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Notes on Early Chinese Logic (IV)

VI. An instance of reasoning in *Mo-tsï* 26 and the problem of relationships between language and the logic of functions in Chinese. — As has been shown in the preceding section (see RO XXVII, 1; pp. 103—121), there are sufficient reasons to interpret the so-called Mohist *hiao* as a specific logical formula belonging to the simple calculus of functions, — even if there is in neither *Mo-tsï* nor another Chinese philosophical text any example of reasoning qualified as *hiao* and corresponding to the formula in question. On the other hand, there are in the body of the *Mo-tsï* instances of reasoning logically valid, which can be adequately analysed (formalised) by means of different and comparatively complicated formulae of the calculus of functions — formulae which have no counterpart in the logical theory of the Mohists. In other words: what appears in the logical theory (that is, explicit logic) does not appear in actual practice of philosophical reasoning (implicit logic), and *vice versa*. This seems paradoxical enough, but we must remember that the early Chinese thinkers were much more sophisticated in actual reasoning than in theoretical reflection on logical problems. In their philosophical practice they were able intuitively to reason according to valid formulae (or inferential patterns) which were sometimes astonishingly complicated. At the same time their logical theory, poor as it was, was necessarily limited to much more elementary logical problems which — precisely on account of their simplicity — played little rôle, if any, in actual philosophical speculation. This, I think, explains the seeming paradox just mentioned The problem of the relation between what I call implicit and explicit logic in early Chinese philosophy deserves further discussion. Since, however, the problem forms part of the general appraisal of Chinese logic, its discussion must be postponed till the concluding chapter of my study[1]. What I should like to emphasise here in connection with the preceding chapter is this: the fact that in the body of the *Mo-tsï* there are instances of reasoning which undoubtedly involve the calculus of functions in its rather complicated forms makes it probable that a comparatively simple formula of this calculus c o u l d have been discussed and explicitly put forward by the

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[1] For the time being, *cf.* the remarks on implicit and explicit logic in my recent article *La logica degli antichi cinesi*, "Rivista degli Studi Orientali" XXXVIII, 2 (Roma 1963), pp. 161—168.

later Mohist dialecticians. That is to say, I regard the instances of reasoning formalisable within the calculus of functions, which occur in the *Mo-tsï*, as indirectly corroborating my interpretation of the Mohist *hiao* in terms of the simple functional calculus[2].

I shall now analyse one such example which seems particularly clear from both philological and logical point of view. The passage as it stands in the *textus receptus* is perfect (at least since P i Y ü a n corrected one evidently wrong character occurring in the earlier editions); therefore its linguistic interpretation presents no problem at all. The reasoning itself does not exceed the stock of operations and formulae common in the functional calculus (including heterogeneous two-place functions with one object-argument and one function-argument). I refer to the passage in chapter 26 (*T'ien-chï shang*) of the *Mo-tsï*, in which M o T i tries to demonstrate his thesis that "Heaven likes righteousness and dislikes unrighteousness". The thesis itself is basic for the philosopher's ethical theory, and, as we shall see, the kind of reasoning advocating this thesis is logically quite elaborate. The Chinese text (*cf.* S u n I - j a n g, *Mo-tsï hien-ku*, *küan* VII, f. 2v) runs as follows[3]:

(1) (a)　　　　　天下 有義則生,無義則死
　　(b)　　　　　　　有義則富,無義則貧
　　(c)　　　　　　　有義則治,無義則亂

(2) (a)　　　然則　天 欲其生 而惡其死
　　(b)　　　　　　　欲其富 而惡其貧
　　(c)　　　　　　　欲其治 而惡其亂

(3)　　此我所以知　天 欲義而惡不義也

A. F o r k e's rendering of the passage (see his *Mê Ti — des Sozialethikers und seiner Schüler philosophische Werke*, Berlin 1922; pp. 315—316) is a good illustra-

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[2] I shall limit myself to the instances drawn from the body of the *Mo-tsï*, that is, the text most closely connected with the later Mohist school. This however does not mean that the elements of the calculus of functions are not implicitly present in other early texts. *Cf.* the preceding chapter for the *Sün-tsï* passages as involving the 'functional' sub-type of the chain-reasoning (RO XXVII, 1; pp. 114—117). I should like to avail myself of this opportunity to improve on a previous statement of mine in which I rather strongly refuted the importance of the rôle of the logic of functions within early Chinese (implicit) logic, see RO XXVII, 1; p. 104. By now, I realise that the rôle of that part of logic in Chinese philosophical reasoning is more important than I thought at the time when I was preparing the preceding section for publication.

[3] In order to make the logical aspect of the passage more clearly visual, I give the text in a specific arrangement which, however, is not a re-arrangement and does not involve any textual change from the original. In particular, the present arrangement is meant to visualise the following important points: the whole passage is

tion of my previous statement (RO XXVI, 2; p. 91, footnote) that the logically important aspects of the Chinese reasoning have usually been very poorly dealt with by translators⁴. M e i Y i - p a o ' s translation (see his *The Ethical and Political Works of Motse*, London 1929; p. 136) follows the original more closely and is better than F o r k e' s. But it still requires reformulation to suit our present purpose (*cf.* especially (1a)—(1c), where M e i' s translation does not render the implicational structure of the corresponding Chinese sentences). Now, the very arrangement of the text as given above (*cf.* also the remarks *supra*, p. 88, footnote 3) shows that the passage can be most adequately rendered in the following way:

"(1) (a) If there is righteousness in the world, there is life; if there is no righteousness [in the world], there is death. (b) If there is righteousness [in the world], there is richness; if there is no righteousness [in the world], there is poverty. (c) If there is righteousness [in the world], there is order; if there is no righteousness [in the world], there is disorder. (2) (a) Now, Heaven likes life [in the world] and dislikes death. (b) [Heaven] likes richness [in the world] and dislikes poverty. (c) [Heaven] likes order [in the world] and dislikes disorder. (3) That is how I know that Heaven likes righteousness [in the world] and dislikes unrighteousness".

Of course, the present rendering has no claim to literary smoothness. The original text itself is an elaborate instance of reasoning rather than a piece of literary work, and it is precisely that aspect of the passage which deserves emphasis in the transla-

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clearly composed of three parts, of which the first ((1a)—(1c)) and the second ((2a)—(2c)) are sets of premises, while the third part (3) is the conclusion; the 'logical subject' in (1a)—(1c) is 'The world' (*t'ien-hia* 天下 , standing to the left in (1a) but also implicit in both (1b) and (1c)), while in (2a)—(2c) as well as (3) the subject spoken of is 'Heaven' (*t'ien* 天 , standing to the left in (2a) and (3)); there is specific parallelism within (1a—c) and (2a—c); the first left-side groups of characters in (2a) and (3) have no logical significance and do not belong to the reasoning.

⁴ In his translation F o r k e unnecessarily complicates the syntactic structure of the passage which is both clear and simple in the original wording; he introduces grammatical subjects non-existent in the Chinese text ('der Gerechte', 'der Ungerechte') and various stylistic reformulations. As a result, his rendering — unlike the original reasoning which is logically clear and easily formalisable — can hardly be subjected to formalisation. Furthermore, F o r k e' s own comment on the whole passage: "Die Beweisführung gerade bei diesem wichtigen Punkte is äusserst schwach" (*ibidem*, p. 316, footnote 1) seems to be due to a misunderstanding. This criticism is acceptable only with regard to the premises which are certainly unfounded, not with regard to the inferential pattern itself. Since however F o r k e rightly emphasised the lack of foundation for the premises at the beginning of his rendering of the passage (*ibidem*, p. 315, footnote 5), and 'Beweisführung' is a logical notion, it seems that his remark now in question was meant to refer to the formal aspect of the whole reasoning. If so, F o r k e' s comment is erroneous, since the reasoning itself is a logically valid inference (although one starting from epistemologically unfounded premises).

tion. It will be noted at once that the insertion of bracketed words in the translation is by no means arbitrary. As has already been remarked, the 'logical subject' (that is, the argument) in (1a)—(1c) is always 'The world'. The logical structure of (2a)—(2c) is more complex, since besides the main argument which is 'Heaven' there is in all three sentences a second argument which itself is a function with its own object-argument absorbed; this absorbed argument, or sub-argument, is again 'The world', as is directly indicated by the particle *k'i* 其 (which evidently refers to *t'ien-hia* spoken of in (1a)—(1c)). This explains the insertion of 'in the world' in (2). In (3), the same sub-argument 'The world' is left entirely unexpressed in the original, but is clearly understood and hence inserted in the translation. All this will appear clearer if we proceed to the formalisation of the reasoning.

For the first part (1) of the passage, sentence (1a) can be regarded as typical, since (1b)—(1c) closely follow its pattern. Linguistic parallelism is matched here by that of the logical structure. Now, (1a) is clearly composed of two sentences: 天下有義則生 and [天下] 無義則死; it is, in fact, a conjunction (logical product) of the two, the operation of conjunction being expressed by mere parataxis. The two component sentences themselves are molecular implicational structures with *tsê* 則 as functor of the implication between the atomic propositions. In all four atomic propositions the only argument is 'The world' (天下) — for which we shall put the letter a — while the propositional function varies from one atomic proposition to another. The first three of these functions offer no problem at all: 'there is righteousness' (有義) can be represented by φ, '(there is) life' (生) by ψ_1, 'there is no righteousness' (無義, that is, the negation of 有義 $= \varphi$) by φ'. Consequently, the first three atomic propositions in (1a) can successively be represented by φa; $\psi_1 a$; $\varphi' a$. The fourth and last propositional function in (1a) requires additional explanation. The problem of the logical interpretation of that function is of considerable importance, since not only just the same situation occurs with regard to the parallel functions in both (1b) and (1c), but the interpretation directly affects the formalisation of (2a)—(2c) and that of the whole reasoning as well. Now, the function, or its linguistic expression, as it stands in the fourth atomic proposition in (1a): '(there is) death' (死), seems to be independent (that is, non-derivable by means of logical operations) of all others which occur in the preceding propositions in (1a). But in fact it should be conceived of as the negation of the second function (standing in the consequent of the first implicational structure), that is, the negation of '(there is) life' (生). In view of the well-known fact that the use of antonymic terms is a common stylistic feature in Chinese, it is not at all surprising that the philosopher preferred to express himself in such terms instead of using mere negation. What imports here is that the character 死 of our text certainly stands for its *implicatum,* that is, the negative phrase 無生 'there is no life'. Consequently, contrary to what might appear at the first glance, the propositional function under discussion is to be represented by ψ_1', that is, the negation of 生 $= \psi_1$, and thus the whole of (1a) becomes: $(\varphi a \supset \psi_1 a) \cdot (\varphi' a \supset \psi_1' a)$. Similarly, in (1b) we shall put ψ_2 for '(there is) richness' (富) and ψ_2' for '(there is)

poverty' (貧, implying the negation of 富 $= \psi_2$), and in (1c) — ψ_3 for '(there is) order' (治) and ψ'_3 for '(there is) disorder' (亂, implying 無治). Thus, the corresponding atomic propositions in (1b)—(1c), in which the argument a is left unexpressed but is always understood, are to be rendered in our notation as: $\psi_2 a$; $\psi'_2 a$; $\psi_3 a$; and $\psi'_3 a$.

The logical structure of (2a)—(2c) is more complex than that of the first part just discussed. (2a) is typical for the part now in question, since, as is easily seen from the text given *supra*, p. 88, there is close parallelism, both linguistic and logical, between (2a) and each of (2b)—(2c)[5]. Now, (2a) is a molecular structure composed of two propositions: 天欲其生 and [天]惡其死, bound up by the logical operation of conjunction, — the conjunction itself being expressed here by the particle *êr* 而 [6]. The object-argument here (and also in (2b)—(2c)) is 'Heaven'

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[5] We should recall that the introductory two-character phrase in (2a) does not belong to the reasoning itself; it merely has a stylistic function and is to be left out of consideration in the logical analysis, *cf. supra*, p. 89, footnote 3.

[6] As a matter of fact, the particle *êr* is not a sign of mere interpropositional conjunction (in the logical sense of the term), since linguistically it also has a contrasting, or adversative, function. This however does not affect the logical rôle of *êr* in the structure under discussion, and logically the particle is to be interpreted here (and also in (2b)—(2c) and (3)) as corresponding to the conjunctional functor (that is, interpropositional "and"). It deserves emphasis that all this runs counter W. A. C. H. D o b s o n's grammatical treatment of the particle. In his *Late Archaic Chinese* (pp. 90—94), D o b s o n recognises solely the subordinative function of *êr*, within which he distinguishes two sub-functions: first, when *êr* is "purely formal, serving to demark the conclusion of the subordinate clause, and to introduce the main verb" (*ibidem*, p. 91, footnote 56); second, *êr* as a conjunction of subordination, "when the agent of the subordinate clause is other than the agent of the main verb" (*ibidem*, p. 93). As is easily seen, (2a)—(2c) and (3) do not fit any of these distinctions. In particular, since the 'agent' (天) is the same before and after *êr* throughout (2a–c)—(3), it appears that the particle should be taken as a 'purely formal' mark at the end of the first clause (regarded as subordinate), — which certainly is not the case. On the other hand, the structure of (2a) seems to fit the distributional pattern established by D o b s o n for *êr* in its second sub-function (as a conjunction, *ibidem*, p. 93). But here again there is disagreement with D o b s o n's definition, demanding different agents in the two clauses and making the first clause subordinate. Clearly, no one of the sentences (2a—c)—(3) has a subordinate structure. Each of these molecular structures is a sequence of two propositions bound up by syntactic co-ordination (corresponding in this case to logical conjunction) with some emphasis on contrast between the component propositions, all this being expressed by *êr*. Its grammatical rôle here in question has been clearly defined by W. S i m o n: as a co-ordinative particle, *êr* "introduces the second of two contrasted sentences or clauses, thereby emphasizing the contrast" (*Functions and Meanings of erl: Part IV*, "Asia Major" IV, 1 (1954); see p. 23 and 30). I hardly see the reason why this co-ordinative-contrastive function of the particle has been entirely omitted from D o b s o n's book. I also doubt whether D o b s o n is right when he says that "The adversative, as a distinct grammatical form, does not occur until Han times" (*ibidem*, p. 90, footnote 55).

(天); it will be symbolised by the letter b^7. But there is also in each of the component propositions another (and more complex) argument, namely, 其生 'life [in the world]' in the first proposition and 其死 'death [in the world]' in the second. The corresponding expressions also occur in (1a), and, as we know, they have been symbolised there by $\psi_1 a$ and $\psi_1' a$ respectively, see *supra*, p. 90. It goes without saying that the same analytic symbols should be used for the given expressions as they stand in (2a). From the logical point of view, the only relevant difference between 生 as it stands in (1a), pregnant for 'there is life in the world' (rendered as $\psi_1 a$), and 其生 as it stands in (2a), pregnant for 'life in the world' (equally rendered as $\psi_1 a$), is that in the former case the expression is to be regarded as an atomic proposition in itself (and one being the consequent of the given implicational structure: $\varphi a \supset \psi_1 a$), while in the present case the corresponding expression — irrespective of its logical complexity as is visualised by the symbolism — represents the second argument of a major function (shortly to be discussed). Of course, the same is true of 死 as pregnant for 'there is death in the world' implying 'there is no life in the world' $= \psi_1' a$, which is the second consequent in (1a), and 其死 for 'death in the world' implying 'no life in the world', which is the second argument of the second proposition in (2a). In both cases the expression has, despite its different logical rôle, the same logical structure to be rendered as $\psi_1' a$. Furthermore, as can easily be seen from the very parallelism in the original Chinese wording, the same refers to any second argument in any component proposition of (2b)—(2c). In their logical structure these arguments correspond to the consequents in (1b)—(1c) and are to be rendered in the same way: $\psi_2 a$; $\psi_2' a$; $\psi_3 a$; and $\psi_3' a$ (*cf. supra*, p. 91).

The specific quality of all these arguments deserves to be briefly discussed. As we know from the introductory remarks in the preceding chapter of this study (*cf.* RO XXVII, 1; pp. 103—104, and the bibliographical references there given), functions of the first type, that is, functions referring to object-arguments (arguments of the thing-type), can themselves occur as arguments of other functions. The latter are called higher functions and are represented (in the notation adopted here) by Greek capitals. For instance, in the structure $\Phi \varphi$ the symbol Φ represents a higher function, and φ is its argument which itself is a function of the first type. In less sophisticated formulation, all this simply means that we can speak not only of properties (φ, etc.) as belonging to some object x, but also of 'higher' properties (Φ, etc.) as belonging to properties of the first type (φ). It goes without saying that we largely exploit both types of functions in our daily discourse; *cf.* "John is yawning",

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⁷ The professional logician may have some doubt whether 'Heaven' (in the transcendent sense) can be put forward as an object-argument of any propositional function. For the historian of Chinese philosophy, however, such a problem does not arise, since in M o T i's philosophy 'Heaven' was conceived as a r eal object: the supreme anthropomorphic deity nearly identical with the 'Supreme Emperor' (*Shang-ti*) of the early Chinese religion.

which is φa, that is, a particular instance of φx with the constant "John" $= a$ for the argument-variable x and "(is) yawning" for φ, vs. "Yawning is catching", which is an instance of $\Phi\varphi$ with "(is) catching" for Φ. The essential difference between ordinary language and the functional calculus in dealing with what logically are functions is of two kinds. First, the very linguistic form of the function-word (or word group, since a function is not always expressed by a single linguistic word) usually changes according to its actual syntactic rôle as a predicate in itself, or as a subject or object (logically: argument) of a major (higher) function. What is more, from the linguistic point of view the function-words are shifted from one grammatical category to another according to whether they stand for predicates or function-arguments. These linguistic distinctions bound to various morphological shapes of what logically are function-words prove to be irrelevant from the point of view of the functional calculus and hence can be disregarded in the logical symbolism: φ as representing the given function and corresponding to various linguistic shapes assumed by the given function-word in different linguistic contexts itself does not change its shape, and its actual rôle within the given logical context is to be inferred from this context. Second, natural linguistic systems do not differentiate grammatically between function-words of the first type and function-words of higher types (practically any such word can indiscriminately be used to express both φ and Φ), while logically the distinction of lower and higher functions is of prime importance and hence must be introduced into the symbolism[8]. All these remarks largely refer to the function-arguments in (2a)—(2c) as introduced *supra*, p. 92, which however specifically differ from the kind of arguments so far spoken of. Each of these arguments is a function of the first type plus its object-argument absorbed ($\psi_1 a$, etc.) — not a bare function (ψ_1, etc.) — and this fact should not disconcert the reader. Now, a function of the first type with its object-argument absorbed, — as for instance (φa), the parentheses indicating here the absorption of the argument — can still be regarded as a new function of the first type. It is new in relation to φ precisely because of the argument absorbed (as is shown in the symbolism: (φa) as against φ), but its type remains the same. Consequently, such a function behaves like any function of its type. In particular, it can take another object-argument: (φa)b, that is, "(φa) of b", and also can itself become the function-argument of another (higher) function: $\Phi(\varphi a)$, that is, "Φ of (φa)". Reverting to the examples previously given *supra*, an actual instance of such a 'compound' function-argument which itself is a function with its object-argument absorbed, can be construed as "John's yawning is catching", — which in symbols already used in the previous examples ("John" $= a$; "(is) yawning" $= \varphi$; "(is) catching" $= \Phi$) gives the formula $\Phi(\varphi a)$. It also goes without saying that such 'compound' functions can occur as function-arguments

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[8] By the way, it is a well-established fact that natural linguistic systems introduce and emphasise grammatical distinctions which are logically irrelevant and even misleading, while on the other hand they often efface distinctions of considerable logical importance.

of higher two-place functions. Of course, all this also refers to $\psi_1 a$, $\psi_1' a$, etc. of the Chinese reasoning under discussion: in (1a)—(1c) they occur as propositions in their own right, while in (2a)—(2c) they are specific function-arguments of a major function. This takes us back to the problem of the major function in (2a)—(2c).

As is easily seen from the Chinese text itself, there are two function-words throughout (2a)—(2c), which are not in a function-argument position and which are grammatical predicates: *yü* 欲 'to wish, to like' in the first and *wu* 惡 'to hate, to dislike' in the second component proposition of each molecular sentence. Evidently, they correspond to what logically are higher functions (of the Φ-type), since their grammatical objects themselves are again function-words. Since however both *yü* and *wu* also have throughout (2a)—(2c) the grammatical subject 天 $= b$ (whether explicitly expressed in the first proposition or merely understood in the others), which logically is to be regarded as the first argument and one of the thing-type, therefore the corresponding higher functions themselves are to be qualified more specifically as heterogeneous two-place functions[9]. Furthermore, similarly to the pairs 死 : 生, etc., previously discussed in connection with (1a)—(1c), see *supra*, p. 90, 惡 is to be rendered as the negation of 欲, not as an independent function; if we put Φ for 欲, 惡 ($\supset$ 不欲) is to be represented by Φ'. Thus, the whole of (2a) becomes: $(b\ \Phi\ \psi_1 a) \cdot (b\ \Phi'\ \psi_1' a)$, and (2b)—(2c) are to be represented in much the same way[10]. Sentence (3), in turn, does not offer any problem of its own, since its structure is largely similar, both linguistically and logically, to that of (2a)—(2c) just discussed. The insertion of the sub-argument 天下 $= a$, unexpressed but understood, has already been explained in connection with the translation of the passage (*supra*, p. 90). The sentence itself is a molecular structure composed of two propositions bound up by logical conjunction (expressed by *êr*). The object-argument in both propositions is 天 $= b$, the major functions are 欲 $= \Phi$ and 惡 $= \Phi'$, the 'compound' function-arguments are *i* 義, interpreted as 'righteousness [in the world]', that is, φa, and its negation *pu-i* 不義,

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[9] This, of course, does not mean that the function-words *yü* and *wu* always correspond to functions of such a specific type. According to what has been said *supra*, p. 93, the words can occur in other contexts as functions of the first type, as one-place higher functions, etc.

[10] In accordance with what has been said *supra* in connection with functions with arguments absorbed, the formulae of the component propositions now in question should be given the form "$(b\ \Phi\ (\psi_1 a))$", etc. rather than "$(b\ \Phi\ \psi_1 a)$", etc. This however would unnecessarily overload the formulae with parentheses. The logical rôle of $\psi_1 a$, etc. as the 'compound' function-argument of the major function Φ (or Φ') is clear from the context and need not be emphasised within the formulae corresponding to the given propositions. In the formalisation of the whole reasoning, *infra*, p. 96, parentheses are used exclusively for the delimitation of implicational structures and component propositions as forming part of larger molecular structures.

interpreted as 'unrighteousness [in the world]', that is, $\varphi'a$ (logically there is no relevant difference between 無義 as it stands in (1a)—(1c) and 不義 in (3)).

I am aware that the foregoing lengthy discussion — which from the logical point of view is both elementary and slightly simplified — may seem unnecessary and even annoying to the reader trained in the logical analysis. For such a reader it would suffice to tabulate the symbols used and pass on to the formalisation of the reasoning itself. None the less, this preliminary discussion of the relevant linguistic and logical features of the passage in its original wording had to be included here for various reasons. First, neither logically trained sinologists nor sinologically trained logicians appear to be numerous — and the present study is mainly intended for professional sinologists. For them, I presume, the foregoing discussion will be useful not only as a necessary introduction to the particular problems involved in the formalisation of the reasoning, but also as a kind of general introduction to specific analytical methods by means of and also in terms of the calculus of functions, methods which, to my knowledge, have never so far been applied to any part of an early Chinese text. The importance of the analytical technique just discussed and exemplified goes far beyond our present example, since similar procedures are to be applied — and will be applied — in the analysis of further instances of the Chinese reasoning which involve the calculus of functions in any of its subdivisions. It is to be emphasised that the sinologist interested in Chinese logic must of necessity become acquainted with this technique, unusual in sinology as it is, and that he should be able to solve by himself the specific problems resulting from the application of the technique to the Chinese text. Now, it seems to me that the *Mo-tsï* passage which is the subject-matter of the present chapter is at the same time a strikingly good sample to serve the purpose of introducing both the logical analysis of linguistic structures in terms of the functional calculus and also the specific problems arising in connection with the application of such methods to Chinese texts. Second, I also think that the foregoing discussion can be helpful to the logicians (or historians of logic) having no knowledge of Chinese who, upon reading the present study, will want to get an idea of what the original wording of the passage to be formalised is like. One of the objectives of this discussion has been to explain the key problems of the Chinese text in such a way as to enable someone without any knowledge of Chinese to follow the formalisation of the whole reasoning on its original wording itself rather than on the translation. Finally, as we shall see later, the preceding pages will be helpful for a further discussion of the problem of relationships between language and logic in Chinese. This latter problem, so far rather inadequately dealt with (or passed over entirely) by students of Chinese philosophy, will be touched upon briefly *infra*, pp. 103 ff.

All symbols to be used in the formalisation of the whole reasoning have already been given and explained in the course of the foregoing discussion. For the sake of convenience, however, it is useful to cull the non-compound symbols from the

preceding pages and list them all together with their actual values in Chinese characters. This gives the following classified list:

天下 $= a$ (有)義 $= \varphi$ 生 $= \psi_1$ 欲 $= \Phi$

天 $= b$ 無義 $\Big\}= \varphi'$ 死 ($\supset$ 無生) $= \psi_1'$ 惡 ($\supset$ 不欲) $= \Phi'$
             不義   富 $= \psi_2$
                                          貧 ($\supset$ 無富) $= \psi_2'$
                                          治 $= \psi_3$
                                          亂 ($\supset$ 無治) $= \psi_3'$

As is easily seen, the first column lists all the object-arguments involved in the reasoning, the second and third column — all the functions of the first type, and the fourth column — the heterogeneous functions, — all with the values they have within the reasoning. The reader will also note that all the function-words of the first type as they stand in the list correspond to 'bare' functions; that is, they are not pregnant for *function + argument* expressions. This is different from the Chinese text itself, in which, as we recall, the argument a — whether expressed or not — is always understood with these functions.

With all this in mind, we can proceed to the formalisation of the whole passage, which gives the following set of formulae:

(1) (a) $(\varphi a \supset \psi_1 a) \cdot (\varphi' a \supset \psi_1' a)$
     (b) $(\varphi a \supset \psi_2 a) \cdot (\varphi' a \supset \psi_2' a)$
     (c) $(\varphi a \supset \psi_3 a) \cdot (\varphi' a \supset \psi_3' a)$

(2) (a) $(b\, \Phi\, \psi_1 a) \cdot (b\, \Phi'\, \psi_1' a)$
     (b) $(b\, \Phi\, \psi_2 a) \cdot (b\, \Phi'\, \psi_2' a)$
     (c) $(b\, \Phi\, \psi_3 a) \cdot (b\, \Phi'\, \psi_3' a)$

(3) $(b\, \Phi\, \varphi a) \cdot (b\, \Phi'\, \varphi' a)$

The highly elaborate form of the reasoning thus formalised itself is not without interest, but need not be emphasised since it can be seen at the first glance. On the other hand, the much more important fact that the reasoning is an instance of logically valid inference is perhaps less clear and must be discussed in some detail. Two main problems arise in this connection, that of the relation of equivalence which is indirectly involved in the reasoning, and that of the possible redundancy of the present inference.

The relation of equivalence (written "$\equiv$" and read "if and only if") so far has not been considered. Its logical character can be best illustrated within the propositional calculus. Now, equivalence is usually defined as 'reciprocal implication', that is, two propositions, p and q, are equivalent ($p \equiv q$) if and only if p implies q and q implies p:

$$(p \equiv q) \underset{df.}{=} (p \supset q) \cdot (q \supset p)$$

Since however the second factor in the *definiens*, $(q \supset p)$, itself is equivalent to $(p' \supset q')$ according to the so-called law of contraposition[11], it goes without saying that $(p \equiv q)$ can also be defined in the following way:

$$(p \equiv q) \underset{df.}{=} (p \supset q) \cdot (p' \supset q')$$

Although there are some reasons to select the first definition cited, as has been done in modern logic (see *infra*), it is to be emphasised that the second is as good as the first, and other definitions of equivalence are also possible. In less sophisticated language, each of these definitions means that two propositions are equivalent if they have the same truth-value (that is, if either both are true, "*1*", or both are false, "*0*"). Of course, equivalent propositions remain equivalent if both are negated: $(p \equiv q) \equiv (p' \equiv q')$, and any of the equivalent propositions can be substituted in place of the other without invalidating the truth-value of the molecular structure within which the substitution takes place.

It is understandable why the first of the two definitions of equivalence cited above is commonly used in our logic: it is the first which is more 'economical' than the second, since it involves only two kinds of logical operations in the *definiens* (those of implication and conjunction) while the second requires one operation more (that of negation). It is however less understandable why the second formula does not at all appear in the many textbooks on logic I have seen. Even if not conceived as a definition of equivalence, the corresponding formula $(p \equiv q) \equiv (p \supset q) \cdot (p' \supset q')$ is a good and useful tautology of the propositional calculus and deserves to be ranked among the so-called laws of dissolution of equivalence (two other laws of dissolution of equivalence are cited in textbooks on logic). What is specifically important from the sinological point of view is that there are good reasons to believe that equivalence — as far as it is actually involved in Chinese reasoning — was conceived by the early Chinese thinkers precisely according to the definition unusual in our logic as $(p \supset q) \cdot (p' \supset q')$ rather than as $(p \supset q) \cdot (q \supset p)$. The reasoning selected for discussion in this chapter is one of the typical examples of dealing with equivalence in such a way. We shall see in another section of the present study that equivalence conceived as 'double implication' simultaneously occurring between the non-negated terms on the one hand and between the corresponding negated terms on the other — and not as 'reciprocal implication' in the sense of the first definition spoken of *supra*, p. 96 — is by no means confined to the reasoning now in question, but seems to be one of the specific features of the Chinese (implicit) logic in general. Another important point is that logical equivalence thus conceived plays some rôle in the calculus of functions as represented in early Chinese reasoning rather than in the calculus of propositions[12]. This also refers to the reasoning analysed in this chapter.

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[11] The general formula of contraposition is $(p \supset q) \equiv (q' \supset p')$, from which we easily obtain the formula $(q \supset p) \equiv (p' \supset q')$.

[12] This explains why equivalence has not been considered in my chapter IV, devoted to the Chinese propositional calculus.

Of course, the essential properties which the relation of equivalence has within the propositional calculus hold equally good within the calculus of functions, quite independently of whether the first or the second definition of the relation itself be selected. Thus, two propositions analysable as having the same argument but differing in function-words, for instance φa and ψa, are to be considered equivalent $(\varphi a \equiv \psi a)$ if we know that $(\varphi a \supset \psi a) \cdot (\psi a \supset \varphi a)$, but also if we know that $(\varphi a \supset \psi a) \cdot [(\varphi a)' \supset (\psi a)']$. Provided that a is not an empty argument (that is, excluding the cases in which the argument-word does not represent any object at all, *cf.* the preceding chapter, RO XXVII, 1; p. 108, footnote 5), the formula corresponding to the second definition, $(\varphi a \equiv \psi a) \equiv (\varphi a \supset \psi a) \cdot [(\varphi a)' \supset (\psi a)']$, can be simplified as follows:

$$(\varphi a \equiv \psi a) \equiv (\varphi a \supset \psi a) \cdot (\varphi' a \supset \psi' a)$$

This latter formula can be regarded as a particular case of the law of dissolution of equivalence within the calculus of functions, and more specifically a case limited to structures (analysable in terms of the functional calculus) involving no empty argument[13]. We also see at once that the molecular structures (1a)—(1c) of the Chinese reasoning are as many instances of 'dissolved equivalence'. According to the last formula given, $(\varphi a \supset \psi_1 a) \cdot (\varphi' a \supset \psi_1' a)$ simply is as much as $\varphi a \equiv \psi_1 a$, and so on. On the other hand, as we know, an equivalence like $\varphi a \equiv \psi_1 a$ itself is equivalent to $\varphi' a \equiv \psi_1' a$, and so on. Substituting the corresponding equivalences in place of their 'dissolved forms' as they stand in the original reasoning, we obtain the following picture of the whole inference (*cf. supra*, p. 96):

(1)	(a)	$\varphi a \equiv \psi_1 a$
	(b)	$\varphi a \equiv \psi_2 a$
	(c)	$\varphi a \equiv \psi_3 a$
(2)	(a)	$(b\ \Phi\ \psi_1 a) \cdot (b\ \Phi'\psi_1' a)$
	(b)	$(b\ \Phi\ \psi_2 a) \cdot (b\ \Phi'\psi_2' a)$
	(c)	$(b\ \Phi\ \psi_3 a) \cdot (b\ \Phi'\psi_3' a)$
(3)		$(b\ \Phi\ \varphi a)\ \cdot (b\ \Phi'\varphi' a)$

[13] Not being a professional logician, I only presume that the corresponding general law has the following form: $\underset{xy}{\Pi} \underset{\varphi\psi}{\Pi} \{(\varphi x \equiv \psi y) \equiv (\varphi x \supset \psi y) \cdot [(\varphi x)' \supset (\psi y)']\}$, — but I have to state that I have never come across any such formula in any treatise on logic. This is perhaps not surprising in view of the fact already mentioned that even the corresponding formula of dissolution of equivalence in the propositional calculus, $(p \equiv q) \equiv (p \supset q) \cdot (p' \supset q')$, — which certainly deserves to be ranked among the useful tautologies of the calculus — has so far not attracted the attention of the writers of textbooks. For our present purpose it is sufficient to emphasise that the formula $(\varphi a \equiv \psi a) \equiv (\varphi a \supset \psi a) \cdot (\varphi' a \supset \psi' a)$, which is directly applicable to the Chinese reasoning under discussion, is easily derivable from the propositional tautology $(p \equiv q) \equiv (p \supset q) \cdot (p' \supset q')$. The formula is, in fact, a mere 'translation' of this latter tautology in terms of the simple calculus of functions $(p = \varphi a;\ q = \psi a)$.

The present formalisation — which, of course, is equivalent to the former one given on p. 96 — makes the logical validity of the inference more spectacular. If, for instance, we know from (2a) that $b\,\Phi\,\psi_1 a$, while $\psi_1 a$ itself according to (1a) is equivalent to φa, it follows inevitably (by simple substitution of equivalent terms) that $b\,\Phi\,\varphi a$ — as is stated in (3). Similarly, if we know from (2a) that $b\,\Phi'\psi_1' a$, and from (1a) that $\psi_1' a$ is equivalent to $\varphi' a$ (the equivalence $\varphi a \equiv \psi_1 a$ itself is equivalent to $\varphi' a \equiv \psi_1' a$), it follows that $b\,\Phi'\varphi' a$ — which corresponds to the second factor in the conclusion. This shows that the conclusion (3) is, in fact, implied by (1a) and (2a) alone, and that, consequently, (1b—c) and (2b—c) are useless premises, unnecessary for drawing the conclusion already arrived at by virtue of (1a) and (2a). On the other hand, the reader will note that the same conclusion (3) can be drawn by taking into account (1b) and (2b) or (1c) and (2c). Thus, the inference as it stands in our text is specifically redundant, and this compels us to deal briefly with the problem of redundancy.

An inference is redundant if it contains one or more useless (pleonastic) premises. One Chinese example of such an inference (drawn from the *Kung-sun Lung tsï*) has already been cited in chapter II of this study (RO XXVI, 1; p. 11). We know from S e x t u s   E m p i r i c u s that redundant inferences (παρὰ παρολκήν) were considered invalid by the Stoics. In this, however, the Stoic logicians were wrong, since redundancy itself cannot make a reasoning invalid, although it makes the reasoning inelegant (in the sense of overloading the inference with useless elements)[14]. This also refers to the Chinese reasoning under discussion, which even if considered redundant remains valid. What is more, the Chinese inference (1)—(3) is specifically redundant, or perhaps quasi-redundant, and not simply redundant in the Stoic sense of the term. As can be seen from the few examples handed down by S e x t u s (*cf.* M a t e s, *ibidem*), redundancy of the reasoning was conceived by the Stoic logicians chiefly (and perhaps exclusively) as connected with the presence of a quasi-premise, entirely extraneous to the given inference. This certainly is not the case with our Chinese reasoning, in which the useless premises are not only closely related to the necessary ones, but themselves form pairs which imply just the same conclusion as that implied by the pair selected as necessary. As a matter of fact, we cannot even tell which one of the three pairs, (1a)—(2a), (1b)—(2b), or (1c)—(2c), is to be considered necessary and which useless, since each of the three can be both. Each of the three pairs in a like way is sufficient for the drawing of the conclusion (3), and all we can say is that if we arbitrarily select this or that pair as necessary, the remaining two turn out to be unnecessary. All this, together with the very close linguistic parallelism throughout (1a—c) and (2a—c), makes me think that the whole reasoning as it stands had better be conceived as a conjunction of three inferences, differing in premises but having the same conclusion, rather

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[14] *Cf.* B o c h e ń s k i, *op. cit.*, p. 100; B. M a t e s, *Stoic Logic*, Berkeley-Los Angeles 1961, p. 83.

than as an instance of redundant reasoning. In other words, our passage which actually has the form

$$\frac{\begin{array}{c}(1a-c)\\(2a-c)\end{array}}{(3)}$$

appears to be a reformulation (reformulation which, by the way, would be in perfect agreement with the linguistic structure of Chinese and the requirements of Chinese literary style as well, *cf. infra*, p. 110) of the following three inferences:

$$\frac{\begin{array}{ccc}(1a) & (1b) & (1c)\\(2a) & (2b) & (2c)\end{array}}{\begin{array}{ccc}(3) & (3) & (3)\end{array}}$$

If so, there seems to be no logical redundancy at all in the passage, since neither the procedure of drawing the same conclusion from various sets of premises nor that of combining such specifically different inferences into what linguistically and stylistically looks like a single piece of reasoning can be termed redundant (in the accepted sense of the term). Proceeding in such a way, the Chinese philosopher must have had in view extralogical — but not extradialectical — objectives. He evidently wanted to make the reasoning more vigorous and to strengthen its persuasive effect, and we remember that the Chinese reasoning was precisely meant as persuasion rather than demonstration or proof in the logical sense of the terms (*cf.* RO XXVI, 2; p. 92). It is also possible that the philosopher, convinced as he himself was of the truth of all his premises, was none the less conscious of the fact that someone might question (or reject) this or that pair of premises while accepting another pair, and that even in such a case the reasoning remained both valid and conclusive. On the other hand, he evidently did not consider the possibility that anybody might reject all three pairs as equally false[15]. With all this, the reasoning as it stands is

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[15] The very order of the molecular sentences in (1a–c) and (2a–c) probably is not accidental, and the philosopher seems deliberately to proceed from 'weaker' to 'stronger' premises. Thus, the first pair, (1a)—(2a), is particularly weak (even from the Chinese point of view) and might be rejected as not withstanding the slightest criticism, while the third pair, (1c)—(2c), corresponds to the otherwise reasonable idea that righteousness is closely connected with social order and unrighteousness with disorder. This idea, even if not universally accepted in early Chinese philosophy, was in fact very common among the Chinese thinkers (also outside the Mohist school); *cf. infra*, p. 101, footnote 17. A specific 'dialectical' objective of the whole reasoning might also have been the following: it is suggested to anyone who might be inclined to reject one or two pairs of premises while accepting another pair (for instance, the 'strongest' one, the third), together with the conclusion which it entails, that he, after all, should accept all other pairs as leading to the same conclusion. Of course, such a suggestion, if present in the passage, is logically indefensible.

logically valid, and the tautology underlying it can be represented by the following formula (in which a and b stand for non-empty object-arguments):

$$\underset{\varphi\psi\,\Phi}{\varPi\varPi} \left\{ [(\varphi a \supset \psi a) \cdot (\varphi' a \supset \psi' a) \cdot (b\,\Phi\,\psi a) \cdot (b\,\Phi'\,\psi' a)] \supset [(b\,\Phi\,\varphi a) \cdot (b\,\Phi' \varphi' a)] \right\}$$

This formula corresponds to any single inference as forming part of the reasoning, and its complexity makes more spectacular both the complexity of the inferential procedure itself and the elaborateness of the whole reasoning as conjunctionally composed of three such parallel inferences.

In connection with all this and in order to avoid any misunderstanding on the reader's part, two further problems deserve emphasis. In the first place, it has by no means been my intention to defend the conclusiveness of the reasoning under discussion, but only to show that the reasoning — contrary to what might appear at the first glance — is logically valid and corresponds to a good (and rather sophisticated) formula. Now, the logical validity of an inference depends on whether the inference follows a pattern which excludes those cases — and only those cases — where true premises might lead to a false conclusion (not: where false premises might lead to a false conclusion). This amounts to saying that a valid inferential procedure should correspond to a tautological formula. It is in this sense that the reasoning discussed in this chapter is logically valid: as has been shown by the formalisation, it follows the inferential pattern which cannot lead from true premises to a false conclusion. But the conclusiveness of an inference is something else, or strictly speaking something more, since it requires not only the validity of the inference, but also the truth of its premises[16], — and this is not the case with the reasoning under discussion. As a matter of fact, none of the three pairs of premises can withstand criticism, and all are to be rejected[17]. This, and not the alleged lack of logical validity (as is suggested by F o r k e, *cf. supra*, p. 89, footnote 4) makes the reasoning non-conclusive. As has already been remarked on various occasions, one of the most characteristic features (and perhaps the most important at that) of the early Chinese reasoning is that inferential patterns which are logically valid were usually put at the service of non-conclusive speculations, this non-conclusiveness being due to the vagueness or falsity (or both) of the premises (*cf.* RO XXVI, 2; pp. 97—98; "Rivista", p. 166 and 168). M o T i, although probably the keenest logician (as far as implicit logic is concerned) among the early Chinese thinkers is by no means an exception to this rule. In the second place, it has not been my

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[16] *Cf.* H. R e i c h e n b a c h, *Elements of Symbolic Logic*, pp. 67—68; and also my remarks in "Rivista degli Studi Orientali" XXXVIII, 2; p. 166.

[17] It has been said *supra*, p. 100, footnote 15, that the third pair, presumably considered the 'strongest' by the philosopher himself, corresponds to the otherwise reasonable idea connecting righteousness with (social) order. But even this idea cannot be accepted in the formulation it receives within the reasoning; for instance, the alleged equivalence of "there is righteousness in the world" and "there is order in the world" ($\varphi a \equiv \psi_3 a$), which is involved in (1c), does not stand the empirical test. This is reminiscent of D. B o d d e' s objections against the chain-reasoning, *cf.* RO XXVI, 2; p. 97.

intention to suggest that the Chinese philosopher might have been cognisant of the logical problems which we have been discussing in connection with his reasoning. On the contrary, the main intention of the present chapter has only been to show that M o T i was able intuitively to reason according to rather sophisticated (even from our point of view) inferential patterns belonging to the calculus of functions, and that on closer examination by means of symbolism and formalisation these patterns prove to be logically valid. This important, and perhaps surprising, fact is by no means invalidated by another one already emphasised, namely that a valid inferential procedure was applied by our philosopher to a non-conclusive reasoning. This latter fact only means that M o T i, like probably all early Chinese thinkers, lacked epistemological criticism, but not that he lacked logical keenness. It goes without saying that neither M o T i as the spiritual author of the 'systematic' part of the *Mo-tsĭ*, nor his direct or indirect pupils who, as is assumed, collectively wrote down the master's teachings sometime after his death, had any logical theory corresponding to the kind of reasoning under discussion in this chapter. In connection with this, it is worth while to emphasise that if my interpretation of the so-called Mohist *hiao* (given in the preceding chapter of this study) is accepted, it only means that the later Mohist dialecticians (who, by the way, lived long after M o T i) actually arrived at a simple and elementary formula of the calculus of functions. The possibility that they ever progressed in this direction and discovered more complex formulae and rules of the functional calculus, like those involved in the instance discussed, may safely be excluded. On the other hand, there is no reason to doubt that our sophisticated instance of reasoning stems from M o T i himself, even if we have to assume a fairly long oral tradition between the master himself and the fixation of his teachings in the written form. Briefly, M o T i's skill in operating intuitively with highly elaborate and logically valid forms of reasoning cannot be put in doubt, and it seems reasonable to look for the factors which possibly facilitated and seconded the philosopher's logical intuition. In my opinion, the most important circumstance in this respect is the linguistic structure of Chinese itself, and this takes us back to the final topic of the present chapter, that is, the previously signalised problem of relationships between language and logic in Chinese.

Strictly speaking, the problem belongs to the concluding section of this study, and we shall have to revert to it there with all our materials at hand. However, occasional remarks on language in relation to logic have already been unavoidable in the previous sections (*cf.*, for instance, RO XXVI, 1; pp. 15—16 and 20—21; XXVI, 2; pp. 103—105) while, on the other hand, the reasoning discussed in the present chapter offers a particularly good occasion for the exemplification of one important aspect of the relationships between language and logic in Chinese, an aspect which so far has remained unnoticed. Therefore it is not out of place to deal briefly with the problem here. Besides a few introductory remarks, the present discussion will necessarily concentrate on that particular aspect of the problem which is very closely connected with the subject-matter of this chapter, that is, the relationship between the Chinese language and the Chinese (implicit) logic of functions.

It has long been a common opinion among sinologists that the linguistic structure of Chinese largely accounts for what might be termed the 'logical underdevelopment' of Chinese philosophy, and for the lack of logic as a distinct philosophical discipline in particular. Such characteristic features of Chinese as monosyllabism, lack of inflections, lack of grammatical word-classes ('parts of speech') and even the Chinese script itself, have been cited as the most important factors necessarily hindering the Chinese thinkers from attaining the logical level of Greek or Indian philosophy. It is true that explicit statements or suggestions to this effect go back to the early decades of this century and that recent writers are mostly silent on the subject, but the opinion about the linguistic structure of Chinese (and that of early Chinese in particular) as detrimental to logic appears to be tacitly assumed, at least by some students of Chinese philosophy and culture up to the present. The whole problem is of considerable importance from various points of view, not only from the sinological, and taciturnity cannot contribute to its clarification. The problem certainly is more complex than it might appear from what has so far been written on the subject. It calls for reconsideration in the light of what has been achieved in the fields of sinology (philosophy and linguistics) and of the general history of logic during the last few decades. Without entering into details lying outside of the scope of the present chapter, I should like provisionally to formulate the following propositions which I consider the most important in connection with the whole problem They are these: 1) The simplified assumptions that there is no logic in early Chinese philosophy need qualification, especially as far as implicit logic is concerned (*cf.* my article referred to *supra*, p. 87, footnote 1). 2) It seems probable that certain linguistic features of Chinese, and the semantic aspects of the language in particular, do to some extent account for the underdevelopment of the Chinese logical theory (explicit logic), but this particular problem has never been dealt with satisfactorily (a possible case here is K u n g - s u n L u n g' s specific anticipation of the theory of classes, which seems to be connected with superficial linguistic suggestions, *cf.* RO XXVI, 1; pp. 20—21). 3) Though it is beyond doubt true that certain linguistic features of Chinese could have a negative bearing on Chinese implicit logic (propositional logic in particular), still the importance of this fact should not be exaggerated, and the lingusitic features involved have little, if anything, in common with those usually considered to have the most negative import in relation to logic; in this connection, the grammatical polyvalence of particles ('empty words') corresponding to logical functors and the lack of a clear linguistic expression for some functors can be cited in the first place (*cf.* my remarks on the lack of logical sum, or alternative, in Chinese propositional logic as connected with the lack of an adequate linguistic means to express interpropositional 'or', RO XXVI, 2; pp. 104—105). 4) Such characteristic features of early Chinese as monosyllabism of lexical units, lack of inflections and lack of clearly delimitated grammatical word-classes (especially the lack of a clear morphological distinction between nominal and verbal forms) could hardly have any negative bearing on Chinese implicit logic; in fact, they are beneficial rather than detrimental to this logic, since they make the Chinese language

more similar to the symbolic language of modern logic than any tongue of the Indo-European type can claim to be. This latter point seems to be of special importance in connection with the (implicit) logic of functions, — and it is precisely this topic which is to be dealt with presently.

Monosyllabism of lexical units, which is indeed characteristic of Chinese at least up to the Han period[18], is in itself a quantitative feature, and as such it might be expected to be indifferent to thinking, whether logical or illogical[19]. But on closer inspection Chinese monosyllabism turns out to have been advantageous rather than indifferent to (implicit) logic. In connection with this, two facts deserve emphasis. First, the quantitative uniformity of linguistic units corresponds better to the logical symbolism (especially that of the calculus of functions) than the quantitative diversity of single words could do. Indeed, I think that it is monosyllabism itself which is one of the factors making Chinese potentially similar to artificial symbolic notation as it is used for the logical analysis of actual linguistic sentences (and other linguistic structures syntactically complex). Second, it is the monosyllabic quality of linguistic units which made possible the development of parallelism as a stylistic (and partly grammatical) device in early Chinese to an extent which is unattainable in any language of our type, precisely because of the quantitative diversity of our lexical units. Strictly speaking, this parallelism, like the monosyllabism from which it derives, is an extralogical factor without any direct or necessary connection with logic, but its potentially positive rôle in spontaneous logical thinking is undeniable[20]. Chinese parallelism has so far been studied mostly as a stylistic and literary pheno-

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[18] By the way, this statement should not be taken in the sense of any 'absolute monosyllabism' of words in early Chinese, but only in the sense of a specific structural principle, *cf.* my *Remarques sur le problème des mots dissyllabiques en chinois archaïque*, "Mélanges publiés par l'Institut des Hautes Études Chinoises" I, Paris 1957; pp. 423—445. Even in the *Mo-tsï* reasoning discussed in this chapter there is one compound lexical unit, *t'ien-hia* '(what is) under Heaven' → 'the world', which goes back to an original syntactic grouping subsequently lexicalised with a specialisation of meaning. But dissyllabic words of any kind, and dissyllabic 'descriptive' or 'emotive' formations indecomposable into meaningful monosyllables in particular, rarely occur in contexts having logical import.

[19] The question how far lexical monosyllabism (together with the limited possibility of derivational word-formation) contributed to the semantic ambiguity of Chinese, which, in turn, possibly accounts for the underdevelopment of explicit logic (see point 2, mentioned *supra*, p. 103), lies beyond our present scope.

[20] For instance, logical parallelism of sentences having the same logical structure and corresponding to one analytic formula is much more frequently matched by linguistic parallelism (and a very rigid one at that) in Chinese than in our languages. Another possible example is this: two or more instances of reasoning logically parallel, that is, following the same tautological formula or inferential pattern and having a logical parallelism which can be made clear by the symbolic notation, are likely to be linguistically parallel (or can easily be made so) in their Chinese wording, while they will hardly be so if translated into a non-monosylabic and inflectional language.

menon, but its possible relevance to Chinese implicit logic seems to have been entirely overlooked. All this, of course, does not mean that I consider Chinese monosyllabism with its implications a warrant against illogical thinking. My sole contention is that monosyllabism in itself was n o t an obstacle to spontaneous logical thinking, and that, contrary to a seemingly common opinion, it even could facilitate the intuitive use of logically valid forms of reasoning by giving such forms a specific uniformity similar to that of the symbolic notation and by furthering the making of closely parallel structures. I think that something of the same sort is true, or even more so, with the lack of inflections and with the lack of clearly distinguishable word-classes, which both are logically positive, and by no means negative, features.

It has long been recognised by modern logicians that the inflectional qualities of our languages are disadvantageous rather than advantageous to logic. This results from the fact that inflections mostly introduce and emphasise word-connections which are either irrelevant or even misleading from the point of view of the logical analysis of linguistic structures. Some time ago, one of the modern logicians launched an attack on the grammatical analysis of *subject-predicate-object* sentences (an analysis based on linguistic criteria, and precisely on immediate word-connections as indicated by inflections) as erroneous, logically misleading and accounting for the fact that traditional formal logic never arrived at the idea of the calculus of relations (two-place functions). This attack itself was due to an obvious misunderstanding, since descriptive or historical grammar of any language is by no means the same as logical analysis of language and cannot be replaced by any 'logistic grammar'[21], but it shows how far modern logicians can go in their condemnation of the grammatical features of our inflectional languages. It remains a fact that traditional logic was for centuries largely handicapped by descriptive grammar of our languages (and, consequently, by the inflectional character of these languages in particular), and that the tremendous development of modern logic is closely connected with its emancipation from grammatical suggestions and with the creation of a specific symbolic quasi-language, independent of the grammatical features of our languages, which quasi-language itself can be termed 'non-inflectional'. Thus, the lack of inflections in Chinese, which entails no immediate word-connections logically misleading and leaves the natural linguistic structures open for spontaneous logical analysis, certainly is an advantage from the logical point of view; also in this Chinese resembles the symbolic language of logic.

Neither can the lack of clearly distinguishable word-classes ('parts of speech') in early Chinese, nor that of morphological differentiation of nouns and verbs in particular[22] (which, by the way, is connected with the lack of inflectional paradigms)

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[21] A more detailed discussion of this particular problem can be found in my article published in Polish, *Językoznawcza analiza zdań podmiotowo-orzeczeniowo-dopełnie-niowych wobec ich analizy logicznej* [= *Linguistic analysis of subject-predicate-object sentences vs. logical analysis of such sentences*], "Rozprawy Komisji Językowej Łódz-kiego Towarzystwa Naukowego", vol. VIII, Łódź 1962; pp. 13—39.

[22] Extreme statements, like H. M a s p e r o' s, about early Chinese as absolutely

be considered a logical defect. This should already be clear from the previous remarks and examples given in connection with the formalisation of the Chinese reasoning (see *supra*, pp. 92—93). In particular, we have already shown that a linguistic expression logically corresponding to a function (φ) or function plus argument (φa) has the same form in the symbolic notation (precisely φ or φa) independently of whether in the given context it represents a grammatical predicate (or proposition) or stands non-predicatively for an argument of another (higher) function ($\Phi\varphi$ or $\Phi \varphi a$) — while in actual linguistic structures of our languages, with their inflections and morphologico-syntactic word-classes, the linguistic form of the given function-word is changed according to whether the word is a predicate, an object of another predicate, etc., and the function-word itself is then shifted from one grammatical word-class (part of speech) to another. In connection with the alleged logical importance of the linguistic differentiation of nouns and verbs as realised in our languages, it should be emphasised that, for instance, the linguistically necessary (in our languages) nominalisation of the verbal form of the function-word when it passes from the grammatical rôle of predicate to that of subject or object (of some other predicate) is, in fact, a handicap to spontaneous thinking in terms of the logic of functions. Our previous examples directly show that this nominalisation is at least logically irrelevant ("John is yawning", or "John yawns": φa; "John's yawning is catching" = "The yawning of John is catching": $\Phi \varphi a$). But it turns out to be a downright handicap if we realise that it prevents one from immediately seeing the logical identity of the function-words involved. By the way, in modern English, with its reduced system of inflections and its word-classes less sharply delimitated than in other IE tongues — both of which features make it to some extent similar to Chinese — the features mentioned are of less importance than in the highly inflectional languages having a much more rigid system of grammatical word-classes[23]. As a matter of fact, the classification of symbols used in the calculus of functions by logically relevant categories as operators, truth-functors, first-type and higher-type functions, etc., has practically nothing in common with the classification of

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lacking of grammatical categories and word-classes, certainly need qualification. Recently, even W.A.C.H. D o b s o n's procedural assumption that in early Chinese "any plerematic word may occur in any form of distribution" and that a classification by word-classes would be "uneconomical as a grammatical analytical device" (*Late Archaic Chinese*, p. 14; similarly in his *Early Archaic Chinese* subsequently published, 1962; pp. xxii and 10) has met with criticism, *cf.* C h o u F a - k a o 周法高, *Chung-kuo ku-tai yü-fa — Tsao-kü pien (shang)* 中國古代語法 — 造句編（上）, Taipei 1961; pp. 22 *et sq.* In my opinion, D o b s o n's assumption is fully justified as a procedural postulate, and C h o u's counterarguments themselves show that there are no clearly delimitated word-classes (of plerematic words) in early Chinese. This is sufficient for our present purpose.

[23] I am far from suggesting that linguistic (grammatical) nominalisation of verbal forms and, inversely, verbalisation of nominal forms, logically redundant or misleading as they are, cannot be subjected to formalisation. As has recently been shown

our linguistic units as 'parts of speech'. The following points may be cited as illustrative in connection with this statement. First, the logically fundamental distinction of arguments and functions resembles to some extent the syntactic distinction between subject and object on the one hand and predicate on the other (without joining the object to the predicate as our linguistic systems do), but not the morphological differentiation of nouns and verbs. Second, the 'argumentisation' of the function-symbol, which is common in some parts of the calculus, involves a change of the rôle of the symbol within the logical context, not a change of its category, and is effected positionally, not by anything resembling the morphological nominalisation of the linguistic function-word. Third, what in the structural aspect of the calculus possibly might correspond to morphological procedure or morphological distinction in the linguistic sense of these terms, that is, the operational procedure of shifting an expression from one logical category to another (for instance, the binding of argument- or function-variables by operators), or the differentiation between first-type and higher-type functions — is only expressible in ordinary language by some periphrastic means, mostly involving various levels of linguistic structure, but has no structural correspondence within the morphological system of any language. (By the way, the distinction of lower and higher functions can hardly be 'translated' into ordinary language which, as has already been said *supra*, p. 93, entirely ignores this distinction). These, of course, are mere examples, and perhaps not the most fortunate ones. We have by no means been attempting a systematic discussion of all the aspects of such a major problem as that of relationships between logic and empirical linguistic systems, but presumably what has been said will be sufficient

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by J. F. S t a a l in his excellent article *The Construction of Formal Definitions of Subject and Predicate*, "Transactions of the Philological Society", 1960; pp. 89—103 (*cf.* especially pp. 98 and 103), such a formalisation is possible by means of specific operations which, as the author states, are similar to those effected in mathematical logic by making use of A. C h u r c h's lambda-operator (and which, as I think, are also similar to those effected by the iota- and eta-operators, *cf.*, *e.g.*, R e i c h e n-b a c h, *Elements of Symbolic Logic*, p. 265). It seems probable that not only nominalisation and verbalisation, but also adverbialisation, adjectivisation, etc., and even the phenomena of the IE morphologico-syntactic structure in general could be formalised along similar lines. Prof. S t a a l's contribution appears to be the first important step in this entirely new field of linguistic research. But it is also possible that in some cases the procedure will prove to be so laborious as to turn out to be uneconomical, and this will show once more (at the level of formalisation at that) the logically intricate complexity, if not the illogicality, of the structure of our languages. It is precisely this problem which the grammarians of the past believed they could deal with and dismiss by introducing the grammatical categories (as allegedly corresponding to the logical ones), and which some modern logicians believe they have solved by a kind of 'logistic grammar' (as allegedly describing actual linguistic systems). From our present point of view, that of possible relationships between the linguistic structure and logic in Chinese, what deserves strong emphasis is that any attempt at the formalisation of the extralogical, linguistic (grammatical) categories is a contribution to the formalised theory of linguistic forms themselves rather than to logic.

to make clear that from the logical point of view it is certainly better for a language not to have any grammatical word-classes at all than to have such as our highly praised Indo-European languages do.

All this also leads to a more specific conclusion that Chinese (early Chinese in particular), with its practically uninflected monosyllabic words, undifferentiated by inherent grammatical quality (D o b s o n, *Late Archaic Chinese*, p. 14), and having no morphologically delimitated but logically misleading 'parts of speech', is much better equipped for spontaneous logical thinking than any of our IE tongues. Not only are linguistic suggestions that are logically misleading less likely to arise from a structural system like that of Chinese, but, in fact, Chinese itself proves to be structurally much like the symbolic quasi-language of logic. Since this latter is only a written medium, it is also worth while to emphasise the otherwise known fact that the structural features of the Chinese *language* are specifically rendered by those of the Chinese *script-system*. Thus, monosyllabic lexical units of speech correspond to single characters in script, the grammatical (and also the semantic) 'field of meaning' of a monosyllabic speech unit corresponds to that of the written character (this not without some qualification, but practically so at least for the period concerned), characters are structurally classifiable according to their 'semantic field' and not by grammatical classes, etc. Consequently, the Chinese script-system itself resembles, like the language which it represents, the (written) symbolic language of logic. To give our main conclusion a more adequate form, we also can say that modern logicians have devised to their own purpose an artificial symbolic quasi-language which structurally in many respects is much nearer to the early Chinese language in its both oral and written form than to any speech-system of our IE type[24]. Reverting to a previous remark made in connection with monosyllabism (*cf. supra*, p. 105), I should like to emphasise once more that all the 'calculatio-

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[24] The present characterisation appears to agree with J. N e e d h a m' s marginal remark that "There is some ground for believing that the structure of the Chinese language is essentially favourable to the types of thinking now being explored in modern combinatory logic" (*Science and Civilisation in China* II, p. 199, footnote d). But it has not been my intention to emphasise, as N e e d h a m does, the 'mathematical quality' of the Chinese language as allegedly due to the fact that "the meaning of the written character is fixed and can be understood by speakers of different dialects" (*op. cit.* I, pp. 32—33). In my opinion, N e e d h a m' s statement to this latter effect is much exaggerated, and there even seems to be some confusion of language and script in such statements. I also doubt whether it is precisely such a 'mathematical quality' of Chinese as that spoken of by N e e d h a m which accounts for a possible stimulating, if any, of the development of mathematical logic in Europe (*op. cit.* I, p. 33). From the present point of view, it is necessary clearly to differentiate between Chinese language and Chinese script, although what can be known of the early Chinese language certainly and exclusively comes from an interpretation of the written texts and that of the script-system itself. Second, for the period with which we are concerned it is advisable to consider the relationships between language and logic rather than those between script and logic, since we know that philosophical teaching was mostly, if not exclusively, oral at the time, and the fixation of the masters' teachings in the written form is of a later date, *cf.*

nal' qualities of Chinese just spoken of by no means automatically guarantee the logical validity of Chinese reasoning. There is no need to dwell on the commonplace that illogical thinking is always possible in any language, whatever its structure might be, whether illogically complex or logically simple, but it is perhaps worth while to recall that even the symbolic language of logic with all its exactness by itself is not a warrant against illogicality. The merits of the logical symbolism which are relevant in connection with our problem are that it greatly facilitates and makes clear the use of valid forms of reasoning, and that it is also helpful in the detection of invalid or defective forms. In our case, this nearly amounts to saying that early Chinese must potentially have been a much better tool for logical thinking than our IE languages are and that, if ably used as a natural kind of quasi-calculus by a sharply-minded thinker, it could largely facilitate valid thinking. More specifically, the contention put forward here is that intuitive reasoning that was logically valid, and expressible in terms of what now corresponds to the logic of functions in particular, was relatively much easier in early Chinese than in Greek or Sanskrit.

I think that all the main points of the foregoing discussion, and also its conclusions, can be exemplified in an almost perfect way by the *Mo-tsï* passage which is the subject-matter of the present chapter, given in Chinese *supra*, p. 88, and subsequently formalised on p. 96. To demonstrate this, we have only to make another formalisation of the passage, a formalisation (or quasi-formalisation) which will be a direct rendering of the Chinese text as it stands in its linguistic form, by means of logical symbols — rather than a 'translation' of the reasoning into the usual symbolism of the calculus of functions. Making use of C h a o Y ü a n - j e n's notions of 'topic' and 'comment' (or even of our usual syntactic concepts of subject and complex predicate, which in the present case amounts to the same thing), we shall consider the whole of (1a—c) as a single (although syntactically rather complex) sentence

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supra, p. 102. The assumptions underlying the present account of the problem deserve to be formulated: the early Chinese thinkers reasoned in l a n g u a g e rather than in characters; in spite of a fairly long oral tradition between the period of the master's teaching and that of its fixation in the written form the available texts faithfully render the original (oral) forms of reasoning (this, of course, except for the cases in which a subsequent corruption of the text is obvious); the deductions so far drawn by sinologists from the written texts and the Chinese script-system with regard to the nature of the early Chinese (oral) language itself are, in the main, conclusive, — especially as far as the general structural features relevant in connection with our problem are concerned. It appears that any successful effort to deal with our problem is possible only on the basis of these assumptions, and these, by the way, have very little to do with either phonological differences among Chinese dialects (early or modern), or the still controversial problem of the reconstruction of the phonetic and phonological shape of early Chinese monosyllables. The influence of the specific Chinese script on the shaping of Chinese philosophical and scientific thinking — which indeed appears to have been considerable, especially at a later stage of development, when the script and the written language itself had ceased to keep up with the evolution of the spoken language — is another major problem which lies entirely beyond our present scope.

with 天下 $= a$ as 'topic' and the rest as 'comment' on this 'topic'. Such an analytical procedure is fully justified from the point of view of Chinese syntax, and the non-sinological reader should not think that it can invalidate the specific arrangement of the text as given on p. 88. In fact, the arrangement was meant to make visual some points of import for the subsequent 'ordinary' formalisation of the reasoning, but it is clear that, for instance, (1a—c), in spite of its length, internal parallelism, etc. is to be interpreted syntactically as a sentence specifically composed of a as 'topic' (or subject) and the rest as rather complex 'comment' (or predicate). Similarly, we shall consider both (2a—c) and (3) as single sentences with 天 $= b$ as 'topic' (the same in both sentences) and the rest as 'comments' on b. Brackets will be used to demark 'comments' from 'topics' in the sentences, and the characters (words) of the Chinese text will be replaced with the respective symbols, the same as those used for the previous formalisation of the reasoning, and listed together with their values *supra*, p. 96. Putting logical functors (negation, implication and conjunction) as they are involved in our text into their usual symbolic form and making use of parentheses for the delimitation of the molecular structures syntactically co-ordinated, we obtain the following symbolic picture of the whole passage:

(1) $a \; [(\varphi \supset \psi_1) \cdot (\varphi' \supset \psi_1') \cdot (\varphi \supset \psi_2) \cdot (\varphi' \supset \psi_2') \cdot (\varphi \supset \psi_3) \cdot (\varphi' \supset \psi_3')]$

(2) $b \; [(\varPhi \, \psi_1 a) \cdot (\varPhi' \, \psi_1' a) \cdot (\varPhi \, \psi_2 a) \cdot (\varPhi' \, \psi_2' a) \cdot (\varPhi \, \psi_3 a) \cdot (\varPhi' \, \psi_3' a)]$

(3) $b \; [(\varPhi \, \varphi a) \cdot (\varPhi' \, \varphi' a)]$

This, of course, is not a formalisation of the given reasoning by means of any usual system of logistic notation. For instance, with regard to (1), we shall note that the argument of a one-place function should be written after the function-symbol, not before it (φa, not $*a\varphi$), and that the procedure of writing the argument a only once when the same argument is present in any link of a specific chain of functions (like the bracketed chain in (1)) is unusual; the whole of (1) should be written as has been done in (1a—c) on p. 96, or in a like way if another usual system of notation be adopted. Similarly, (2) and (3) cannot be written as they stand in the present notation within any notational system in use. But the specific quasi-formalisation (1)—(3), unusual as it is, is at the same time something more than any usual formalisation of a text. The reader will note the following points. First, it is a very faithful rendering of the actual linguistic structure of the whole passage, at the syntactic level in the first place, but also at the morphological one. Since there are no morphological word-connections nor any such morphological modifiers inherent in word-forms which should be put into our quasi-formalisation to make it represent the (linguistically) morphological level of the passage structured as it is[25], we can say that (1)—(3) is a very adequate and direct rendering of the morpho-

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[25] This does not mean that I am unaware of derivational connections occurring between monosyllabic units. Such mostly obscure connections constitute something like the morphological (word-formative) system (very unsystematic, by the way) of early Chinese. Immediate word-connections between words in larger structures practically do not exist and are never indicated by morphological marks inherent in word-forms.

logico-syntactic structure of the passage. Second, (1)—(3), as can easily be seen, represents an almost completely symbol-for-character (that is, symbol-for-mono-syllable, or symbol-for-word) rendering of the Chinese passage. Third, the complex (1)—(3) is, after all, a specific and specifically adequate formalisation of our Chinese text, since not only can it be easily 'retranslated' into any usual system like the one adopted for the previous formalisation on p. 96, but nothing — except perhaps for purely practical reasons — actually forbids us to devise a system of logistic notation like the one spotaneously resulting from the l i n g u i s t i c (morphologico-syntactic) symbol-for-word analysis of the *Mo-tsi* reasoning here discussed. It is only because of the fact that such a system of notation does not exist that our (1)—(3) rendering of the passage may be termed quasi-formalisation.

To sum up: no such a nearly symbol-for-word morphologico-syntactic analysis of reasoning in any IE language (especially in a highly inflected one), an analysis necessarily taking into account the intricacies of the given linguistic system (morpho-logical word-classes in relation to syntax, immediate word-connections, nominali-sations, etc.), can yield a kind of spontaneous logistic notation directly applicable in the calculus of functions (*cf.*, for instance, a similar procedure with regard to the English translation of the Chinese text, *supra*, p. 89). In Chinese, on the other hand, as I hope to have demonstrated, this is possible. Early Chinese seems to be the only language known which possesses intrinsic 'calculational qualities' to such an extent, and these must have been a very important factor facilitating spontaneous logical thinking in valid and quite elaborate forms like those involved in the *Mo-tsi* reasoning here discussed. On the other hand, the question remains why in such essentially favourable circumstances early Chinese implicit formal logic, although in fact much richer and variegated than has so far been thought by many, could not develop to a still greater extent. Another interesting question is whether, para-doxically enough, the 'calculational' qualities inherent in the language, making the procedure of spontaneous reasoning more obvious and less intricate, could have been a handicap for the development of a systematic logical theory (explicit logic).