possibility in terms of whether *Zhangsan* runs or not. As such, we can properly apply the requisite choice function, the one picking one of the cells as true while rejecting the other as false.

However, when an A-not-A question takes a quantified NP in its subject position, this choice function cannot be properly applied. This is so for the following two reasons.

First, an A-not-A question having a quantified NP in its subject position, if interpreted, might partition the possible states of affairs into more than two cells. As noted earlier, a quantifier denotes a set of sets, and to interpret it we permute each member in the NP set and map them onto the predicate set sequentially. As a result, the set members might be split in that some of them belong to the predicate set and some to its complement set. Given a model having two members in the set, say, John and Mary, the partition may generate three cells in terms of whether or not they belong to the predicate set, say, *run*.

(8) a. Positive Cell: {John ran, Mary ran}
b. Negative Cell: {John didn't run, Mary didn't run}
c. Mixed Cell: {either John or Mary ran, but not both}

Second, the negation contained in an A-not-A form is morphological, combining with the following verb to form a complex predicate of some sort. This entails that the negation takes scope over the following predicate only, just like *un* in the word *unhappy*. Whether a negation takes narrow scope (over a predicate only) or broad scope (over an entire sentence) has no effect whatsoever on the interpretation of a sentence when its subject is a referential NP. However, when a subject is a quantified NP, it does have an effect on the interpretation of a sentence. For example, the following two formulae are logically different.

(9) a. $\neg\forall x\ (Px)$
b. $\forall x\ (\neg\ Px)$

(9a) says it is not the case that for every x, x belongs to the predicate set P; (19b) says for every x it is not the case that x belongs to the predicate set P. What is crucial for our analysis is that, since the negation contained in the A-no-A form takes narrow scope, the potential negative answer to a quantified A-not-A question like (3a) would be logically equivalent to (9b), not to (9a). Consider (10).

(10) a. meigeren dou pao
everyone all run
'Everyone runs.'
b. meigeren dou bu pao.
everyone all not run
(i) 'No one runs.'
(ii) *'Not everyone runs.'

(10a,b) are affirmative and negative answers to the A-not-A question in (3a), respectively. Note that the only possible interpretation of the negative answer in (10b) is as indicated in (i), which, if translated into a logical formula, would correspond to (9b). The affirmative answer in (10a), if translated into logical formula, would correspond to (11).

(11) $\forall x\ (Px)$

Crucially, the logical relation between (10a) and (10b) is what logicians call 'contrary'; and if two propositions are contrary to each other, both may be false.

Bearing this in mind, we are now in a position to see where the restriction comes from. Given the model described in (8), if the positive cell or the negative cell corresponds to the true state of affairs, we can give the affirmative answer in (10a) or the negative one in (10b), respectively, without invoking any interpretive problem. But, if the mixed cell happens to correspond to the true state of affairs, we are caught in a dilemma, for we can neither give the affirmative answer, nor can we give the negative one, since both turn out to be false in this situation. Consequently, we are not able to assign the requisite choice function, as this function requires that one of the possible answers be true and the other false. Thus, the two possible answers are not jointly exhaustive in that they leave the mixed cell uncovered.

In a similar vein, we can explain the unacceptability of the A-not-A question in (3c) whose subject NP is a negative existential quantifier. Again, given the partition in (8), if the positive cell corresponds to the true state of affairs, we can respond to it by employing the negative answer as indicated in (12).

(12) meiyou ren bu pao.
no one not run
'Everyone runs.'

If the negative cell corresponds to the true state of affairs, we can respond by employing the affirmative answer as indicated in (13).

(13) meiyou ren pao.
no one run
'No one runs.'

The problem is if the mixed cell happens to be true, neither of the two possible answers in (12) and (13) can truthfully represent it. As such, no answer can be given, and the requisite assignment of the choice function is therefore blocked.

The problematic situation with the A-not-A question in (3b) whose subject NP is an existential quantifier is reversed. The two possible answers are given in (14).

(14) a. you ren pao
someone run
'Someone runs.'
b. you ren bu pao
someone not run
'Someone does not run.'

If the positive cell holds true, we can give the affirmative answer in (14a); if the negative cell holds true, the negative answer in (14b), though both are weak assertions with respect to the situations they represent. What poses a problem is the situation in which the mixed cell holds true. In this case both the affirmative and the negative answers would be true: the former would be true because one of the two members belongs to the set of things that run; the latter would be true because one of the two members belongs to the set of things that don't run. As a consequence, the two answers are not mutually exclusive and the requisite choice function thus cannot be assigned, for this function is intended to reject one of the two possible answers as false while picking the other as true.

In short, the semantic anomaly of A-not-A questions like (3) is caused by the fact that they partition the states of affairs into more than two cells and therefore the two possible answers cannot be jointly exhaustive or mutually exclusive.

At this point, the natural question to ask is why Y/N questions do not suffer from this restriction. I will defer this discussion until Section 3.

### 2.3. Some Further Issues

Some further evidence that can be brought to bear on this issue is the following contrast:

(15) a. tamen pao bu pao?
they run-not-run
'Do they run or not run?'
b. naxie xuesheng pao bu pao?
those student run-not-run
'Do those students run or not run?'
(16) a. ?tamen dou pao bu pao?
they run-not-run
'Do they run or not run?'
b. ?naxie xuesheng dou pao bu pao?
those student all run-not-run
'Do those students run or not run?'

In both (15) and (16) the subject is a group-denoting NP. While the examples in (15) are perfectly acceptable, those in (16) in which the group-denoting subject is followed by an extra *dou* (all) are deviant.

There is not much to say about the acceptability of (15) except to point out that a group-denoting NP by itself is nonquantificational, i.e., to interpret it we do not go through each member in the group, rather, we take the group as a whole and map it onto the predicate set in the same way as we do with a proper name. Let us take (17) for illustration.

(17) a. Everyone runs.
b. They run.

To interpret (17a) we permute the NP set and map its members onto the predicate set sequentially. For the sentence to be false it suffices to have only one of the members in the NP set that does not belong to the predicate set. To interpret (17b) we map the group denoted by *they* onto the predicate as a single entity. Thus, for the sentence to be false, it has to be the case that none of the members in the group runs. What this means is the group members cannot be split like the set members. Given this, we can conclude that the examples in (15) are good for the same reason that (2) is good.

The question which concerns me is where the deviance detected in (16) comes from. To answer this question, let us consider what *dou* contributes to the semantics of a group-denoting NP.

(18) a. tamen mai le yi ben shu
they buy ASP one CL book
'They bought a book.'
b. tamen dou mai le yi ben shu
they all buy ASP one CL book
'They each bought a book.'

(18a) and (18b) are identical except that the latter has an extra *dou*. As indicated by the English translation, *dou* adds distributivity to the interpretation of a sentence. Thus, (18b) means each group member bought a book, and if there were three members in the group, then there were altogether three books being bought. The *dou*-less version in (18a), however, can only mean that they, as a group, bought one and only one book. This suggests that *dou,* somehow, turns a group-denoting NP into a universal quantifier. If this is what happens, then the deviance in (16) is expected on the present analysis.

## 3. A Counterexample?

As noted at the outset, forming an "A-not-A question" by reduplicating the copula *shi* (be), instead of a main verb (henceforth B-not-B questions), will render all the otherwise unacceptable sentences acceptable. I will argue that the negation in a B-not-B question is sentential, which enables it to avoid the restriction in question.

### 3.1. B-Not-B Questions

Let me present the facts first.

(19) a. shi-bu-shi meigeren dou pao?
be-not-be everyone all run
'Is it the case or not that everyone runs?'
b. shi-bu-shi you ren pao?
be-not-be someone run
'Is it the case or not that someone runs?'
c. shi-bu-shi meiyou ren pao?
be-not-be no one run
'Is it the case or not that no one runs?'

By contrast to (3), the B-not-B questions in (19), though having quantified NPs in subject position, are perfectly acceptable.

### 3.2. Why is the B-Not-B Question Different?

Why can the B-not-B question be exempt from the restriction we have discussed so far? To see where the answer lies, let me first point out two crucial facts with regard to the B-not-B question. First, as shown in (19), the be-not-be form precedes a quantified subject NP, if not, unacceptability ensues:

(20) a. *meigeren dou shi-bu-shi pao?[2]
everyone all be-not-be run

[2] The be-not-be form can go between *meigeren* (everyone) and *dou* (all):
a. meigeren shi-bu-shi dou pao?
everyone be-not-be all run

b. *you ren shi-bu-shi pao?
   someone be-not-be run
c. *meiyou ren shi-bu-shi pao?
   no one be-not-be run

In contrast, if the subject is a referential NP, the be-not-be form can either precede or follow it:

(21) (shi-bu-shi) Zhangsan (shi-bu-shi) pao?
be-not-be Zhangsan be-not-be run
Is it the case or not that Zhangsan runs?

Under the generally accepted assumption that Chinese surface ordering reflects its quantifier scope I take this to mean that the negation contained in the be-not-be form must take scope over the quantified subject NP.

The second important fact is that the copula *shi* (be) used to form the be-not-be complex is used as a tag to answer a Y/N question in Chinese. What this suggests to us is that the be-not-be complex is formed by conjoining both the affirmative and negative tags. What does a tag do? If we think of a tag as a sentential operator, then, an affirmative tag is an affirmative operator that binds a proposition that follows; likewise, a negative tag is a negative operator that binds the same proposition. Given the fact that the be-not-be form is nothing but a conjunction of the affirmative and negative tags, I suggest, along the above lines, that to interpret a B-not-B question, we assign a choice function to two complementary operators, which means we choose between two complementary sentences. I propose the logical form in (22) for the B-not-B question in (19a).

(22) {P| E (c) (P= ^ (c(y v n) meigeren dou pao) & true(P))}
everyone all run

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But, this does not affect the generalization made here if the real universal quantificational force is thought of as coming from *dou* rather than *meigeren*, an assumption that has its validity, as *meigeren* can never appear without *dou*.

(22) is a set of true propositions P such that there is a choice function **c** that applies to the two sentential operators **y** (affirmative) and **n** (negative). Either one of them can be chosen to bind the proposition that follows. If this analysis is correct, then it explains why a B-not-B question can be answered by employing either the affirmative tag *shi* (be) or the negative tag *bu-shi* (not be) without necessarily repeating the propositional content, assuming that the propositional content that either sentential operator ranges over is implicitly understood.

It looks like the B-not-B question is semantically similar to the Y/N question rather than to the A-not-A question. First, both the B-not-B question and the Y/N question can be, or rather, must be answered by employing either the affirmative tag or the negative tag, but the A-not-A question cannot. Second, if a tag is a sentential operator, as I claimed above, then in answering a Y/N question, we will do the same thing as we do for a B-not-B question. That is, we allow a sentential operator, either affirmative or negative, to have broad scope over an entire sentence, and for that matter, over a quantified expression contained therein. Consider how you answer a Y/N question like (23) negatively .

(23) Does everyone run?

The appropriate one would be (24a), not (24b).

(24) a. No, not everyone runs.
b. ?No, no one runs.[3]

For a similar reason, the appropriate negative answer to the B-not-B question in (19a) would be (25a), not (25b).

(25) a. bu, (bu shi meigeren dou pao).
no, not be everyone all run
'No, (not everyone runs).'

[3] The oddness comes from the fact that it somehow challenges the presupposition that the question has.

b. *bu, (meigeren dou bu pao).
no, everyone all not run
'No, (no one runs).'

In both the appropriate answers the negation takes scope over the quantifier, which, as we will see shortly, is crucial to the proposed solution.

In short, the B-not-B question and the Y/N question are of the same semantic type except that the former overtly realizes the affirmative and negative tags and, in a sense, it wears its logical form on its sleeve. If this grouping is correct, then whatever explains the B-not-B question can be carried over to the Y/N question.[4]

With these crucial points in mind, we are now in a position to explain why the B-not-B question does not suffer from the restriction that the A-not-A question does.

Let us first consider the B-not-B question with a universal quantifier in subject position in (19a). Crucially, its appropriate negative answer as given in (25a) is contradictory, rather than contrary, of the affirmative answer given in (26).

(26) shi de, (meigeren dou pao).
be DE everyone all run
'Yes, (everyone runs).'

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[4] It has to be pointed out that the B-not-B question and the Y/N question differ in their pragmatics. For example, as pointed out by Li and Thompson (1981), the Y/N question can be used to ask a rhetorical question, by which the speaker brings an assumption to the speech context.

(a) Zhangsan nandao hui shuo yingyu ma?
Zhangsan really can speak English Q
'Can Zhangsan really speak English?'

In (a) the speaker assumes that Zhangsan cannot speak English, and thereby expresses his disbelief of the fact that Zhangsan actually can speak English. Neither the B-not-B question nor the A-not-A question can be used in this context. This is perhaps because both the B-not-B and A-not-A question are neutral with respect to whether a contained proposition is true or false.

Logically speaking, for two propositions to be contradictory of each other they must be so related that if one is false the other must be true, unlike two contrary propositions that can be both false.

This, if correct, provides a ready answer to the question of why the B-not-B question does not suffer from the same restriction that the A-not-A does. Let us use the same partition in (8) for illustration. The negative answer in (25a) would cover the mixed cell rather than the negative cell, and the affirmative answer in (26) covers the positive cell. These two answers are mutually exclusive in that they can neither be both true nor be both false.

Mutually exclusive as they are, the question one might ask, given that there are three cells, is how these two answers can be jointly exhaustive, as clearly the negative cell still remains uncovered. If the negative cell happens to correspond to the true state of affairs, what shall we do? The answer to this question lies in the fact that the negative cell is not logically excluded by the negative answer given in (25a). That is, if the negative cell happens to be true, one can still use the answer in (25a) without making a false assertion of the situation. In other words, an assertion like (25a) is true of the situation described by the negative cell, though a weak one in the sense that by saying *Not everyone runs* one may implicate *Someone runs*. This implicature, however, can be canceled, as one can perfectly say (27).

(27) Not everyone, in fact no one, runs.

By adding *in fact no one*, the speaker does not contradict himself. Rather, he cancels the implicature that *not everyone* might otherwise generate. In view of this, I suggest that the negative answer as given in (25a) will cover the negative cell via implicature cancellation, and as such, the two possible answers are jointly exhaustive.

For the same reason, the B-not B question having a negative existential quantifier in subject position poses no interpretive problem. The two possible answers to (19c) are given in (28).

(28) a. shi de, (meiyou ren pao).
be DE no one run
'Yes, no one runs.'

b. bu shi, (you ren pao).
   not be some one run
   'No, someone runs.'

This time, the affirmative answer in (28a) covers the negative cell; the negative answer in (28b) covers the mixed cell. By canceling the implicature that *Someone runs* might otherwise generate, the negative answer can be used to cover the remaining positive cell. That is to say, though by saying (29a) one may implicate (29b), yet this implicature can be canceled as shown in (29c).

(29) a. Someone runs.
     b. Not everyone runs.
     c. Someone, in fact, everyone runs.

The analysis of the similar sort can be extended to the B-not-B question having an existential quantifier in subject position in (19b). The following are two possible answers to it.

(30) a. shi de, (shi you ren pao).
        be DE, some one run
        'Yes, someone runs.'
     b. bu, (meiyou ren pao).
        not, no one run
        'No, no one runs.'

The affirmative answer in (30a) covers the mixed cell; the negative one in (30b) covers the negative cell. The remaining positive cell can be covered by the positive answer via implicature cancellation as shown in (29).

Summarizing, what makes the B-not-B question exempt from the restriction under discussion is that the negation contained in the be-not-be form is sentential, thereby the two possible answers would be contradictory of each other, and hence they are mutually exclusive. The requirement of joint exhaustiveness can be met via implicature cancellation.

## 4. Concluding Remarks

The formation of an A-not-A question is restrictive in that it is not compatible with a quantified NP in subject position. I argued, in the spirit of Higginbotham (1993), that an A-not-A question is a partition of the possible states into two mutually exclusive but jointly exhaustive cells, and to answer an A-not-A question one assigns a choice function to it to pick one of the cells as true and reject the other as false. The A-not-A question exhibits this restriction because the partition may generate more than two cells, and as such, the two possible answers are not jointly exhaustive or mutually exclusive, thus, blocking the proper assignment of the choice function. I also considered a possible counterexample in which the A-not-A complex is formed by reduplicating the copula, instead of a main verb. I argued that this so-called B-not-B question is free from the restriction because it is semantically similar to the Y/N question rather than to the A-not-A question. It has two mutually exclusive sentential operators (affirmative and negative) binding the entire proposition, and to answer it one must pick either one of them and reject the other. Thus, the two possible answers are contradictory of each other, and therefore mutually exclusive. They are also jointly exhaustive in that one of the two answers can be used to cover the remaining cells via implicature cancellation.

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