

PART THREE  
FIXEDNESS OF THOUGHT-MATERIAL

CHAPTER VII

ON FUNCTIONAL FIXEDNESS OF REAL SOLUTION-OBJECTS<sup>131</sup>

1. SETTING OF THE PROBLEM. THE  
CONCEPT OF HETEROGENEOUS  
FUNCTIONAL FIXEDNESS

IN CHAPTER II, 6 and 7, it was pointed out that the different parts of the situation, whose (appropriate) variations represent solutions of the problem, or which enter into solutions as "material", may display very different degrees of "disposability" (looseness). For the psychology of thinking, there hardly exist more fundamental differences among the various relevant elements of a problem-situation than those which determine how easily or with what difficulty they may be recognized as conflict-elements or as solution material. These differences are independent of possible "knowledge" by which *post festum*—the elements concerned could be evaluated with respect to their conflict-character or their suitability as material.

A few of the factors which determine disposability, specifically that of conflict elements, have already been worked out in Chapter II. Now we shall examine more closely the *disposability of solution material*, in the more specific form of "real solution-objects sought".

Whether a sought "object" is found more easily or with more difficulty depends, among other things, on the degree of "fixedness" of the object. A chimpanzee who stands in need of a stick (something long, firm . . .) sometimes has

difficulties in recognizing the stick in a branch still growing on the tree, in seeing it as a percept apart (20, p. 106). On the tree it is a "branch", a part of the visual figural unit "tree", and this part-character—more generally, this "*fixedness*"—is clearly responsible for the fact that to a search for something like a stick, the branch on the tree is less "within reach" than the branch on the ground.

What we just named "fixedness" may, however, be conditioned *functionally* as well as by such factors of visual organization. For instance, a stick that has just been used as a ruler is less likely to appear as a tool for other purposes than it would normally be. In the following, the discussion will be chiefly of such functional fixedness ("bias"), more particularly, of *heterogeneous* functional fixedness, i.e., fixedness as the result of a function *dissimilar* to that demanded. The question is: *What determines whether, and to what degree, heterogeneous functional fixedness of an object hinders the finding of this object?*

On this question I undertook a series of experiments.<sup>132</sup> The principle was as follows: For a particular purpose, a certain function, a suitable object is needed. *This object has already been used in the same problem-context, but in another way, in another function.* Question: what effect has this pre-utilization? When does it hinder the selection of the object

<sup>131</sup> The minuteness of detail in the following treatment of a special problem is somewhat out of proportion to its theoretical importance in the framework of the present investigation.

<sup>132</sup> For the conscientious carrying out of these experiments, I am greatly indebted to Miss Rosenbusch, cand. phil.

for the new function, the "recentering" of the object?

Be it expressly noted that what, in the present chapter, is stated for thing-objects (specifically tools) is valid, in principle, for thought-material in general. (See for instance, Chapter VIII.)

## 2. EXPERIMENTAL PROCEDURE, METHOD OF EVALUATION, AND PROBLEMS

We experimented with all sorts of objects in daily use (e.g., boxes, pliers, etc.), which were first claimed in their usual function ( $F_1$ ) and then, within the same problem-situation, for a new, unusual function ( $F_2$ ). The crucial object was each time to be selected as the suitable tool out of a great number of objects which lay in confusion on a table.

In our problems, the pre-utilization of the crucial object was chosen in such a way as not to give it a special prominence in the problem situation. In other words, in  $F_1$  no new centering took place, but solely a freshening, an "actualization" of the usual centering of the object concerned. For  $F_2$ , on the contrary, the object concerned was "unprepared," although by no means inappropriate.

In order to observe the effect of fixedness on recentering, each problem was given in two settings, once without and once after pre-utilization of the crucial object. The setting without pre-utilization we shall briefly designate *w.p.*, that after pre-utilization, *a.p.* The most important experiments were carried out on five different problems. One-half of the Ss received the problems in the settings: 1) *w.p.*; 2) *a.p.*; 3) *w.p.*; 4) *a.p.*; 5) *w.p.*; the other half of the Ss, in the opposite settings. In this way, differences of results in the *w.p.* and the *a.p.* experiments were made independent of individual differences among the Ss and among the problems.

The following is a short description of the five problems and of the experimental technique.

*The "gimlet problem."* Three cords are to be hung side by side from a wooden ledge ("for experiments on space perception"). On the table lie, among many other objects, two short screw-hooks and the crucial object: a gimlet. *Solution:* for hanging the third cord, the gimlet is used. In the setting *a.p.*, the holes for the screws had yet to be bored; in *w.p.*, the holes were already there. Thus,  $F_1$ : "gimlet";  $F_2$ : "thing from which to hang a cord".

*The "box problem."* On the door, at the height of the eyes, three small candles are to be put side by side ("for visual experiments"). On the table lie, among many other objects, a few tacks and the crucial objects: three little pasteboard boxes (about the size of an ordinary matchbox, differing somewhat in form and color and put in different places). *Solution:* with a tack apiece, the three boxes are fastened to the door, each to serve as platform for a candle. In the setting *a.p.*, the three boxes were filled with experimental material: in one there were several thin little candles, tacks in another, and matches in the third. In *w.p.*, the three boxes were empty. Thus  $F_1$ : "container";  $F_2$ : "platform" (on which to set things).

*The "pliers problem."* A board (perhaps 8 inches broad) is to be made firm on two supports (as "flower stand or the like"). On the table lie, among other things, two iron joints (for fastening bars and the like on stands), a wooden bar perhaps 8 inches long (as the one "support") and the crucial object: the pliers. *Solution:* this pair of pliers is utilized as the second support of the board. In the setting *a.p.*, the bar was nailed to the board and had to be freed with the help of the pliers; in *w.p.*, it was only tied to the board. Thus  $F_1$ : "pliers";  $F_2$ : "support".

*The "weight problem."* A pendulum, consisting of a cord and a weight, is to be hung from a nail ("for experiments on motion"). To this end, the nail must be driven into the wall. On the table lies, among other things, the crucial object: a weight. *Solution:* with this weight (as "hammer"), the nail is driven into the wall. In the setting *a.p.*, the weight is given expressly as pendulum-weight (with the string already tied to it); in *w.p.*, a joint

serves as pendulum-weight. Thus  $F_1$ : "pendulum-weight";  $F_2$ : "hammer".

*The "paperclip problem":* A piece of white cardboard with four black squares fastened to it is to be hung on an eyelet screwed into the low ceiling ("for visual experiments"). On the table lie paperclips, among other things. *Solution:* a paperclip is unbent, one end is fastened to the eyelet and the other put through the cardboard. In the setting a.p., the four black squares must previously be attached to the cardboard with paperclips; in w.p., on the other hand, they must be glued to it. Thus  $F_1$ : "something for affixing";  $F_2$ : (unbent) "hook".

The differences among the five problems are to be discussed later; see 6.

The general *instruction* for all the problems ran as follows: "You will receive several little technical tasks. For solution, certain objects are needed which you will find among the objects here on the table. Everything which lies on the table is completely at your disposal. You may use what you like in any fashion you wish. Please think aloud during the experiment, so that I may hear as many of your ideas as possible, including those which you take less seriously".

With each problem there lay on the table—aside from the objects already mentioned—all kinds of material, partly less suitable and partly completely unsuitable for the solution, such as paperclips, pieces of paper, string, pencils, tinfoil, old parts of apparatus, ashtrays, joints, pieces of wood, etc. Each problem had its own inventory. (No object was put at the subject's disposal which might be better suited to the solution than the object then crucial.) The objects lay in apparent confusion, but in definite places. The crucial object never occupied a prominent place.

The experiments were *evaluated* in two ways: (1) The solved and the unsolved problems were counted. Of course, a problem counted as "correctly" solved only when it was solved by use of the crucial object, which, as stated, was always the best and simplest of the possible solutions. A problem was broken off as unsolved if for two to three minutes the  $S$  produced no more proposals, and if at

the same time his attitude had become so negative that no more sensible ideas seemed forthcoming. (2) The proposals preceding the solution and different from it, the "pre-solutions", were counted (but only with those experiments in which the correct solution was finally found, as otherwise measurements 1 and 2 would not have been independent of each other). As "presolutions" counted not only those actually carried out, but also proposals merely formulated, also such as the  $S$  rejected as unsuitable. If, however, an object was only "grazed", i.e., just touched or picked up quite briefly and silently laid aside again, the fact did not count as a pre-solution.

Of the two methods of evaluation just described, the first is naturally the more adequate and by far the more important, while the second is rather superficial and dependent on chance influences. We shall find, however, that both methods yield results which are essentially in agreement.

### 3. PRINCIPAL EXPERIMENTS AND PRINCIPAL RESULTS

The principal result of the experiments is immediately evident from Table 3.

We see that the results of the a.p. experiments clearly deviate from those of the w.p. experiments in the expected direction. This holds in both measurements, which are independent of each other, and not only for the average of all five problems, but also within each single problem. Only in the weight problem are the two averages of pre-solutions equal.

Therefore we can say: *Under our experimental conditions, the object which is not fixed is almost twice as easily found as the object which is fixed.*

The quantitative results were sup-

ported and clarified through qualitative findings. When, at the close of an a.p. experiment, the S was asked: "Why have you not used this object" (the crucial one) or, "Why have you used it only so late?", the answer was frequently: "But

there were many among our Ss for whom it was as if "the scales had fallen from their eyes" when the crucial object was afterwards pointed out. They did not have the feeling of having been victims of a false interpretation of the experimental conditions. In the third place, certain experiments to be cited

TABLE 3

Problems	No. of Ss	No. of problems solved	No. of problems solved in %	Average no. of pre-solutions per problem
w.p. {	Gimlet	10	100	0.3
	Box	7	100	1.3
	Pliers	15	100	1.9
	Weight	12	100	0.8
	Paperclip	7	85.7	0.8
Arith. Mean	—	—	97.1	1.0
a.p. {	Gimlet	14*	71.4	1.6
	Box	7	42.9	2.3
	Pliers	9*	44.4	2.3
	Weight	12	75.0	0.8
	Paperclip	7	57.1	1.5
Arith. Mean	—	—	58.2	1.7

\* The inequalities in the number of Ss in w.p. and a.p. are due to the fact that certain Ss transformed the problem-setting intended for them into the opposite setting. In the gimlet problem, for instance, three Ss assigned to the w.p. group actually had to be counted in the a.p. group: one attempted, using the gimlet, to stuff the cords into the holes which were already there; the other two bored holes with it because they did not quite trust the holes which were there. On the other hand, one S assigned to the a.p. group immediately picked up the gimlet as "thing with which to hang up. . .". Thus he did not use it in  $F_1$ , and had therefore to be counted with the w.p. group.—In the pliers problem, three Ss did not utilize the pliers for freeing the bar which was nailed to the board, and therefore had to be counted in the w.p. group.

that is a tool", or, "Such a use would not be suited to the material", or, "I thought it was there simply for . . . ( $F_1$ )".

The last observation might suggest the following objection: It is not the effect of a "bias" of the crucial object which is measured in the experiments but rather the effect of a bias of the subject. The S may be of the opinion that the experimenter has put the crucial object on the table especially as a tool for  $F_1$ , that it does not belong to the actual experimental material. (Such false "self-instructions" are not infrequent in the relatively artificial situations of the laboratory.) This objection, however, hardly holds water. In the first place, little significance should be ascribed to statements after the fact, such as "I thought. . .". They often express only "rationalizations". Secondly,

later (see p. 96 below) also refute this objection.

#### 4. ON FIXEDNESS "RELEVANT TO THE SITUATION" AND ON "CONTACT"

With the box problem and one not mentioned till now, the cork problem, we undertook a few more specific experiments on the possible influence of certain differences in the way the crucial object was pre-utilized.

The cork problem consisted of the following: A triangle was to be drawn on a piece of cardboard which was in turn to be fastened to a wooden bar. The wooden bar was then to be fixed in a doorframe without the help of nails. But the bar

was about 2 cm. shorter than the distance between the two sides of the frame. On the table lay, among other things, the crucial object: a cork. Solution: With the help of the cork, the bar is wedged between the sides of the frame. In the a.p. setting, the cork stuck as a stopper in an ink bottle, from which the ink for drawing the triangle was to be taken. In

drawing, but in a superfluous empty one (the triangle was here to be drawn with pencil). The crucial objects, therefore, had a function  $F_1$ , it is true (therefore the designation a.p.'), but a relatively peripheral, irrelevant function  $F_1$ . We expected that in this situation the re-centering would succeed more easily, in the belief that an irrelevant ("dead")

TABLE 4

Problems	No. of Ss	No. of problems solved	No. of problems solved in %	Average no. of pre-solutions per problem solved
a.p. { Box	7	3	42.9	2.3
{ Cork	7	1	14.3	2
a.p.' { Box	7	1	14.3	4
{ Cork	7	0	0	—

w.p., the cork lay free on the table, at some distance from the ink bottle. Thus,  $F_1$ : "stopper;"  $F_2$ : "thing for wedging something."

The cork problem is clearly related to the box problem even by external appearance. Here, as there,  $F_1$  is given not by an action but "statically." Here, as there, the crucial object is fixed by  $F_1$ , not only functionally, but visually as well. The cork problem, incidentally, proved to be the most difficult of our six problems.

These two problems were also given in the following variation (a.p.): The crucial object was burdened with a function  $F_1$  "peripheral to the situation," not with one "relevant" or "central to the situation." That is, in the box problem, the three boxes were filled not with material relevant to the problem (candles, matches, tacks), but with neutral material (buttons and the like). In the cork problem, analogously, the cork was not stuck in a full ink bottle necessary to the

function comes nearer to absence of function than does a "living" one. The experimental results (see Table 4), and above all certain qualitative remarks of the Ss, soon made us aware, however, that in this reasoning we had obviously overlooked an important factor.

11 of the 13 Ss who had not solved the cork problem in the a.p. and the a.p.' settings subsequently received this same problem in the w.p. setting. Under these circumstances 8 of the 11 Ss, i.e., 72.7% solved the problem. Of course, the fact has here been of some influence that the Ss were especially directed to the stopper by the difference: "formerly stopper in full ink bottle, now stopper near empty ink bottle" (although we tried to counteract this suggestive difference by other differences introduced *ad hoc*). The suggestive effect of such differences is considerable.

Table 4 shows—and similar experiments undertaken in a seminar furnished corroboration—that, far from facilitating

the solution, the a.p.' setting actually makes it more difficult in comparison with the a.p. setting. For this reversal of the expected results, a factor is responsible which was also met elsewhere: *the more central to the situation is  $F_1$ , the greater the "contact" between the S and the crucial object.* For example, the candles, as the most important objects in the box problem, are undeniably in the center of the material offered, one might almost say: in the fixation point. And the box holding the candles profits from this. For, it is mostly emptied first, i.e., before the two other, less central boxes. The box of buttons, on the other hand, is a quite peripheral part of the problem. In the cork problem, the situation is to some degree similar. The same factor of "contact" was expressed in the remarks

*cilitating the solution. "Contact" might well be able to overcome the necessarily accompanying fact that a  $F$ , which is relevant to the situation causes strong fixation.*

##### 5. CORRELATION OF QUANTITATIVE AND QUALITATIVE FINDINGS

Until now, the experimental results have been considered only in reference to the general difference between the w.p. and the a.p. settings. However, it is obvious that the different problems exhibit the hindering effect of heterogeneous fixedness of the crucial object in different degrees. The box problem shows the greatest difference between the w.p. and the a.p. settings, the weight problem the least.

If one orders the five problems accord-

TABLE 5

	Box	Pliers	Paperclip	Gimlet	Weight
$\frac{S(w.p.)}{S(a.p.)}$	2.3	2.3	1.5	1.4	1.3

of two Ss when they solved the a.p. setting of the paperclip problem: "in handling the paperclips" (in affixing the square, thus in  $F_1$ ), "I became aware of them."

"Contact" between S and object probably played a rôle also in the following proposal from the pliers experiment: "Break off a piece of the board and use it as the second support." The board stands, of course, in the center of the situation—the S even had it in his hand—just as did the candles in the box experiment. (Of course, the fact also has an influence here that the board can "give up parts;" further that, like the first support, it is wooden.)

*Everything indicates that this factor of "contact" has sometimes an effect of fa-*

ing to the size of this difference, measured by its most important indicator, namely, the size of the quotient:

$$\frac{\text{no. of solutions with w.p.}}{\text{no. of solutions with a.p.}}$$

abbreviated:  $\frac{S(w.p.)}{S(a.p.)}$ , the rank order in

Table 5 results:

In the following discussion, we shall include the cork problem as well. This problem was surprisingly seldom solved in the a.p. setting; see Table 4. The w.p. setting of this problem was given only subsequently, it is true, i.e., after the a.p. or the a.p.' setting. Therefore the uncommonly large quotient  $\frac{S(w.p.)}{S(a.p.)} = \frac{72.7}{14.3} =$

5.1 is not fully analogous to the quotients

of Table 5, and probably too large in comparison with them. Yet an entirely analogous quotient would probably still be among the largest.

Let us now examine these characteristic differences of the quotients in their relation to the psychological nature of the problems concerned. To this end we shall investigate each one of the six a.p. problems as to all the factors which

right according to diminishing quotients  $\frac{S(w.p.)}{S(a.p.)}$ .

If one of the six problems contains one of the ten hindering factors, this is indicated by a plus sign at the proper place in the table. A positive correlation between the quotients of the different problems on the one hand and the number and probable weight of the hinder-

TABLE 6

	Cork	Box	Pliers	Paper-clips	Gimlet	Weight
1. No signalling of the perceptual properties of the crucial object	+	+	-	-	-	-
2. $F_1$ still quite real	+	+	-	+?	-	+
3. $F_1$ habitual for the crucial object.	+	+	+	+	+	-
4. The crucial obj. not familiar as "differently applicable"	-	-	-	+	+	-
5. $F_2$ not familiar as realizable by different objects	+	-	+?	+	+?	-
6. The crucial object must first be altered for $F_2$	+?	+?	-	+	-	-
7. $F_1$ given really (not merely "in thought")	+	+	+	+	+	-
8. The crucial object individually identical in $F_1$ and $F_2$	+	+	+	-	+	+
9. The crucial object not very suitable for $F_2$	+	-	+?	-	-	-?
10. The crucial object not ready for $F_2$ as a result of $F_1$	+	+	+	+	-?	+

(Explanations: + means that the hindering factor is present.

- means that it is not present.

+? means that it is probably or to some degree present.

-? means that it is hardly present.

might be supposed to hinder the required recentering. In Table 6, in the left-hand column, is a list of ten such factors, beginning with those which are probably the most effective. (The more precise explanation and analysis of these factors will follow in the next paragraph.) The six problems are given side by side above, ordered from left to

ing factors on the other hand should therefore be noticeable in an increase of plus signs from right to left.

#### 6. ANALYSIS OF THE FACTORS WHICH HINDER RECENTERING

For the understanding of Table 6, an analysis of the ten hindering factors is required. We shall treat them in order.

1. "No signalling of the perceptual properties of the crucial object." In all six problems, an application or function of the object sought is originally anticipated, "something to . . ." But for a search in the perceptual field—in our problems, the table is searched with the eyes—such a functional and topical signal is too vague, too *unprägnant* (see Chapter VI, 6). Visual search concerns visual properties. *The functional and topical anticipation must therefore be transformed into an anticipation in terms of perceptual content, into a signalling of visual contents, in order to be prägnant, to "hit."*

*Example:* Something is sought "with which to drive a nail into the wall" (see the weight problem). This topical anticipation forthwith arouses the visual image of a 'hammer' or of an 'object like a hammer, i.e., hard and heavy' (transformation into signal in terms of content). And not until there is such a visual model is the visual search begun.

How promptly the original topical anticipation may lead to an (approximate) anticipation in terms of content follows from these remarks of Ss in the weight problem: "I am accustomed to use as a hammer whatever is at all solid and heavy," or: "Often enough I take a stone, if I have no hammer." It is generally true that, the more typical the function  $F_2$  is for the crucial object or its like, the more easily the original signal by function is transformed into a signal by content appropriate to the crucial object.

Analogously in the pliers problem, the functional and topical anticipation: "a support for the board," immediately calls forth the anticipation by content: "something long, solid. . . ." Just so, the anticipation: "something from which to hang a cord," suggests something in the form of a hook or of an eyelet.

Two of our problems—the cork and the box problem—are in this respect worse off than the rest. Here, as a rule, the original functional and topical signal did not succeed in arousing an adequate model of search in terms of content. It could be seen quite clearly how in these two problems the visual search frequently took place under the original function-signal as such ("something to fix the bar which is a bit too short," or, "something to fasten the candles to the door"). But that means that here—*faute de mieux*—the search is with an *unprägnant* signal.

To such anticipations of function, not defined by content, quite different objects may correspond. The candles could simply be fastened to the door somehow or other with tacks or with the help of a cord or of a plug—solutions which were often actually tried. In other words, the anticipation was not specifically directed to something like boxes. It was interesting to see, both from reports and from observed behavior, that, with the box problem, two of the three successful Ss in the a.p. group arrived at the solution in this way: they started from tacks and looked for a "platform to be fastened to the door with tacks." To these Ss, therefore, the tacks suggested a signal already fairly concrete, which in turn could not fail to suggest immediately the visually represented properties: "light material," "supporting surface"—perhaps, as immediately as in the pliers problem the support-function suggests the visual properties: "something long, stable . . ."

Now, if the general function alone is anticipated, there is a "gap" between signal and object. The filling in of this "gap" has to start from "below," from the object.<sup>133</sup> *And it is really this emer-*

<sup>133</sup> See related material on "suggestion from below" in Chapter I, 11.



gence of the new centering ( $F_2$ ) from the object itself which is hindered by functional fixedness of this object.

This statement will find corroboration in further experimental results to be cited below. There we shall see that a heterogeneous functional fixedness of the crucial object is unable to resist a sufficiently "pointed" (*prägnant*) property-signal. For the time being, the statement will suffice that the condition: "no signalling of perceptual properties of the crucial object", radically hinders a recentering.

2. " $F_1$  still quite real" means that at the time in which  $F_2$  becomes real the function  $F_1$  is still itself psychologically real, still "lives" as function. The boxes, e.g., persist in their ("static") function of containers. On the other hand, the ("dynamic") pliers-function of the pliers actually ceases along with its use as pliers. Here, therefore, no more than after-effects of the function  $F_1$  exist at the time when  $F_2$  becomes real. In a more general sense of the word (if we include after-effects in "reality"),  $F_1$  is of course in both cases "still real."

This general factor, the "overlapping of the spheres of reality of  $F_1$  and  $F_2$ ," will also be subjected to closer examination in the report on further experiments. Here its immediate plausibility may suffice: if something like functional fixedness exists at all, it must be the greater, the more real  $F_1$  still is.

A few examples from other experiments and observations: A child builds a tower. This collapses. A block remaining upright promptly becomes a "soldier," and when the "soldier" falls, it at once becomes a "sword."<sup>134</sup> This chain of recenterings is made possible, *inter alia*, through the fact that every time a struc-

ture is destroyed from without (cf. the collapse of the tower), the old function vanishes, so that the object becomes once more relatively *neutral*.—This same reduction of 'reality' can be caused by "satiation." The recentering of playthings to be observed so often with children typically appears after they have played with a given object for some time and after satiation has therefore set in. According to Karsten, satiation finds its clearest expression in striving for variation. On the other hand, often it is indubitably the unfolding of the  $F_2$ -situation which destroys the 'reality' of the old situation and of the function  $F_1$  indigenous to it. In reference to this, an observation of my own: I lay the pencil as bookmark between two pages, while I read something at another place in the book. I wish to make a note on what I have read here, and unhesitatingly take for the writing ( $F_2$ ) the pencil, whose function as a bookmark then naturally becomes illusory. This is facilitated by the further fact that the function "for writing" is the habitual function of the pencil (see page 92 above).

3. " $F_1$  habitual for the crucial object" means that the function  $F_1$  has really passed into the "flesh and blood" of the crucial object, and can now be called its "quasi-property." Now this is not the case with the weight problem. A weight is for weighing, but it is by no means familiar as pendulum weight. To be sure, a weight may originally have about as much affinity to a pendulum weight ( $F_1$ ) as to a hammer ( $F_2$ ). An object is of course especially easy to recenter when  $F_2$  represents its original function which is only temporarily supplanted by  $F_1$ . (Example: a large log of firewood, still to be chopped, which has served as chopping block for its like, is itself eventually chopped up.)

<sup>134</sup> According to Muchow; see Scheerer (34), p. 232.

4. "The crucial object not familiar as 'differently applicable'." It is clear that a heterogeneous pre-utilization will "fix" the object the less, the more this object already has the character: 'variously applicable'. A box, a pair of pliers, e.g., are probably less specialized in function than a paper clip or a gimlet. Thus, pliers are often used as substitute for a hammer, a box frequently as support.

A parallel from Köhler's experiments: "Besides, the blanket, is seen and used daily, and is thus unique and in a different category from other objects." (20, p. 38, footnote.) This is given as partial explanation of the fact that the blanket was relatively promptly used as substitute for a stick. The effect of the daily handling can hardly be conceived otherwise than in the sense of our factor of variable applicability—in connection with the factor of "contact".

5. " $F_2$  not familiar as realizable by different objects." Some functions are "fixed" from the start to quite definite objects; other functions may be realized by rather heterogeneous objects. The statement of a subject (p. 92): "I am accustomed to use anything suitable as a hammer," points directly to the fact that the hammer function does not tend to be very fastidious in the selection of its objects. In the same way, the function  $F_2$  in the box problem: "something on which to put . . ." has, of course, countless possibilities of realization in objects. In the course of time one does put almost everything on about everything else.

6. "The crucial object must first be altered for  $F_2$ ." This factor is unambiguously present in the paperclip problem. A paperclip which is unbent and a proper paperclip have not much more in common than their material. To be sure, in the box problem, and similarly

in the cork problem, the necessary alteration does not happen to the crucial objects *per se*; but it does happen to the visual whole of which the crucial object is a part. An empty box is visually something other than a filled one, an isolated stopper something other than one "sticking in" a bottle. An alteration (in our case, a rupture) of a whole alters the phenomenal character of the part.

7. " $F_1$  given really (not merely "in thought") means that  $F_1$  was or is an actual "fact", that it is not merely ideally ("merely psychologically") given—as is the function of the weight as a pendulum-weight in the weight problem. (Despite the string fastened to it, the pendulum weight would be fully realized only if the pendulum were hung up.)

8. "The crucial object individually identical in  $F_1$  and  $F_2$ ." Only in the paperclip problem does  $F_2$  not take place with the identical object of  $F_1$ , but merely with a representative of the same *genus proximum*. A whole genus may be functionally "fixed".

9. "The crucial object not very suitable for  $F_2$ ." This factor is related to Factor 1. The less adequate  $F_2$  is for the object, the more difficult is the recentering into  $F_2$ . Pliers and cork were sometimes perceived as not especially suitable for  $F_2$ , and once this happened with the weight.

10. "The crucial object not ready for  $F_2$  as a result of  $F_1$ ." This factor is just about the rule in our problems. Yet it happened in the gimlet problem that the gimlet used for boring ( $F_1$ ) obtruded itself as a thing on which to hang the cord because it was already sticking in place.

By this discussion, the ten hindering factors in Table 4 ought to have become concrete. Now if we look at Table 4, at least one thing must strike us im-

mediately: the great difference between the first two problems and the sixth, in respect to the number and weight of the hindering factors. We have here all the correlation with our quantitative results which one can wish for. Also in respect to the difference between the first two and the last four problems, the correlation is fairly good—as good as one can expect with factors considered merely in a qualitative, not in a quantitative sense.

#### 7. EXPERIMENTS ON THE 'REALITY' OF $F_1$

On the question of the 'reality' of the earlier function ( $F_1$ ), I undertook a series of experiments which would at the same time test the main result in a somewhat modified experimental procedure. I started from the assumption that the functional fixedness of an object would have to be less if  $F_1$  did not belong to the same problem-context as  $F_2$ . To test this assumption, problems in three variations were set up (of which only the one named in second place—*b*—is new):

a)  $F_1$  and  $F_2$  belong to the same problem-context.

b)  $F_1$  and  $F_2$  belong to different problem contexts which, however, follow in quick succession and have the same inventory of objects.

c)  $F_1$  is lacking.

Three problems were used (one old and two new).

1. The *pliers problem* (see p. 86 above). The *variation b*) here required a new but extremely simple problem in which the pre-utilization of the pliers had to occur: the S, sitting on a chair, had to get hold of an object far enough away so that a stick was necessary. The stick was nailed to a board (which functioned in the  $F_2$ -problem as "flower-stand") and was to be freed with the pliers. Immediately following,<sup>135</sup> the pliers problem

as described above (p. 86) was presented, of course, in the w.p. setting—in other words, as in the *c-variation*.

#### 2. The *book problem*.

Variation a: The S was to raise a projected image through lifting the lens of the projector, and the extent of this had to be calculated by reference to a table of logarithms ( $F_1$ ) in a book—the crucial object. By far the simplest way to lift the lens was then to set it on the book ( $F_2$ ).

Variation b: Here a series of computations, the last one with logarithms, was to be carried out. Following this, the problem above was then immediately presented—now, of course, without reference to the table of logarithms, i.e., as in the *c-variation*.

#### 3. The *yardstick problem*.

Variation a: Two pendulums of different length were to be hung from the table-top side by side ("to test the dependence of the period on the length of the pendulum"). The length of the pendulum was to be measured ( $F_1$ ) with a (folding) yardstick (crucial object). As support of the pendulum ( $F_2$ ) the yardstick was by far the most suitable object if it was screwed to the table top.

Variation b: A problem concerning visual length perception, at the end of which the yardstick was used to test the accuracy of achievement. The problem above, omitting measurement of the pendulum length, followed immediately.

The experimental procedure was similar to that in the preceding experiments. But more objects, more carefully selected, were offered for choice on the table. My purpose was to put the main emphasis on the number of pre-solutions, instead of, as formerly, on the number of solved and unsolved problems. For this reason, the Ss were also urged to produce new proposals tirelessly until they reached the correct solution. No time limit was set in this case, except for that imposed by complete "exhaustion." Unfortunately, however, this method of experiment and

<sup>135</sup> Lest the two variations a) and b) differ in respect to the time-interval between  $F_1$  and  $F_2$ , care was taken that each time in the b-variation

a clear hiatus, but no pause, occurred between the two part-problems. Therefore, the instructions for both problems were given together at the beginning.

of evaluation proved to be less appropriate than the earlier one. A pre-solution is more difficult to observe than the fact that the problem is not solved and, beyond this, it depends more on chance influences.

Each S was given all three variations—distributed among the three problems—

TABLE 7

	Variation a	Number of Pre- solutions in Variation b	Variation c
Cycle I*	25	13	15
Cycle II	19	7	10
Cycle III	14	12	10
Total	58	32	35

\* In cycle I, the *a*-variation was twice not "correctly" solved at all, while in all other experiments the correct solution was eventually found.

and, altogether, the three variations fell with equal frequency on the three problems. In all, we worked with nine Ss: three "cycles" were thus realized. In each cycle, each of the three variations was carried out on three Ss.

The results (the numbers of pre-solutions) from all three cycles are contained in Table 7.

From Table 7 it can be seen:

1. that the separation of the two functions  $F_1$  and  $F_2$  in two independent problem-situations about eliminates the disturbing functional fixedness of the crucial object. The results of a few seminar experiments<sup>136</sup> set up exclusively with the pliers problem were similar (see Table 8). Obviously, the psychological "reality" of  $F_1$  is restricted to the problem situation in which  $F_1$  occurs. At

<sup>136</sup> Here individual differences could not be eliminated. Four Ss were given the *a*-variation and four other Ss the *b*-variation.

any rate, beyond this area the reality of  $F_1$  is abruptly lowered.

2. From a comparison between *a*-variation and *c*-variation a complete confirmation of our main result follows also: heterogeneous fixedness, with the old function still 'real', hinders recentering if the  $F_2$ -signal is relatively *unprägnant*.

## 8. EXPERIMENTS WITH A MORE PRÄGNANT SIGNAL

The thesis has already been formulated and supported that heterogeneous functional fixedness of an object hinders solution especially if the signal is relatively *unprägnant*.<sup>137</sup> Since this statement has great significance for the theory of the "finding of a solution through resonance," I have endeavored to confirm it by experiments.

A very simple observation: Suppose that, in the box problem, one or all of the boxes are green, while all other ob-

TABLE 8

S	No. of Pre- solutions in Varia- tion a	S	No. of Pre- solutions in Varia- tion b
1	2.5*	5	0
2	1	6	2.5
3	4	7	1
4	6.5	8	3
Arith. Mean	3.5		1.6

\* Those pre-solutions which were either not taken quite seriously by the S (e.g., which had wish-character) or which represented renewal of earlier proposals were valued as "half" pre-solutions.

jects are not green, or very little so. If the following instruction is now given:

<sup>137</sup> We found in Chap. VI that "*unprägnant*" by no means coincides with "ambiguous". The most definite, least equivocal signal can be completely *unprägnant*, i.e., it can unambiguously correspond to the object without hitting its characteristic nature.

"The solution-object is green. Look for something green," the box will be found at once, despite ever so 'real' fixedness. The same thing happens if some other visual property of the crucial object is anticipated by the signal. Here hardly any trace of a difficulty in recentering will be found.

An explanation for this was already given in an earlier passage (see p. 93 above). Only if the signal is *unprägnant*, or does not reach into the autochthonous nature of the crucial object, if therefore there is still an unbridged distance between the content of the crucial object and that of the signal, and if consequently the crucial object (like any neutral object) must be "evaluated" for its possible suitability—only then does heterogeneous functional fixedness have a hindering effect. It is the development of the new centering from the object itself which is hindered by the fixedness. The central significance of this fact was already discussed in Chapter III, 4, under the title: *A More Precise Demand Facilitates Restructuration*. See also Chapter VIII, 8.

Whereas in the observation just mentioned the signal was extremely *prägnant*, one that is less *prägnant* is involved in the following experiment. The box problem was so altered that only *one* candle was to be fastened to the door, and that one box filled with candles was on the table among other objects. One group of 4 Ss—the P-group—was given the problem with a relatively *prägnant* signal, 4 other Ss—the U-group—with a relatively *unprägnant* signal. After the general problem had already been described in other respects, the P-group received the instruction: "Use for the solution the tacks and something which can easily be fastened to the door with tacks." The U-group, on whose table

there were no tacks, received the instruction: "Not everything which you need for the solution is on the table. You may ask for what is lacking."—While in the first case, therefore, a signal by function was given, through which the decisive properties of the object (platform, light material) were very strongly suggested, there was in the second case only the noncommittal anticipation: "something for fastening the candle to the door." Even the tacks, which could easily have suggested a *prägnant* signal, had been removed from the visual field of the Ss. —A third group of 8 Ss,<sup>138</sup> the I-group (intermediate group), received the problem in the "normal form," i.e., tacks were on the table. Only the anticipation contained in the general setting of the problem: "something for fastening the candle to the door," was here explicitly given. But from the tacks there issued at least a suggestion of the signal (which was explicitly added for the P-group)—hence the name: "intermediate" group.

Table 9 contains the results of this experiment. (From the statistical point of view, I admit, these results are not yet quite conclusive.)

Explanations: the results were evaluated according to the number of pre-solutions and to the total time up to the final solution (thus according to two parameters dependent on each other). The pre-solutions were divided into three classes: whole, half and quarter pre-solutions. Thus instead of the number of pre-solutions, the "measure of pre-solutions" was used. What counted as a "half" pre-solution, has been explained in the footnote to Table 8. I counted a "quarter" pre-solution if an object was only "grazed," i.e., touched or picked up quite briefly. Since this ordering to quite definite fractions of

<sup>138</sup> The double number of Ss is explained by the fact that originally two groups were here planned: for one, the tacks were put right next to the box; for the other, at a greater distance. This difference, however, proved to be of no importance.

TABLE 9

<i>P-group</i>			<i>I-group</i>			<i>U-group</i>		
S	Measure of pre-solutions (see below)	Time (sec)	S	Measure of pre-solutions	Time (sec)	S	Measure of pre-solutions	Time (sec)
1	0.75	40	5	1.5	30	13	3.0	105
2	0	0	6	1.0	15	14	5.75	150
3	0.5	5	7	3.5	65	15	2.0	25
4	1.25	40	8	0	0	16	0	0
			9	0	0			
			10	0.5	8			
			11	1.0	10			
			12	2.0	70			
Arith. Mean	0.6 (1.5)	21		1.2 (1.5)	25		2.7 (3.2)	70

unity contains arbitrary elements (which are, however, uniformly distributed) I add in brackets, as a further control, the arithmetic mean of the "number of pre-solutions", i.e., of the pre-solutions counted as integers.

Table 9 shows that the more *prägnant* the signal (or the more suggestive a *prägnant* signal), the easier the recentering, i.e., the lower the measure of presolutions and the total time. The times and

material central to the situation (candles) and one with material peripheral to the situation (buttons). Suppose, moreover, that the following two premises are valid: (1) the less *prägnant* the signal, the more effective a fixedness; (2) an object charged with a function relevant to the situation is more fixed than one charged with an irrelevant, peripheral function—while the former has more

TABLE 10

	P-group (12 Ss)	U-group (14 Ss)
candle box	chosen* 10 times	chosen* 7 times†
button box	chosen once	chosen 7 times
both at once	chosen once	chosen 0 times

\* Or merely: "The thought of using a box came to me in connection with this box."

† With two of these 7 Ss it could clearly be followed how *spontaneous* formation of the *prägnant* anticipation preceded the choice of the candle box. The two Ss sought expressly for something which could be fastened with nails (which they requested).

the "numbers of pre-solutions" do not show this correlation between P-group and I-group—yet, they do not show a negative correlation.

#### 9. PRÄGNANT SIGNAL AND FIXEDNESS RELEVANT TO THE SITUATION

Suppose that in the box problem, where this time only one candle is to be fastened, two boxes are put among other objects on the table, one box filled with

"contact" with the subject than the latter. If this be granted, then under the above experimental circumstances, the chances of the box of buttons must increase, the less *prägnant* is the signal. Thus the experiments just indicated were carried out. One group of Ss was given the *prägnant* signal (introduced in 8), another the usual, *unprägnant* signal. Table 10 shows the result.

Table 10 shows that the box of buttons

actually increases its chances if the signal is less *prägnant*, and if consequently the greater fixedness of the box of candles becomes still more decisive.—If Ss who had chosen the box of candles or that of buttons were asked why the thought of using a box came to them in connection with this and not with the other box, the answer was frequently: “because it had something to do with the candles,” or: “because the candles were in the other.” Of course this could also be rationalization.

#### 10. ON HOMOGENEOUS FIXEDNESS AND ON TRANSFER

Until now, only heterogeneous fixedness has been discussed. What really happens in the case of *homogeneous fixedness*?

An extreme case: Let  $F_1$  be “something on which to hang a whisk broom”; let  $F_2$  be “something on which to hang a shoe-horn”. Will  $F_1$  disturb  $F_2$ ? No, on the contrary.  $F_2$  will remind of  $F_1$ , and the use of the crucial object in the function  $F_2$  will therefore *profit* from its previous use in the function  $F_1$ . In other words, a *transfer* will take place.

To use an example cited by Selz for “means-abstraction conditioned by chance:” When a soaring kite brought Franklin to the idea of the lightning-rod, the kite’s function  $F_1$  (specifically the “reaching up high”) suggested the function  $F_2$  (“some such thing could catch the lightning”); it certainly did not suppress it. Kite and lightning-rod both contain the same functional components, just the “reaching up high.”

The ground for such a facilitation of the solution may be very precisely formulated: *The fact that  $F_1$  and  $F_2$  are homogeneous means simply that by  $F_1$  the crucial object is expressly “tuned” to  $F_2$ . But this again means that the  $F_2$ -signal*

becomes *prägnant* in respect to the object “prepared” by  $F_1$ . Thus homogeneous fixedness has as consequence that the  $F_2$ -signal becomes particularly *prägnant*. Hence the solution is facilitated.

For transfer to be possible,  $F_1$  and  $F_2$  need not be just the same function. If one considers the functions concretely enough, they are always different. “Hook for the whiskroom” is not the same as “hook for the shoehorn”. But what matters is merely that the two functions be based on the same general function in the same way, ultimately on the same properties (dispositions) of the crucial object.

Each function of an object is based on certain properties of this object, for instance, the function “ruler” of a bar is based on the straightness of its edge, the function “stick (to lengthen the arm)” is based on length. Or—to remain with our crucial objects—the properties: “levers, crossing each other, firmness . . .” make the pliers into “pliers”, the properties: “length, firmness . . .” into “support”.

An example for two quite different functions which are nevertheless founded on the same properties of the object:  $F_1$ , “something from which to hang two pendulums side by side”;  $F_2$ , “something over which to lay a flower stand”. Both functions are based on the properties: “lengthy”, “stable”.

In all cases of functional fixedness which played a part in our experiments,  $F_1$  and  $F_2$  were based on *different* properties of the crucial object, more correctly: on two different “reliefs” of the properties. (For it does not matter whether a property merely enters into the function concerned; rather it matters how, at what place, and with what weight it enters in.) Moreover, there was not any more basic and general function which  $F_1$  and  $F_2$  had in common. In

short, there was not the slightest cause, no foundation whatever, for a recognition, no reason why the object used in  $F_1$  should "resonate" when the signal  $F_2$  was given.

#### 11. THE DYNAMIC MEANING OF HETEROGENEOUS FUNCTIONAL FIXEDNESS

It is now time to raise the question: *What sort of alteration does an object undergo through heterogeneous functional fixedness?*

As I see it, there are three kinds of alteration:

1. By means of  $F_1$ , the crucial object is embedded in a particular context, in a functional whole, which is to some degree dynamically segregated. In this fashion the object is "*absorbed*", "*capsulated*". If this functional whole disintegrates—see the factor of "reality" (7 above)—its parts, the functions, certainly die with it, but naturally not in its elements, the objects. These it "releases from its grasp".

2. Through  $F_1$ , *the relief of properties in the crucial object is altered*. The properties particularly claimed by the function  $F_1$  stand out, become dominant, "central" (hence the expression: "recentering"). Those claimed less or not at all recede, and sometimes drop out completely.<sup>139</sup> The crucial object is so to speak specifically "polarized" by the forces of the functional "field."

3. In the degree to which  $F_1$  and  $F_2$  belong to the same comprehensive whole and are experienced as mutually required functions of this whole, a curious factor enters into play. The crucial object is expected to change over from one

function into *another* function of the *same* comprehensive whole, i.e., into a function which is in active relation with the first. And this "*shift of function within a system*" frequently offers considerable difficulties to thinking.

As clarification of the concept of "shift of function within a system:" I call two different functions of the same object "contrary". This is a generalization of the logical concept: "contrary terms". For example, one calls long and short (or red and blue) contrary, because in a pure form they are mutually exclusive. They belong to the same "dimension," concern the object in the same respect, have the same structural locus, and consequently are in specific and active relation to one another. Long and red, on the other hand, are not contrary terms; between them there is, in a way, a "dead interval."

Until now the concept "contrary" has been defined in logic only with reference to abstract or ideal wholes (namely, property dimensions). I apply it analogously in relation to "real wholes," i.e., to particular and sometimes unique real structures in which different functions demand each other in different places, such as, e.g., hammer and anvil, father and son, radius and tangent. Such functions may be called "really contrary." Now, if one and the same object is to take on in succession "really contrary" functions, we shall call this a "shift of function within a system."

All three factors probably play a rôle in heterogeneous functional fixedness as it appears in our experiments. The third factor is probably the least important, since our problem situations are not very "strong" (functional) *gestalten* (W. Köhler), and since consequently the intra-systemic functions  $F_1$  and  $F_2$  are in

<sup>139</sup> See Chap. VI, 1, on the recentering of an object or field as to content when it is under a specific pressure of search.



only weak "contrary" relation if in any.<sup>140</sup>

It is certainly probable that both factors 1 and 2 are here effective, yet it must be pointed out that in actual fact all our results could be explained by either of the factors alone. After all, we do not know their quantitative potency.

On the other hand, it may at first appear as though several arguments could be raised against an influence of factors 1 and 2 in our experiments. Against 1, one could object as follows: With homogeneous fixedness, which involves "capsulation" (factor 1) but no alteration of the relief of properties (factor 2), no inhibition, no hindering of the solution takes place, but on the contrary a facilitation. On this account, "capsulation" cannot decisively hinder the solution. This objection sounds very plausible at first. In reality, however, it is not valid. The "homogeneity" of the fixedness means (as was already observed) that when  $F_1$  has occurred just the function (or property)  $F_2$  of the object is actual-

ised, brought into readiness, or even made a quasi-property of the crucial object. But through this the signal becomes *prägnant* in respect to the object. Now, we know that a *prägnant* signal may overcome fixedness. Thus that objection to the factor of capsulation becomes untenable. Homogeneous fixedness does mean capsulation; but it means at the same time that the signal becomes more precise, and this enables the search to penetrate all "capsule walls."

Against factor 2 as well an objection suggests itself at first. Suppose that in heterogeneous fixedness the relief of properties in the crucial object were really and essentially altered, so that the parts of the relief corresponding to the function  $F_1$  became dominant, and those corresponding to the heterogeneous function  $F_2$  became in contrast recessive. Then, with heterogeneous fixedness, how could an  $F_2$ -signal ever be *prägnant*? For, those properties of the crucial object which correspond to  $F_2$  would always be relatively recessive. To this I should like to answer: 1) With heterogeneous fixedness a maximally *prägnant* signal may not in fact be possible. 2) The heterogeneous deformation of the relief of properties is probably not so great that a search directed to certain properties could not find these properties despite the deformation.

<sup>140</sup> From the finding that the fixedness virtually disappears if  $F_1$  and  $F_2$  belong to expressly different problem situations, one could be tempted to infer that the third factor, too, has considerable influence. However, that finding can be fully explained by simple loss of "reality" (disintegration) of the functional whole to which  $F_1$  belongs, therefore by exclusive application of the factors 1 and 2.