SUCCESS AND UNDERSTANDING

By Jean Piaget et al

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Preface

In his rather neglected but interesting *Les Formes inférieures de l'explication* (1927), D. Essertier has devoted a few pages, written with obvious reserve, to the relationship of skill (technique) and knowledge (science): '*Homo faber* will . . . long remain a mechanic who ignores mechanics' (p. 23), for it must be recognized that 'the manufacture of artificial tools was not necessarily *the* primitive form of intelligence and that this form could not, in any case, have been the only original one, from which all the others were derived' (pp. 31–2). Nevertheless, 'the first form of knowledge was, indeed, a form of doing, though it should not be forgotten that the source of the evolution of thought does not lie here, and that this first "physics" appeared relatively late in the day' (p. 34). 'Knowledge is contained in tools. But if we look more closely, it is not from tools that it is deduced, but from the intelligence as such' (p. 35). In short, 'the persistent illusion of continuity masks the very problem of evolution' (p. 36).

It seemed expedient to quote these comments because they show that the combined lights of history, prehistory and ethnography do not suffice to solve the important problem of the relationship between action and thought, and that their findings must be complemented with a psychogenetic analysis of the data. Essertier is quite right to make a qualitative distinction between 'doing' and 'knowing', and also to stress the time lag between them, but these are not sufficient grounds for questioning their filiation. However to reconcile the affiliation of 'knowing' to 'doing' with their qualitative differences, we must lay hold of the underlying transformative mechanism, and this is precisely what psychogenetic studies can help us to do, whereas history or anthropology can only throw light on the succession of, or differences in, level.

The first step of our analysis was taken in our preliminary *The Grasp of Consciousness*, in which we drew attention to precociously successful actions, complex enough to suggest all the characteristics of knowledge, or rather of 'know-how'; and argued that the progression from this practical form of knowledge to thought was effected with the help of cognizance, which in no way reduces to a sudden illumination but involves a true conceptualization, that is, a transformation of action schemata into concepts and operations. Now this fundamental transformation is wrought many years after the achievement of practical success because cognizance is delayed by a host of deformations, including the most spectacular 'repressions', as a result of which the subject fails to 'see' easily observable features ensuring the success of his actions.

In the present work, we shall first try to determine whether the autonomy and cognitive character of action are maintained, prior to cognizance, even when the action is not precociously successful but is effected by stages and by means of increasingly complex co-ordinations. Next, we shall look at the gradual reversal of that situation as soon as conceptualization catches up with action, to outstrip it at about the age of 11–12 years, when it begins to direct action and to programme it in advance. Our main purpose is to define the similarities of, and differences between, 'success' as the legitimization of 'know-how', and 'understanding' as a characteristic of conceptualization, regardless of whether it succeeds action or precedes and guides it. With the help of the data gathered in this way, we shall finally try to verify the laws governing the progression of cognizance from the periphery to the centre, and the interdependence of the movements of interiorization (in the direction of logico-mathematical structures) and of externalization (in the physical direction), and also make some preliminary remarks on the relationship between affirmations (or positive elements of conceptualization) and negations, a relationship which constitutes an important aspect of the processes leading from the periphery to the centre.

The topics covered in this book are thus wide enough to justify the publication of a separate work, the more so, I should like to repeat, as the solution of the problems examined is likely to throw fresh light on the fundamental epistemological question of the relationship between technical skill and knowledge.

J. P.

Houses of Cards[1]

Constructing a house or a roof of cards, or merely leaning one card against another to form a T-shaped figure, raises all sorts of special problems. In particular, the relative weightlessness and thinness of the cards make it difficult to apply such common physical concepts as thrust, support, resistance, etc. As a result, these delicate constructions throw a most interesting light on the practical action of leaning[2] one object against, or resting it on, another (*cf.* chapter 4), no less than on our subjects' conscious grasp (cognizance) and conceptualization of that action.

In fact, two distinct cognitive aspects must be co-ordinated before such actions can be interpreted. The first of these is logical and intervenes in all comparisons of the leaning card with the one on which it presses down. Next there is a geometrical aspect, bearing essentially on the positions of the cards (parallel, perpendicular, etc.) by which their equilibrium is ensured. Finally there is a dynamic aspect which depends on whether a card is thought to rest on another or to immobilize it by means of an effect halfway between pressure and thrust (9–11 year olds sometimes speak of the weight of the cards).

The child is presented with a pile of playing cards and asked to construct a 'house' (the demonstrator having first established whether or not the child has done this before). In case of difficulty, the child is asked to begin with a 'roof' of two cards and is then encouraged to proceed to various other constructions (including a T-shaped figure with a vertical and an oblique card). Having allowed the child to proceed with the minimum of interference, the

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[1] In collaboration with R. Maier.

[2] The French verb *appuyer* means variously 'to lean', 'to support', 'to press' and 'to prop up'. (Trans.)

demonstrator goes on to ask various questions about the equilibrium, for instance enquiring what will happen if a given card is removed, and so forth.

Level IA

Examples

PAS (5,4) tries to build a house by placing two cards vertically on the table, one with each hand, transferring both to one hand and placing a third on top with the (now) free hand. He makes several attempts. How about a roof with two cards? (Numerous attempts, then success.) How do they manage to keep up? *They're firmest at the bottom.* And on top? *They hold by the edges.* Does one card hold up the other? *That one, because it's the king.* Can you put up two cards like that (one vertical and the other at 120°)? *No.* Try all the same. (He succeeds after several trials and then adds two symmetrically placed cards (house of four cards).) Does one card hold up the others? *This one* (sloping) *holds this one and that one.* And what about the third? *This one holds that one and that one holds these.* If I remove this one will some of the cards fall down? *Everything will fall down* (false). He predicts that the cards will fall outwards.

CAL (6,6) tries to build a house by holding one card in each hand, setting them up vertically and at right angles to each other, and then resting a third on top of them. Failure. What about a small roof? (Success.) Does that hold? *Yes.* Why? *I've held that one* (1) *and I've put this one* (2) *on top.* Does one hold up the other? *Yes, this one* (1). Why? . . . Can you add another one? (Puts up a third card at a slant, and rights it gradually.) Could you set them up like this (in a triangle)? (He succeeds by leaning 1 against 2 and 3 against the other side of 2 but leaving a very slight gap between 3 and 1. Does this one 3 stand up all by itself? *Yes it does* (3 does not touch 1). How does 1 stay up? *With 2.* Can you remove one but leave the rest standing? (He removes 1.) Why does it stand up? . . . What will happen if you remove two? Will both of them fall down, or just this one (3)? *Just that one* (3).

JUL (6,3): Can you make two cards stand up on edge? (He holds up just one then tries to build a kind of roof, but at first without adjusting the edges of the two cards. Finally success.) How does it keep up? *Because it touches.* How so? . . . Does one hold up the

other? *Yes. This one; no, that one.* And what about this one? *It holds it up as well.* Can you put these cards up differently? (He tries to arrange them in a straight line. He fails to build a house even with three cards.) Can you do this (T-shaped figure)? (He makes them touch at the bottom.) (He is shown the T and the roof.) Is that the same thing? *No.* In this one (T), are the cards straight or bent? *Straight* (clearly fails to appreciate that one of the cards is at a slant). And here (roof)? *Bent.* In this one (T), which holds up which? *This one* (vertical) *holds up that one. If it weren't there the other one would fall down.*

Level 1B

At Level 1B, the subjects grasp that some of the cards must be at an angle.

Examples

MON (5,4) tries first to construct a roof with two cards but at too obtuse an angle, and then a house with two parallel, vertical cards carrying a third card across the top (collapse). She tries another roof and succeeds. Why does that one stay up? *Because I've made it tighter.* How do they keep together? *Because they are together.* Where do they hold? *By the corners.* Does one hold up the other? . . . What if I removed one? *The other will fall down.* Why? *Because they won't be together any longer.* Can you put them up like that (three cards; 1 and 2 at 30° and 2 and 3 at 70°)? (She produces a correct copy.) How does that one keep up? *By the two sides* (1 and 3). Does it stand up better or worse than before? *The same.* Can you make one like this (a vertical card touched by another three-quarters of the way up at an angle of 120°)? She holds them up vertically, then gradually changes the inclination and succeeds. Why does it suddenly hold up? *Because I've made it lean over a bit.* Does one of these cards hold up better than the other? *They're the same.* Do they stand up the same way? *No.* What's the difference? . . . Is it the same as that one (roof)? *No, because that one stands up and this one doesn't* (false). Can you build a wall like that (— —)? (She tries.) Why doesn't it stand up? . . . And can you make a single card stand up? *No* (hesitation, then tries again).

GIL (6,11) succeeds straightaway in building a roof with two lateral cards supporting two further cards (house of four cards).

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How do they stand up? *Here* (top) *they touch and there* (bottom) *they're held up by the small hairs of the carpet.* Do they hold by the top or by the bottom? *By the bottom . . . by the hairs.* If I remove one (from the roof) will the other ones stay up? *No, we need a second card to hold it up.* Why? *Because they prop each other up in the middle. One pushes against the other and so they stay up.* Can you build walls along the side of this house? *If everything is straight* (vertical) *I can't; they must prop each other up.* I'd like you to make me a corner of a house. (He leans one card against another, vertical, card: T). Which card keeps up which? *That one* (the vertical) *is stuck between the hairs, that props it all up, it's that one* (the vertical) *which does it.* Why? *It holds the other one up, but perhaps the other one does the same.* But does one do more holding up than the other? *It's the first one* (the vertical card) *because it holds better. The other leans. But not this one, so it* (the vertical card) *has a better hold than the other one.* Will it stand up by itself? *No. There must always be two, and they must touch.* Is it the same thing here (roof) as there (T)? *Over there* (roof) *it's the two that hold each other up. But one is not so steep and so it holds better. You can never say which one is the higher one, and it's the highest one which holds it all up.* But is there one that's higher here (roof)? *Here it's the same thing, it's the hairs. Over there, one* (the vertical card of the T) *stays up better, so the other one* (the leaning card) *can rest on it.*

COR (7,7) after numerous trials, constructs a tent (roof) sur-rounded by a square covered with two horizontal cards (8 cards in all); two cards of the square lean against the edges of the tent and the other two are held up by the first two. What did you do? *I put two cards like this, two like that,* etc. (points to the angles but proffers no further explanation). A vertical card held up by a leaning one: What if I remove that one (the leaning one)? *It won't hold the other one up. I think this one* (the vertical card) *holds up that one.*

It is characteristic of subjects at level IA that, despite some successes (all of these subjects manage to construct a roof with two cards and many follow on with a construction of four cards) they do not mention or consider the fact that some of the cards are set up at a slant. This fact must, however, dawn on some if only for brief moments, since they make practical use of it. Thus JUL, in reply to a question, pointed to the sloping cards of the roof (but not that of the figure T). However, since they do not appreciate the causal role of

the inclination, they tend to ignore it. Another remarkable reaction is their failure to distinguish between propping up and pressing down, let alone to appreciate the reciprocal nature of these two effects. Thus, when it came to the construction of the T-shaped figure, JUL assumed that the vertical card alone keeps the structure up, because the other card is 'bent' and tends to fall down for that very reason. This explains why JUL started out by trying, first, to stand a single card on edge and then to put up two vertical cards in a straight line. Similarly, MON at level IB tried to stabilize two parallel verticals by putting a third card across them, or even to make a perpendicular card stand up by itself. In brief, these children seem to assign a privileged role to the vertical card, which is not surprising when we consider that we must stand up if we are to keep our balance.

As for the relationship between two leaning cards that hold each other up (roof), these subjects do not appreciate that both play an equally important role. Thus PAS asserted that the King was the most important element of his structure, and CAL attributed the greater importance to the card he had put down first. JUL vacillated between the two cards, though he admitted in the end that each one of the two cards propped up the other (a fact he forgot in his construction of the T). This explains why all these subjects find it so difficult to predict which card will fall and which will remain in place when a particular card is removed.

Subjects at level IB have made progress in two respects. To begin with, they grasp that some of the cards must be put up at an angle. This advance goes hand in hand with an understanding of the causal role of the slant. Thus MON said that her three cards eventually stood up *because I've made it lean over a bit*, and GIL remarked *if everything is straight I can't* (build the walls); *they must prop each other up*. This advance thus involves a tendency to grasp the mutually supporting effects of the cards. MON said the cards held each other up *because they are together* (but the experimenter had used this word in his question). GIL went further and, for a moment, almost attained level IIA when he explained that *they prop each other up in the middle*. But in the same way that MON still demonstrated her continuing faith in the greater stability of verticals, so GIL specified that despite the need for mutual support, it was the *highest* card, that is the least inclined, which *holds better* than the other, and so also paid tacit tribute to the privileged role of the vertical. COR did

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so quite explicitly when, his gestures notwithstanding, he explained that an inclined card cannot keep a vertical one in position: *It won't hold the other one up. I think this one* (the vertical card) *holds up that one.*

Level IIA

At this level, which brings a general grasp of reversibility, our subjects assume that once two cards are placed symmetrically, they will have reciprocal effects on each other.

Examples

TIE (7,0) constructs a roof. Why does it stay up? *Because the cards hold each other up.* Which one holds up which? *The two hold each other up.* In the same way? *Yes.* He is shown a T-shaped figure, which he copies: How does that one keep up? *This card is skew and so it holds up* (the other), *the other one stands up as well; they keep each other up, both of them.* Is it the same with the roof? *No. This one* (T) *has one at a slant and a straight one and that one* (roof) *has two at a slant.* How does this one (T) stay up? *The straight card holds up the skew one and the skew one holds up the straight. But that one* (the straight card) *holds up more. It pushes a bit to keep that one up.*

FLA (7,3) stands up a vertical card (2) between two inclined cards (1 and 3), then props a fourth one (against 3). Why does 1 stand up? *Because 2 holds it up.* And 3? *Also* (!). And 2? *Because of 1 and 3.* And 4? *Also.* Roof: *They cling together.*

ALA (7,10) tries first of all to set up two vertical cards with one horizontal card across them. The structure will not stand up *because it's very thin* (not sturdy enough). Next he constructs three contiguous roofs. What holds them up? *One holds the next and that one jams against the ground.* Which holds up which? *This one* (1) *holds that one* (2) *and that one* (2) *holds this one* (1), etc. He leans one card (2) against a vertical (1), and another (3) against the bottom edge of 2, and finally places 4 against 1 and 3: *2 holds up 1, 3 holds up 2* (which is, in fact, held up by 1) *and 4 holds up 3* (another misconception). What if I remove 3? *4 and 2* (contiguous) *will fall, down and then 1.* (Tries.) Why didn't they fall down? . . . And what if I remove 4? *1 will fall because it's straight and then 2 will drop away from it.*

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FRA (8,4) constructs an angle and places a third card on top. Does it do anything? *It holds up 1 and 2.* He next holds up a vertical card (2) with two inclined cards (1 and 3) on either side of it. What makes 3 stand up? *Because it leans on 2.* And 1? *Also.* And 2? . . . Does it keep up all by itself? *No.* So? . . .

SCA (8,4). Roof: *They stand up because they touch each other.* And this one (T)? *Because one of them* (the leaning card) *is propped up against the other one.* And how does the other one keep up? . . . All by itself? *No.* How then? *Don't know.*

STI (8,7). Roof: *Because they hold each other up.* Does one of them do more holding up than the other? *No. It's the same.* In the T-shaped figure, the vertical card does the holding up *because it's right on top. The other one touches it and the two balance.* Is it the same as with the roof? *No. Here* (roof) *they balance by leaning and there* (T) *they balance because one is on top and the other one does the leaning.*

SCO (8,8): *This one* (vertical) *keeps it up.* How? . . . And the other one? . . . Does this one stay up just like that one (T)? *Yes.*

BEA (9,6): *This one* (the vertical card) *holds up the other one.* How? *It's like a wall, and the other one just leans against it.* But how? *That one* (vertical) *stands up and so it can't fall and stops the other one from falling too.* But how is it kept up? *It's got an edge, so it can't slip because the other edge touches the other edge and stops it from slipping.* BEA thus believes that the T is balanced in the same way as the roof.

GAB (9,6). Roof: *The two hold each other up.* With four cards, she constructs *two straight ones* (1 and 3) *and two leaning ones,* first propping 2 against 1, then 3 against 1, and finally leaning 4 against 2. How does it stand up? *1 and 4 keep up 2* (1 or 4 suffice). What if I take one away? *The whole thing will collapse because it has to be propped up from both sides.*

We see first of all that, with the roof, all these subjects affirm the reciprocity of the supporting effects, and when asked, the equality of the actions. When it comes to the T-shaped figure, however, though some subjects do state that the leaning card helps to prop up the vertical, they nevertheless continue to believe that the vertical card plays a more important role. Unlike subjects at stage I, they no longer tend to think that the vertical card could stay up by itself; far from it, many of them will insist that with the T-shaped figure no

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less than with the roof, both cards are needed to keep each other up. But they do not judge their respective contributions to be equivalent because the composition of forces involved is asymmetrical. In fact, they believe that a force ceases to act under static conditions, so much so that, for these subjects, the inclined card does not so much prop up, as is being propped up by, the vertical (FRA, SCA, BEA). Now this is quite in keeping with the explanations these subjects proffer for the roof: they do not argue that the two cards prop each other up but that they 'cling together' (FLA). In the case of the T-shaped figure, the vertical card plays a more effective role because it does not lean so much on the other (*it's like a wall*, BEA said).

A second notable difference between these subjects and those at level IIB goes hand in hand with the failure to distinguish between 'leaning' and 'holding up': the belief that any two touching cards also support each other. Thus ALA, having placed one inclined card against a vertical one and having added another inclined card, etc., attributed the same role to the superfluous cards as to the necessary ones and concluded that if any one were removed all the others would collapse; when they failed to do so he was quite unable to explain why. FRA thought that a horizontal card placed on top of two cards forming an angle will *hold them up*, and GAB having propped up the vertical with an inclined card insisted on adding another *because it has to be propped up from both sides*. These superfluous measures recall the behaviour of subjects at the same level in dealing with counterweights: when the end of a plank kept in place by a counter-weight supports the end of another plank (in the construction of a bridge), subjects at level IIA tend to add another counterweight as if the first no longer sufficed. Such behaviour, in the case of cards no less than of the bridge, probably reflects a failure to construct models of mediate transmission. From the logical point of view, it might seem as if these subjects had taken a first step towards transitivity, which generally appears at level IIA, together with reversibility through reciprocity. In fact, what we have here is rather a confusion of precise physical concepts coupled to the difficulty of composing static forces.

Level IIB and stage III

At about the age of 9–10 years (and in some precocious cases, at the age of 8 years), the card-construction problem is solved.

Examples

ERM (8,2). Roof: *They hold each other up.* T-shaped figure: *One stands on end and the other one holds it up.* Which holds up which? *That one* (the leaning card). And the other one? *It rests on top. The other one holds it up.* He ends up with four (leaning) walls: *Some support each other at the corners: 1 holds 2, 2 holds 3, 3 holds 4, and 4 holds 1.*

HIL (8,7). Roof: Why does it stand up? *Because they support each other on top.* In the same way as the others? *Yes.* Can you arrange them differently? (He constructs a T.) How does this one (the inclined card) stay up? *It's propped against that one, and that one* (the vertical card) *holds it up.* And how does the other one stay up? *Because this one* (the inclined card) *has dropped on top of it and it* (the vertical card) *can't budge because this one lies on top of the other one, and the other one can't fall down.*

CIP (8,8) constructs a T (but at 60°) after he has first built a roof. How does this one (the leaning card) stay up? *It's this one* (the vertical card) *which keeps it up.* And how does that one stay up? *Because the other one leans against its top.* But how does that hold it up? *By lying on top of it.*

CEL (9,0). T: *This one is skew and the other one holds it up.* And how does the other one stay up? *Because the skew one makes it stay up.* Does this one (the inclined card) lean on that one? *Yes.* And that one on this one? *No.*

VIR (9,3) begins by setting up a vertical card between two packs, then proceeds to set up two cards at right angles, followed by three (two leaning, one vertical) and four (same principle). He is asked to compare a T-shaped figure with a roof: *In this one, one of the cards leans against the other one and keeps the two of them up.* Which one does the leaning? *That one.* And the other one? *It keeps this one up.* And the first one (the leaning one)? *It keeps the other one up.* How? *It puts its weight against the other one.*

DOQ (9,11) constructs a square of two vertical cards and two inclined cards (3 and 4). How does 3 stay up? *It is held up by 1 and 2.* And what does 3 do to 1? *It holds it up.* And how does 2 stay up? *It is held up by 3 and 4.*

LIC (10,5). T-shaped figure: *It (the vertical) has the other one propped against it and that stops it from slipping.*

There is a marked difference between these reactions and the preceding ones. The inclined card has come to exert pressure thanks

to its very position: *It puts its weight against the other one* (VIR); *it has dropped on top of it* (and the vertical card) *can't budge* (HIL); *it stops it from slipping* (LIC); etc. As for the vertical card, it has assumed a purely retaining function: *It stands on end and the other holds it up* (ERN); and unlike the leaning card it is not held up (CEL). As a result the more complex compositions show a clear and transitive conceptualization of the connections.

At stage III, at which hypotheses are first handled and subjects become capable of co-ordinating inversions and reciprocities and hence of understanding actions and reactions, there sometimes arise curious complications, no doubt due to this very need to introduce reciprocity into physical reactions.

Examples

INI (11,3). T: *That one* (the leaning card) *forces it to stay up.* And does this one (the vertical card) lean against the other one? *Yes . . . The two of them keep each other up by leaning against each other.* Do they do the same thing? *The straight one keeps the leaning one up.* And the other one? *If we took it away, the straight one would fall down, so it keeps it up as well; the two of them do almost the same thing . . . As they have the same weight they hold* (each other up). *If we put them up like a roof they would touch over a large area, but here it is only over a small one.*

    FRE (12,0). T: *The skew card leans against the other one, but the two of them hold each other up.* Does this one (the vertical card) hold up the other one? *Yes. If it wasn't there the other one would fall down.* And why doesn't the vertical card fall down? *Because it's kept up by this one.* How? *It holds it up by leaning against it on top.*

It is plain that these subjects' grasp of detail is the same as at level IIB: the inclined card *forces* the other card to stay up; it holds it up *by leaning against it on top*, etc. But because the vertical card also acts as a support, albeit in a contrary sense, and since moreover the two cards *have the same weight* and must therefore act with equal force, these subjects refuse to accept the idea of a privileged action and insist, on logical grounds, that the two cards *do almost the same thing,* and that the vertical card leans on the inclined one (IMI) just as much as the inclined card leans on the vertical, all the while

realizing that the 'leaning' is not the same in both cases. With greater physical knowledge, this insistence on reciprocity would lead to dramatic insights, and it is interesting to note the appearance of such scruples at this level.

Conclusions

In respect of the actions involved, the development we have just examined poses no problems: as always our subjects advance step by step after trial and error and at first without any overall plan. In due course, they learn to anticipate more effectively and hence succeed with more complex combinations. As it is, at level IA, our subjects already succeed in building a roof with two cards and become increasingly adept at constructing the T-shaped figure, which means that, in these two cases, they have become capable of using inclinations to stabilize their constructions.

As for the cognizance and conceptualization of the actions thus performed, however, the part played by the inclinations faces them with a long series of difficult problems. First of all, subjects at level IA try, time and again, to put up vertical structures (PAS and CAL by standing two cards up on end and covering them with a horizontal card; JUL by trying to make a single card stay up and then two in a straight line). Though practice soon teaches them the futility of these attempts, not one of them mentions, let alone insists on, the fact that the only viable solutions are those in which one or more of the cards are inclined. At level IB, by contrast, the inclination is remarked upon and used as an explanation, but the subjects still cannot specify how they have arrived at the idea of reciprocity or equilibration in the case of symmetrical structures (roof). In other words, much as subjects at this level believe that counterweights push down or pull up depending on their position, so, in the present case, they believe that inclined cards lean on the vertical cards, which do most of the supporting.

At level IIA, the idea of reciprocity is grasped in the symmetrical structures, but reactions to the T-shaped figure show that the causal significance of the inclination is not yet truly appreciated even though the subjects see clearly (and often state) that the inclined card can only fall forward while the vertical card might equally well fall to the right as to the left. Now it may well be this very connection between the inclination of the leaning card and the direction of its

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fall, which persuades the subject that the inclined card 'leans' on the vertical much more strongly than the vertical leans on it. In other words, the equivocal meaning of 'leaning' or 'supporting' which tends to be mastered at this level when applied to balance and counterweight, persists much longer in the case of card constructions in which this physical effect is so much more complex. Even so, subjects at this level succeed remarkably well in constructing T-shaped figures, though they still fail to rationalize their actions. To do that, they must first proceed to an inferential co-ordination, and that is precisely what they manage to do at level IIB: by then they have come to appreciate that when the oblique card leans on the vertical, it is not only held up but also immobilizes the vertical by its own weight, by 'dropping on it' or 'lying on top of it'. Although subjects at state III try unsuccessfully to improve upon this explanation by looking for the common elements of roof and T-shaped figure in the direction of a wider reciprocity, the model produced at stage IIB shows most convincingly that in order to co-ordinate the data yielded by his own actions the child must appeal to inobservable, deductive relations which transcend his actions. In this particular case, he must correlate the relative thrusts of the cards (with transitive transmission in the case of several cards) paying due attention to their positions and directions. In other words, the ultimate grasp of the effects, including that of the inclined card, depends on the co-ordination of the weight with the spatial factors, a co-ordination that generally begins at level IIB (conservation of weight despite changes of shape, vertical descent of falling objects, horizontality of water tables due to the weight of the water, early intuition of 'moment', etc.) and develops further at stage III (vector compositions, density, pressure, moment, work).