Some Thoughts on Mohist Logic

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ABSTRACT. The paper is an exploration of the old Chinese texts called the *the Mohist Canons* from a modern logical perspective. We explain what the Mohists have contributed to logic, while we also provide some new interpretations of the issues discussed in the Canons.

1 Introduction

Aristotle's logic, especially the well-known 'Syllogistic', is often considered the first systematic formalization of basic logical issues. The Stoic school then made a further contribution through the development of propositional logic. This tradition of formalism has had an unparalleled impact on the history of Western thought, with a remarkable similarity in topics from Aristotle to Frege and Russell more than two thousand years later. Removing some camouflage, many of these issues are still of significance to our agenda today. Indeed, this tradition has led to the flowering of both traditional and modern logic in the West.

This paper, however, turns East, on a long journey back to Ancient China, and attempts to seek answers to the following questions. Have the Chinese ever developed any logic similar to Aristotle or the Stoics? What sorts of reasoning were they using? What are the similarities and differences between the Chinese tradition and the Western one? What new understanding can we achieve by re-interpreting old Chinese texts with our modern logical theories?

Mozi and the Mohist Canons Logical themes occur in many philosophical works in Ancient China, such as the oldest text *the Book of Changes*, the works by the dominant Confucian school, and the texts of the Sophists, e.g. GongSun Long's well-known thesis 'A white horse is not a horse'. However, perhaps the greatest relevance and significance to logic is found in the school of Mohism, founded by a teacher named Mozi 墨子 (Master Mo, his actual name was Mo Di 墨翟), who lived during the fifth century B.C. Mozi was the first to challenge Confucianism by making reasoning the core of intellectual inquiry. The Mohist school was very influential during the Warring States period (479-221 B.C.).

The term *Mozi* is also used to refer to all works written by anonymous members of the Mohist school. These texts cover a great variety of topics: epistemology,

geometry, optics, economics, and so on. Among them, there are six books, *Jing Shang* 经上, *Jing Xia* 经下, *Jing Shuo Shang* 经说上, *Jing Shuo Xia* 经说下, *Daqu* 大取 and *Xiaoqu* 小取. The collection of these six is usually called *The Mohist Canons*. For simplicity, we will sometimes call it the Canons in this context. *Jing Shuo Shang* is an explanation to *Jing Shang*, the same with *Jing Shuo Xia* and *Jing Shuo*. It is believed that *Daqu* was devoted to ethical issues, though there are major textual difficulties in understanding it. In this regard, *Xiaoqu* is much less problematic. It contains lots of logical topics, coherent and well-structured. (for a new attempt of re-translation and analysis of *Daqu* and *Xiaoqu*, see [Joh00]). This paper will concentrate on these six books, although we will occasionally cite episodes from other books in the *Mozi*.

Research around *the Mohist Canons*, including its textual emendation, has been carried out in China, especially in the 20th century. As more and more logic books were being translated into Chinese in the early 20th century, *the Mohist Canon* also attracted more attention than before, witness the books and papers [Lia22], [Tan35], [Sun54], [Tan64], and more recently, [ZZ97], [Zho02] and [Zha04]. Outside of China, the Chinese scholar Hu Shi for the first time introduced Chinese Ancient logic in his dissertation [Hu22] to the Western academic community. [Gra78] provided a significant introduction to the above six books, despite the criticisms raised later by [Gea99] and some other authors. Language and logic-related issues in Ancient China that are not restricted to the Canons have been discussed in [Chm62], [Han83], [Har98] and many other works.

Aims and methodology Our aim in this paper is twofold. First, although there is some research on the Canons both in China and abroad, unfortunately, over the last two decades there has been little interaction between the two sides. Recent research results in Mainland China are not truly recognized by scholars abroad, and the same is true vice versa. This paper is an attempt to fill this gap, and we will include some important current results from the Chinese literature. Second, we will focus on a new reading of the text of the Canons, and analyze it with relevant knowledge of modern logical theories, developing our own interpretation. Hopefully this will shed some new light on this old text.

We will use *modern logic* (including its mathematical and philosophical aspects) as a tool to look at the issues considered by the Mohists. By itself, this approach is not new. Łukasiewicz adopted this approach to read Aristotle's work in a new light, witness the title of his book [Luk87]. And early in 1960s, the Polish sinologist Chmielewski advocated and used this methodology to study Chinese logic in his Series of papers entitled 'Notes on early Chinese Logic' (the first is [Chm62]). Actually, like other Chinese scholars, we ourselves have used this method: [Zha89] explored the logical thought in *the Books of Changes*, [Rie81], [Liu97] and [Zho96] looked at Gongsun Long's works, especially his thesis 'a white horse is not a horse', and [Luc05] used many-sorted logic to analyze the

notion of 'class' in Mohist logic. The present paper continues this line.

Moreover, we will take a *comparative perspective* throughout our investigation. We compare Mohist logic and Western traditional and modern logic, with a focus only on logical theoretical aspects. However, we are aware of the differences in other regards, e.g., Western traditional logic is ontological oriented while Mohist logic is more argumentation-oriented. Two facts are important to keep in mind here. First, Mohist logic did not survive in the Chinese history, and so it is hard to find a consistent development of it. Second, the logics that were studied in subsequent centuries in China were mostly imported. For instance, Buddhist logic was introduced from India during the Tang Dynasty (618-907 A.D), Western logic became popular starting from the 17th century[1]. More logic books were translated at the start of the 20th century.

The paper is structured as follows. Section 2 is about the classical topic of the correct use of 'names'. We look at the syntactic and semantics aspects of names as studied by the Mohists, and especially their use of variables. In Section 3 we will consider the many kinds of propositions that existed in the Canons. Section 4 has a focus on reasoning, and we will try to enhance our understanding of some key reasoning patterns, such as *mou*. Section 5 then explores what are the basic logical laws one has to follow in a disputation, and what is the purpose of a disputation. Section 6 discusses several paradoxes found in the Canons. We summarize our main conclusions in Section 7.

2 Names and variables

2.1 Genus and differentia

$Ming$ 名 'Name' is one of the most important notions in Ancient Chinese philosophy. The issue of 'rectification of names' has been a core theme for many schools in the pre-Qin period, which provided rules of how to use names correctly, and also how to correct wrong usage. The contribution of the Mohists in this respect is their discussion of many of these issues at an abstract meta-level. We first review their basic theory.

As "以名举实"(NO 11)[2] says 'one uses names to refer to objects'. To give a name to some object, there are two basic things to consider, namely, ruo 若 'like' and ran 然'so'. These two things determine so called *fa* 法'standard', namely, "that in being like which something is so" (A70). So, in order to use one name

[1]The first translation of Euclides' *Elements of Geometry* by the Jesuit Matteo Ricci and a Chinese scientist Guangqi Xu appeared in 1607.

[2]In this paper we follow Graham's numbering of the Canons. He made a hybrid text from *Xiaoqu* and part of *Daqu* under the title "Names and Objects"(abbreviated 'NO') and most of the remainder of *Daqu* as "Expounding the Canons"('EC', for short). 'TC' and 'HC' abbreviate *Daqu* and *Xiaoqu*, respectively. We will make some revisions of Graham's translation where necessary.

consistently, we must follow *fa*. For instance, the name of 'circle' can be applied to the compass, too, since it fits the same standard (A 70).

Names can be of different kinds, as described in "名。达，类，私。"(A 78). Here three kinds of names are mentioned, viz. unrestricted names, classifying names and private names. For instance, 'thing' is 'unrestricted', as any object necessarily requires this name. 'Horse' is a 'classifying' name, for anything 'like the object' we necessarily use this name. The name 'Jack' is a 'private' name, as the name stays confined to this object. This is a classification of names from an extensional point of view, as the denotations of the three kinds go from the whole universe to a single object. It seems that only 'thing' falls into the category of unrestricted names. Classifying names are the most common ones people use, they are what we would call generic names or predicates nowadays. And private names are simply what we would now call proper names.

Most importantly, the Mohists proposed principles regarding the distinction between any two classifying names. In fact, this follows from the notion of 'standard' we have seen above. They say that proposing a 'standard' is not arbitrary, we have to pick those properties which one has and the other lacks. In other words, the properties have to help us differentiate two kinds of objects. This is interpreted in the following passage, which contains a nice example too: "狂举不可以知异，说在有。牛与马虽异，以牛有齿马有尾说牛之非马也不可。是俱有，不偏有偏无有。"(B 66) In translation: *By referring arbitrarily one cannot know differences. Explained by: what they have. Although oxen are different from horses, it is inadmissible to use oxen having incisors and horses having tails as proof that oxen are not horses; these are things which they both have, not things which one has while the other does not.*

This is very similar to what Aristotle proposed. According to Aristotle, a species is defined by giving its *genus* and its *differentia*: the genus is the kind under which the species falls, and the differentia states what characterizes the species within that genus. It is species that have *essence* which should be the base of a correct definition. The notion of essence is similar to *fa* in Mohist logic. The above text gives us a good example. Oxen and horses belong to the same kind 'animal', and one should find a *fa* for each species that differentiates one from another within the same kind. We can fairly say that the theory of classifying names by Mohists had the same spirit as Aristotle's account of 'genus and differentia'.

Regarding the relationship between names and objects, the Mohists claim that different names can be used for the same object, and different objects can share the same name. A good example for the former is that the dog is an object with two names, *quan* 犬 and *gou*狗. For the latter, according to the given standard, objects sharing the same name are not necessarily alike except in the respects covered by the standard. For example, pieces of stone and of wood both of which fit the stan-

dard for ‘square’ share the same name ‘square’. This statement on the relationship between names and objects suggest that the Mohists realized that there is a distinction between *syntax* and *semantics*, in our modern terminology. The same point was made by Frege at the beginning of the 20th century. Doesn’t the example of *quan* and *gou* remind us of Frege’s famous discussion of ‘the morning star’ and ‘the evening star’? As we know, ‘the morning star’ and ‘the evening star’ are two different names, but they refer to one and the same object, the planet Venus.

2.2 Usage of variables

The issue of whether variables were used in Mohist logic has been a point of controversy. The importance of this question goes without saying, as we know what a central role variables have played in logic. They are an indicator of true insight into formalism. In what follows, we will streamline some observations on this topic in the earlier literature. In particular, we will state some new insights by Chinese scholars that have not yet been recognized.

Harbsmeier has a positive view on Mohist uses of variables in [Har98]. His example is the following:

“In case of naming on the basis of shape and characteristics, we necessarily (*bi*) know that this thing is X (*mou*), only then do we know X (*mou*). In cases where naming cannot be on the basis of shape and characteristics, we may know X (*mou*) even if we do not know that this thing is X (*mou*).” (NO2)

Harbsmeier thinks that “the use of 某 *mou* came closest to the use of variables”. As we understand the matter, *mou* in the above text can be read as ‘something’: it is an indefinite pronoun that can refer to something identifiable but as yet with no specific name. What is special about an indefinite pronoun is that it has no properties that one can recognize as belonging to a particular thing, but one can replace it with a particular name given a specific context. This is what is usually meant by variables. The word *mou* is used in a similar way even in the modern Chinese language. E.g., ‘mou ren’ means ‘someone’, and ‘mou wu’ means ‘something’.

One more example was considered in [Zho02] and [Zha04] concerning Mohist usage of variables. It involves the two demonstrative pronouns, *bi* 彼 ‘that’ and *ci* 此 ‘this’. Just like *mou*, both of them are used very much like variables. Consider the following text:

正名者彼此彼此可。彼彼止于彼，此此至于此，彼此不可。(B 68)

In translation: *It is admissible for the man who uses names rightly to use ‘that’ for this and ‘this’ for that. As long as his use of ‘that’ for that stays confined to that, and his use of ‘this’ for this stays confined to this, it is inadmissible to use ‘that’ for this.*

Clearly, in the preceding text ‘that’ and ‘this’ are used to denote two different names. Roughly speaking, in order to use names correctly, one has to make a

distinction between ‘that’ and ‘this’, ‘that that’ and ‘this this’. Confusion is not allowed. So here the demonstrative pronouns ‘that’ and ‘this’ are just two symbols (and hence once again, variables) of two different names. [3]

A somewhat dramatic further observation was also made in [Zha04]. As we have noticed from reading the Canons, the names *niu* 牛‘ox’ and *ma* 马‘horse’ have been used very frequently to explain things in situations which have nothing to do with the animal *niu* and *ma* themselves. For instance, “牛不二，马不二，而牛马二。则牛不非牛，马不非马，而牛马非牛非马。” (*Jingxia*) is supposed to explain what is a compound name. The example goes like this: *niu* is a single name, and *ma* is a single name too. However, *niu-ma* is a compound name. It is not the same as *niu*, nor the same as *ma*. Here the point is the difference between *niu-ma*, as a compound name and *niu* or *ma* as a single name, rather than explaining what is *niu* or *ma* itself. Clearly, this is a generic explanation, and the two specific predicates are being used as variables!

There are many other places where *niu* or *ma* occurs in the Canons. With this new interpretation in mind, it should be easier to understand some of the texts. Take the following example: “或谓之牛，或谓之非牛，是争彼也。” (A 74) which talks about a disputation. It says in English *‘One calling it ‘ox’ and the other ‘non-ox’ is contending over claims which are the converse of each other’*. Here again, from a logical point of view *P(ox)* and $\neg P$ *(non-ox)* are used to express two contradictory predicates or propositions, and one of them should come out through disputation. So this passage seems to suggest that *ox* almost serves as a propositional variable here.

Surprisingly, we can find this use of variables even earlier: in the work of the Sophist Gongsun Long. As we know, Gongsun Long proposed the famous thesis ‘a white horse is not a horse’, which was challenged by the pupils of Confucius. Let us look at how he defended it. He said: “Why would it be a problem to say ‘a white horse is not a horse’ if we accepted what Confucius said ‘Chu’s man is not a man’?” Clearly, what he took for granted is that his thesis is not about a particular statement involving a white horse and a horse, but about all propositions of that form, where ‘horse’ can be substituted for by other names. Thus, the idea of variables and schematic assertions existed even before the Mohists.

In the above we have shown the similarity between Mohist views of names and those of Aristotle and Frege. We have seen that the indefinite pronoun *mou*, the two demonstrative pronouns *that* and *this*, and even the specific predicates *horse* and *ox* were used as variables in the Canons. Furthermore, we showed that the idea of variables can be pushed even back to the Sophist’s period before the Mohists.

[3] [Zha04] made an attempt to interpret this in terms of set-theoretic operations:

That $\cup$ That= That.

That $\cup$ This $\neq$ That.

This use of variables reflects the effort Mohists made toward formalism. To do so, they appeal to natural language while taking some particular words as variables. A similar approach occurs in Stoic logic, where the ordinal expressions 'the first' and 'the second' were used as propositional variables.

3 Propositions and logical constants

As "以辞抒意" (NO 11) says, propositions are used to elucidate ideas[4]. We express our ideas by means of various propositions. The Canons discussed different types of proposition involving logical constructions like quantifiers, conditionals and modalities. Since there is no systematic categorical classification of propositions in the Canons, in what follows we are going to review it based on our modern view of the matter. Along the way, we will pay attention to how Mohists perceived differences between the propositional types, and especially how they use logical constants to indicate these types in the language.

Quantifiers: all and some The universal quantifiers is expressed by the word *jin* 尽. As explained in "尽，莫不然也。" (A 43), 'all is none not being so'. Written in a logical formula, it is $\forall x = \neg\exists x\neg$. Notice that here *chin* is defined in terms of *mo* (莫)) 'none' which is taken as a primitive; and thus, the universal quantifier is defined by a double negation. Besides *chin*, other words, like 俱, 周, 盈, 遍, are often used to express the universal quantifier, they all mean 'all'. One can easily find propositions containing such words in the Canons. The negation of the universal quantifier is defined as well: in "或也者不尽也。"(NO 5 HC 6B/3-5), it means "some is not all". Put again in a logical formula, we get $\exists x = \neg\forall x$. This is not exactly what existential quantifiers mean nowadays ($\exists x = \neg\forall x\neg$.). Probably the Mohist text is not a definition, but it wants to make the point that 'some' (as a part) differs from 'all' (as the whole).

Disjunction, conjunction and conditional The expressions *huo...huo.../* 或...或... (either... or...) are used to express disjunction in the Canons. Of the many examples, here are two: "或谓之牛，或谓之非牛"(either call it ox, or call it non-ox), and "其体或去或存"(*Jingshan*, in translation: either its body is gone or it is still here.) Concerning conjunctions, it seems that there is no clear sign for this in the language, but the Canons have many propositions which express the idea that several things should hold at the same time. Probably, juxtaposition was seen as implicit conjunction. [5]

The conditional is defined as "假者今不然也。"(NO 5 HC 6B/3-5), which means 'the loan-named is not now so'. Conditions or causes that lead to some phenomenon are called *gu* 故. There are two types of *gu*, *major gu* 大故 and *minor gu* 小故. The distinction between them is illustrated in the following text:

[4]The translation by Graham was 'propositions are used to dredge out ideas'.

[5][Zho02] proposed that 盈 (which really means 'all') can also be seen as a conjunction sign.

故，所得而后成也。小故，有之不必然，无之必不然，体也，若尺有端。大故，有之必然，无之必不然，若见之成见也。(A1)

In translation: *The gu of something is what it must get before it will come out. Minor reason: having this, it will not necessarily be so; lacking this, necessarily it will not be so. It is the unit, like having a starting-point. Major reason: having this, it will necessarily be so; lacking this, necessarily it will not be so. Like the appearing bringing about the seeing.*

According to the explanation, *major gu* and *minor gu* are actually what we nowadays call 'sufficient condition' and 'necessary condition', respectively. In the Mohist texts, *ruo...ze*/ 若...则... 'if...then...'(sometimes 'ruo' is omitted when it is clear from the context) are often used to express conditionals.

Modalities Interestingly, modalities are considered in the Canons too. First, the word *bi* 必 is used to express *necessity*. For instance, "谓辩无胜，必不当" says 'There necessarily exists a winner in a disputation'. Several tensed modalities are also considered. The word *qie*且 is used to express the future tense. E.g., in "且出门，非出门也。", two states of going out in the future or going out now are distinguished. Likewise, *yi*已 is used to denote the past tense in the language.

Complex propositions One striking phenomenon is that the Canons are replete with complex propositions such as "riding a white horse is riding a horse", "killing a thief is not killing a man", etc. They are not simply constructed from basic propositions by means of the logical constants we have seen so far. Instead, they have much richer variations in the predicates. Thus, reasoning with complex propositions is more complicated, as will be explored in Section 4 below. Here we only mention one logical issue relevant to the complex propositions, namely that of extension, which is the basis of correct reasoning with complex propositions. To illustrate this, here is one example:

爱人待周爱人而后为爱人。不爱人不待周不爱人，不周爱因为不爱人矣... ...此一周一不周者也。(NO 17)

In translation: *'He loves people' requires him to love all people without exception, only then is he deemed to love people. 'He does not love people' does not require that he loves no people at all; he does not love all without exception, and by this criterion is deemed not to love people. ... These are cases in which something 'applies without exception in one case but not in the other'.*

Considering the correct application of certain predicates is exactly to spell out their extensions. We will come back to this point in the next section.

Remark The diversity of propositions considered by the Mohists involves different indicators in the language, e.g. 'huo... huo...' for disjunctions. The clear identification of those structuring expressions suggests that the Mohists realized

the distinction between logical and non-logical expressions. The former are the protagonists of modern logic, and they determine logical structures in general. Consider two examples we have seen: “或谓之牛，或谓之非牛”, and “其体或去或存”. They have the same logical form “或...或...”, but are about different subject matters. As we know, Stoic logic contributed much to the study of propositional logic, especially in their work on conditionals. In its account of sentence structure, Mohist logic seems closer to Stoic logic than to Aristotle.

4 Reasoning

4.1 Reasoning and knowledge

The word *shuo* 说 means ‘clarification of a statement’, as defined in ‘the means by which one makes plain’(所以明也)(A 72). From this initial meaning, *shuo* gets its further meaning which refers to reasoning or providing proofs, as in “以说出故” (NO 11): ‘by means of explanations bring out reasons’. This point becomes much clearer when the sources of knowledge are discussed. The Canons say “知：闻，说，亲。” (*Jingshang*). It means that there are three different ways to get knowledge: viz. learning from others, reasoning from what one knows already, and getting from one’s own experience. A nice example to show these distinctions is also given. Imagine that someone, say Jack, is standing outside of a room, and he sees an object which is white. From the very beginning then, he knows from his own observation that ‘the object outside of the room is white’. But now, there is another object in the room, of a yet unknown color. Now Jack is told that the object in the room has the same color as the one outside. Now he knows that ‘the object in the room has the same color as the one outside’, by learning from others. Finally he also knows that ‘the object in the room is white’, via his own reasoning based on what he knows. This example illustrates exactly how *shuo* works for us when acquire knowledge. Our exploration on *shuo* in this section will be based mainly on its meaning of reasoning.

4.2 Patterns of reasoning

To get to know something by means of *shuo*, we can appeal to many different kinds of reasoning. This section is about reasoning patterns in the Mohist texts. Our focus are the characteristics of these patterns and their validity. We will start with a simple pattern called *Xiao*, as explained in *Xiaoqu*:

效者为之法也，所效者所以为之法也，故中效则是也，不中效则非也。

The name used for reasoning here is *xiao* 效 which means ‘to imitate’. The above text is translated as ‘The *xiao* consists of setting up the *fa* (standard). That which things are modeled after is that which is to be set up as the *fa*. When it conforms to the *xiao*, it is right. When it does not conform to the *xiao*, it is wrong’. Put differently, there is a general set-up *fa* (standard), and using it, we try to infer whether

specific things conform to this standard or not. We can see that this reasoning goes from a general rule or standard to specific cases, and hence it can be thought of as a *deduction*. Now we go on with a few more patterns mentioned in Mohist texts:

辟也者，举他物而以明之也。侔也者，比辞而俱行也。援也者，曰子然我奚独不可以然也。推也者，以其所不取之同于其所取者，予之也。(NO 11 6B/5-8)

In what follows, we discuss the reasoning patterns *pi*辟 'Illustrating', *yuan* 援'Adducing', *tui* 推'Inferring' and *mou* 侔'parallelizing', occurring in the above text. We explain the reasoning by concrete examples, and try to analyze it in terms of logical rules. In particular, we try to apply some results from what is sometimes called 'natural logic' (monotonicity reasoning) to the pattern *mou*, which abounds in the Canons.

Pi/illustrating 'Illustrating' originated in works much earlier than the Canons, like the *Shi jing* (or 'Book of Odes') around 1000 B.C. Another well-known Sophist Hui Shi (380-305 B.C.) is famous for his talent in using this sort of reasoning in his arguments. The idea of 'Illustrating' is that in order to make someone else know that A, you refer to A' known by him already. This is based on the similarity or analogy between A and A'. Take this example from the book *Gongshu* of *Mozi*. Mozi met the King of the State Chu. In order to convince the King that it is not right for the rich Chu to invade the poor State Song despite being wealthy, he used a more obvious example. Namely, it is not right for rich people to leave their property behind and go robbing poor people. Since the King sees the injustice of the latter, he realizes that of the former, too. Notice that the purpose of illustrating is to make someone else know, not to make oneself know. In this sense, it is more like the process of explanation.

Yuan/adducing 'Adducing' means: if it is so in your case, why may it not be so in mine too? We mentioned one example in Section 2, when Gongsun Long defended his thesis 'a white horse is not a horse'. The reasoning used there is 'Adducing'. He asked why it would be a problem for him to say 'a white horse is not a horse' if we accepted what Confucius said: 'Chu's man is not a man'. This has the flavor of Modus Ponens, but also that of the 'consistency' found in argumentation theory or legal practice.

Tui/inferring To interpret 'Inferring', consider this scenario. If someone proposes a statement you do not agree with, what you need to do is choose a statement which belongs to the same kind as what he proposed (and which he should therefore accept), but in fact he cannot accept it. In that case, he has to give up his initial statement. Consider this example in the book *Gongmeng* of *Mozi*: Mencius [6] does not think gods or ghosts exists, but nevertheless, he claims that gentlemen(jun zi)

[6] Mencius (372-289 B.C.) was the most famous Confucian after Confucius himself.

should learn how to pray. Mozi then says: 'What Mencius said is just like saying you have to learn how to treat your guests well, but there is no guest at all. This is also like having to make a fish net, but there is no fish.' The absurdity of the last two cases is clear, so we conclude that what Mencius said was wrong. The logical reasoning pattern here can be formulated as: $\vdash p \rightarrow q$ and $\vdash \neg q$, we get $\vdash \neg p$. This is is Modus Tollens!

Mou/parallelizing As explained in the above text, 'parallelizing' is comparing propositions and then letting all 'proceed'. This is the style of reasoning with complex propositions introduced in our previous section. Three varieties of this are considered in the Canons. We will look at each in what follows, and try to propose a new interpretation.

Case 1: from positive to positive "是而然": *something is so if the instanced is this thing.*

The general feature of this case is: we get an affirmative proposition from an affirmative one. Here are some examples:

白马马也，乘白马乘马也。骊马马也，乘骊马乘马也。获人也，爱获爱人也。 (No 14)

In translation: *A white horse is a horse. To ride a white horse is to ride a horse. A black horse is a horse. To ride a black horse is to ride a horse. Jack is a person. To love Jack is to love people.*

Consider the following related example:

- If some dogs walked, then some animals walked.

This is a typical example of an 'upward monotonicity inference' considered in medieval Western logic, and revived in its modern variants of 'natural logic' (see [Ben91], [Eij05]). The reason why the implication can proceed here is that the interpretation of 'animals' is an extension of that of 'dogs', while the quantified sentence 'some dogs walked' creates a 'positive' or 'upward-entailing' environment for the predicate 'dog'. In Aristotle's terms, such contexts allow us to move from a species up to a larger genus. In the same spirit, the Chinese horse-riding example can now be re-written as:

- If you ride a white horse, then you ride a horse.

The initial sentence 'a white horse is a horse' provides the relevant extension of predicates. The expression 'you ride a horse' sets up an upward-entailing inferential environment for the predicate 'horse'. Thus we can successfully apply upward monotonicity, and infer that 'you ride a horse'. The same analysis applies to the other examples, including the one with the individual 'Jack', which we may construe either as upward monotonicity on a singleton predicate, or as a case of Existential Generalization.

Here is a related Mohist example: “狗，犬也，杀狗谓之杀犬，可。” says that ‘a gou is a quan, to kill a gou is to kill a quan.’ We can formulate this in an analogous way:

- If you kill a gou, then you kill a quan.

As we learn from the section 2, *gou* and *quan* are different names with the same extension. We can either view this as monotonicity inference, or as a case of Replacement of Identicals. The Chinese text does not tell us enough to decide which interpretation fits better.

Next, we consider inferences involving negations.

Case 2: Negative conclusions and non-conclusions “是而不然”: *something is not so though the instanced is this thing.*

Here are some cases where upward monotonicity does not apply. The reasons can be different, and we will try to explain them, again, in modern logical terms.

其弟美人也，爱弟非爱美人也。车木也，乘车非乘木也。船木也，入船非入木也。盗人也，多盗非多人也，无盗非无人也。(NO 15)

In translation: *(a) Her younger brother is a handsome man, but loving her younger brother is not loving handsome men. (b) A carriage is wood, but riding a carriage is not riding wood. (c) A boat is wood, but entering a boat is not entering wood. (d) Robbers are people, but abounding in robbers is not abounding in people, being without robbers is not being without people.*

Consider (a) first. It says that she loves her younger brother, but she need not love handsome men. We do have ‘Her younger brother is a handsome man’, which suggests the inclusion of extensions. What happened to block the upward monotonicity? It seems that the Mohist text here takes *intensionality* into account. ‘Love of her brother’ is not the same as ‘love of a handsome man’. This same style of thinking also explains (b) and (c). In (b), riding a carriage means to ride-qua-vehicle, whereas one does not ride ‘wood-as-a-vehicle’. In modern logical terms, one would accept the stated inference read in an extensional sense, but not in an intensional sense. Example (c) even uses a Chinese pun. The idiom ‘entering wood’ means ‘going to die’ while ‘entering a boat’ just means ‘going into a boat’.

The fourth example (d) involves two further phenomena. The verb ‘abounding’ has the force of an indefinite quantifier ‘many’, whose interpretation depends on some standard supplied by its left-most predicate. In particular, the standard for ‘abounding’ in the context of the predicate ‘robbers’ is different from that for the predicate ‘people’. Thus, in addition to intensionality, the Mohist text observes quite correctly that *context dependence* can block monotonicity inferences. The last sentence is yet different. The word ‘no’ generally blocks upward monotonicity,

even in purely extensional settings. Actually, 'no' tends to create contexts licensing downward monotonic inferences, the natural companions of upward monotonic ones. For instance, 'being without people' implies 'being without robbers', where robbers is a subpredicate of people. While such downward consequences occur in medieval Western logic, and in modern natural logic, they seem absent from the Mohist texts.

Finally, here is a third scenario in the Mohist canons. We can also get an affirmative proposition without the inclusion condition.

Case 3: Positive conclusions not based on inclusions "不是而然": *something is so though the instanced is not this thing.*

Again, here are some typical examples:

读书非书也，好读书好书也。斗鸡非鸡也，好斗鸡好鸡也。且入井非入井也，止且入井止入井也。(NO 16)

In translation: *(a) Reading a book is not a book, but to like reading books is to like books. (b) A cockfight is not a cock, but to like cockfights is to like cocks. (c) Being about to fall into a well is not falling into a well, but to stop someone from being about to fall into a well is to stop him from falling into the well.*

(a) says that, if you like reading books, then you must like books. This is not like what we had in *Case 1*, as no explicit inclusion is spelled out. Instead, 'reading a book is not a book' is only a negative assertion. How can we relate them? It seems that the Mohist text is rather after the notion of *presupposition* here, as when we conclude from 'My wife is pregnant' that the speaker has a wife. Likewise, when you say that you like reading books, the presupposition is that you have some books. Since some books are books, we get 'to like (having) books' from 'to like reading books', by way of the presupposition. The same explanation may be given for (b)[7]. Example (c) is different, but not hard to understand in terms of presuppositions of 'being about to' plus the tenses that are involved.

This concludes our brief survey and explanation of key reasoning patterns in the Mohist Canons. The analogies in form and spirit to Western logical themes are quite striking. In fact, more propositional kinds of reasoning were considered as well, based on the earlier disjunctions and conditionals. We will leave these to another occasion.

5 Disputation

Next, inferences, valid or not, do not occur in isolation: they form part of larger human activities. Just as in Ancient Greece or Rome, disputation was popular among

[7]The first part of (a) and (b) seems strange: we know that reading a book is definitely not a book itself, but people rarely say it that way in natural language. But the logical point of the text is that, given this negative fact, the inference cannot be a simple replacement.

various Schools of thought during the Warring States period. They criticized each other and tried to convince their King with their new proposals. The Mohists were not only concerned with the practice of disputation, but also with its meta-theory. We can find many illuminating discussions of this topic in the Canons. For instance, here is how they define a disputation: "辩，争彼也。"(A 74). This says that *Bian* (disputation) means contending over claims which are the contradictory of one another. To show what such contradictory claims are, one example given is: "谓之牛，或谓之非牛，是争彼也。"(A 74). This says that 'One calling it 'ox'(P) and the other 'non-ox'($\neg P$) is contending over claims which are contradictories of each other'. Furthermore, the Mohist Canons propose basic principles regulating disputations. The first says that of two contradictory propositions, one must be false: they cannot be true at the same time: "是不俱当，不俱当必或不当。"(A 74). This is exactly the Law of Non-Contradiction! Secondly, the texts say that it two contradictory propositions cannot be both false, one of them must be true: "谓辩无胜，必不当，说在辩。"(*Jingxia*). This, of course, is the Law of Excluded Middle. There seems to be a consensus nowadays that the Mohists explicitly proposed two basic logical laws, but cf. the earlier discussion in [Les64].

What is more, the Mohists also talked about the broader purpose of disputation in general. We would like to conclude this section by citing their comprehensive and yet highly concise description in the following text:

NO6
HC 6A/9-6B/1 夫辩者，将以明是非之分，审治乱之纪，明同异之处，察名实之理，处利害，决嫌疑，焉摹略万物之然，论求群言之比。"

The purpose of disputation is (1) by clarifying the portions of 'is-this' and 'is-not', to inquire into the principle of order and misrule; (2) by clarifying points of sameness and difference, to discern the patterns of names and of objects; (3) by settling the beneficial and the harmful, to resolve confusions and doubts. Only after that, one may by description summarize what is so of the myriad things, and by asserting seek out comparables in the multitude of sayings.

6 Paradoxes

Finally, we mention one more striking analogy between Mohist Logic and its counterparts elsewhere in the world. Many *paradoxes* were discussed in the Canons. This phenomenon may lie in its direct connection to disputations, where one has to avoid being self-contradictory. Let us start with the first example, which is stated in "以言为尽悖，悖。说在其言。"(B 71). In translation, it says: *To claim that all saying contradicts itself is self-contradictory. Explained by: what he says himself.* Here is the implicit argument. Assume that we accept 'all saying contradicts', then the sentence 'all saying contradicts' is false itself. What this means is some statements are not contradictions. Thus, the Mohists were aware of the phenomenon

of self-reference, and its remarkable logical consequences. Clearly, this example is close to the paradox ascribed to the Cretan philosopher Epimenides in the sixth century B.C., who asserted that "Cretans are always liars." While this is not quite the famous Liar Paradox which is contradictory whichever way one looks at it, it comes close.

We conclude with another Mohist paradox, which seems original without an obvious Western counterpart. The text "学之益也，说在诽者。"(B 77) says, in translation: "That it is useful to learn. Explained by: the objector." The underlying argument goes like this. Thinking that someone does not know that it is useless to learn, you therefore inform him. This is causing him to know that it is useless to learn. But if it is really useless to learn, to teach (making people learn things) is to contradict oneself. This paradox seems new, involving pragmatics of speech acts, though of course, it sounds highly congenial to Western logicians.

We will leave a more detailed exploration of other Mohist paradoxes to other occasions. As we know from history, far from being isolated puzzles, paradoxes have contributed immensely to the development of logic. In this respect, it may be fair to give some credit to the Mohists for their contribution to this subject.

7 Conclusion

From the standpoint of modern logic, and taking a comparative perspective, we have given a survey of some major themes in Mohist Logic, while arguing for the following more specific conclusions:

- Variables were used by the Mohists, and even earlier by the Sophists.
- The Mohists had the idea of logical constants, distinguishing these from non-logical expressions in natural language.
- They had a systematic abstract reflection on reasoning and some of its central valid and invalid patterns, including reasoning based on monotonicity, as well as various factors blocking this.
- The Law of Non-Contradiction and the Law of Excluded Middle were proposed as central to driving the process of disputation.
- They made original contributions to the development of logical paradoxes.

Our work is a very first step, and further systematic study is needed. But we hope this paper gives our readers a rough picture of the Mohist Canons, and hence logical activity in China around 500 B.C., from a modern point of view.

Living in Ancient China over two thousands years ago, the Mohists may have had no idea what was going on in Ancient Greece, Rome, or even India.[8] However that may be, nowadays we are amazed by the similarity of great minds across

[8] But one should never underestimate what Ancient people already knew about the world at large through trade and other contacts.

cultures. Unfortunately, the two stories have gone very differently as one travels toward modern history. Although the Mohists provided an option of making reasoning and disputation the core of intellectual inquiry, their doctrine did not survive in Chinese history and philosophy. As we know, after the first unified dynasty Qin was founded, Confucianism became the dominant doctrine, which has lasted throughout Chinese history. In contrast to this, in the West, no lasting unification took place, and in the Western philosophical tradition, the rationalistic dialogical approaches of Plato and Aristotle were adopted and developed further. This historical observation may provide some explanation of the differences between Chinese and Western culture.

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