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THE CONTRIBUTION OF INTUITIVE THINKING TO DIVERGENT PRODUCTION AND THE SOLUTION TO "GESTALT" PROBLEMS

Ben Wolters
University of Nijmegen

Abstract

The intuition-based theory of ideational productivity is a more plausible theory than the information processing approach to the interpretation of problem solving phenomena of the type divergent production and "Gestalt". The solution to this type of problems requires restructuring of knowledge. A review of the criticism on the information processing approach yielded evidence that this approach is not appropriate to the explanation of restructuring. The explanation of restructuring in terms of the information processing approach seems to be rather superficial. In the intuition-based theory of ideational productivity, formulated in this paper, it is just restructuring which forms the core of the theory. This makes it plausible that the intuition-based theory of ideational productivity is more adequate for explaining the problem solving process of the divergent production and "Gestalt" problems than the information processing approach.
From biographies of scientists and artists (Beveridge, 1970; Cannon, 1965), and from old and recent publications about thinking, it appears that in the process of thinking a distinction has been made between two aspects. These two aspects have been characterized as: "reasoning versus imagination" (Vinacke, 1952, p. 3), "reality-adjusted thinking versus autistic thinking" (McKellar, 1957, p. 5; Bleuler, in Neisser, 1963), "association versus bisociation" (Koestler, 1964, p. 35-36), "conscious work versus unconscious inspiration" (Revesz, in Patrick, 1955, p. 50), "reproductive thinking versus productive thinking" (Patrick, 1955, p. 57), "vertical thinking versus lateral thinking" (de Bono, 1968, p. 6), "logical reasoning versus original thinking" (Hitt, 1965), "rational knowing versus intuition" (Westcott, 1968, p. 179), "Regelbewusstsein versus Beziehungsbeunusstsein" ["consciousness of rules versus consciousness of relations"] (Bühler, 1969, p. 69), "analytic thinking versus intuitive thinking" (Bruner, 1965), "convergent production versus divergent production" ( Guilford, 1967), "intelligence versus creativity" (Getzels & Jackson, 1962), "formal reasoning versus plausible reasoning" (Hodgson, 1991).

The problem solving situations in which the second mentioned aspect of thinking is prominent are of the type divergent production (Guilford, 1967) and "Gestalt" (Wertheimer, 1964). Divergent production is concerned with productivity of ideas, which is best represented in the divergent production factor of "ideational fluency" in the "Structure-of-Intellect" model of Guilford (1967), and in "productivity and uniqueness of ideational associates" (Wallach, 1970, p. 1249; Wallach & Kogan, 1965). A typical divergent production problem is: "give as many uses of a brick as you can". Typical "Gestalt" problems are the two string problem (Maier, 1931) and the tumor problem (Duncker, 1935).

Some researchers contend that both aspects of thinking, hereafter indicated as analytic thinking versus intuitive thinking, are represented evenly in present-day cognitive psychology, that is to say, in the information processing approach (Fischbein, 1990, p. 49; Simon, 1987, p. 492; cf. Costall & Still, 1991, p. 4). Others are of the opinion that the information processing approach is not sufficiently able to account for problem solving in general (Costall & Still, 1991; Graham, 1993; Hodgson, 1991), as can be illustrated by the statement of the mathematician Poincaré: "reason is only the servant of our intuition: ... it is by logic that we prove. It is by intuition that we discover" (Bastick, 1982, p. 2; Hodgson, 1991, p. 148).

Is an alternative theory for the information processing approach, which will be developed here, a more adequate theory for explaining these two types of problems? Possibly, but still researchers have explained productivity of ideas and the solution to "Gestalt" problems in terms of the information processing approach. How did they do that? This question needs to be answered, because an explanation according to an alternative theory can only be qualified as better if it is compared with the explanation according to the traditional theory. So there are two
questions to be answered:

Questions

1. In which way can productivity of ideas and the solution to "Gestalt" problems be explained in terms of the information processing approach?
2. Is it possible to have a more adequate theory for explaining productivity of ideas and the solution to "Gestalt" problems?

Method

Question 1 will be answered by reviewing some authors who give an explanation for the solution to problems of the type productivity of ideas and "Gestalt" in terms of the information processing approach. Although such an explanation appears to be possible, some caution is recommended with respect to the plausibility of such an explanation. This caution is based on the use of the computer metaphor in formulating the information processing approach.

The answer to question 2 requires the formulation of the intuition-based theory of ideational productivity, on account of the literature which criticizes the one-sidedness of the information processing approach to human thinking. It will be investigated whether the intuition-based theory of ideational productivity is a more plausible theory for explaining the solution to problems of the type productivity of ideas and "Gestalt" than the information processing approach.

Results Question 1

Question 1 will be answered by reviewing some literature concerning explanations of problem solving of the following types:
- productivity of ideas
- "Gestalt" in terms of the information processing approach.

The explanation of productivity of ideas in terms of the information processing approach

When a primary school pupil is asked to mention things which are round, the answer will be ball, circle, and perhaps some other round things answering to the description "round", and stored in long term memory. However, long term memory contains much more elements corresponding to the description "round" than those entering into mind. According to Elshout (1976), these elements will be remembered when the description "round" is extended by means
of a strategy of profiting improvisation. That is to say, a search for implications of "round" takes place on the basis of round things already mentioned. For instance, one implication of "ball" is "rolling". To the question: which things are rolling? the answer will be: "a wheel", "an engine". A wheel fits the description "round", but a locomotive does not. Another implication of "ball" is "bouncing". What can be bouncing? He or she will answer: "a marble".

According to Elshout (1976, p. 75-76), this strategy of profiting improvisation yields more results the more the cognitive structure is differentiated. With a more differentiated cognitive structure, more ideas are being produced on a divergent production task.

Butterworth (1992) considers differences in ideational productivity to be the result of composition and extensiveness of the social context in which the pupil participates. Goodnow & Warton (1992) have confirmed this interpretation in an empirical research. Parents who demonstrate an ideological attitude towards situations impart to their children a restricted social context. As a consequence, some possible cognitive positions towards the situation concerned do not form part of the cognitive structure. Contrary to this, parents who live in a rich, differentiated social context impart this context to their children. As a consequence, these children develop a differentiated cognitive structure (Schroder, Driver & Streufert, 1967; cf. de Klerk & Verschaffel, 1990, p. 306-307: "situated cognition") that yields many responses to divergent production tasks.

These two instances of interpretations in terms of the information processing approach demonstrate the validity of this theory for explaining productivity of ideas.

"Gestalt" phenomena

The solution to "Gestalt" problems, such as the two string problem of Maier (1931) and the tumor problem of Duncker (1935) require a restructuring of the problem situation to achieve a solution. This restructuring often involves a Eureka Experience ("Aha Erlebnis"), and this Eureka Experience is often the end of a period of ruminating on the problem: incubation. Simon (1987) states that a rapid response to a "Gestalt" problem, for example, the expert medical diagnosis of a physician, without being able to provide a veridical account of every problem solving step, is essentially synonymous with recognition (p. 482). The same is true for the almost instantaneous grasp of the important chess relations by examining an unknown board position (p. 486).

The "Gestalt" phenomena Eureka Experience and incubation are often mentioned in autobiographies of famous scientists and artists (Beveridge, 1970). Sudden solutions to problems after incubation can be explained without postulating anything else, except that forgetting goes on during the incubation period. Distracted by this forgetting from the current
rut, and on resuming attention to the problem, the problem solver attacks it from a new angle, which happens to be the right one. The Eureka Experience is associated with success in discovering a plan for the solution to a problem. It is an interjection indicating confidence that the road to a solution is open now (p. 484).

Simon (1987) notes that processes of recognition, such as solving "Gestalt" problems, have long been successfully modeled by computer programs (p. 489). Moreover, the Eureka Experiences, associated with success in discovering a plan for the solution to a problem, can be and have been simulated by computer programs (p. 484). For Simon (1987), it is beyond doubt that the validity of the information processing approach is determined by the possibility of computer simulation: "The real test of programs is whether they can simulate the actual human behavior that they purport to model (p. 490)". If this is the case, we are obliged to reject any interpretation of Gestalt theory that insists on distancing itself from these empirical tests (p. 491-492).

**Conclusion**

Question 1: "in which way can ideational productivity be explained in terms of the information processing approach?", has been answered now.

**Discussion**

Nevertheless, it remains to be seen whether the above mentioned interpretations in terms of the information processing approach are the most adequate. This doubt arises from the literature in which severe criticism has been expressed of the use of the computer metaphor lying at the root of the information processing approach. It is reasonable that the information processing approach only concerns the analytic thinking aspect in the mentioned opposites between the aspects of thinking (see Introduction). This one-sidedness of the information processing approach makes it reasonable to start searching for a theory which is as plausible as the information processing approach to the explanation of productivity of ideas and "Gestalt" phenomena, to say the least of it.

Moreover, is it acceptable to identify computer simulation of the process of thinking with the way human beings are thinking? It is far from sure that computer simulation of recognition, perception and thinking corresponds to the way human beings recognize, perceive and think (Coolen, 1990, p. 144; Swart, 1990). So it is reasonable to start an investigation for an alternative theory for explaining productivity of ideas and "Gestalt" phenomena.

**Results Question 2**
First some literature will be reviewed which criticizes the mechanistic, physical character of the information processing approach. Next some concrete deficits will be mentioned that prevent mechanistic thinking to be a "mental event". After that it will be possible to formulate a theory which gives an alternative explanation of productivity of ideas and the solution to "Gestalt" problems.

Mechanistic thinking

Since the origin of the information processing approach, the computer has often been used as a research instrument. As such, the computer plays an essential role in theorizing about human cognitive functioning, such as comprehension, learning, and problem solving. However, it seems that the moment has come that a turning point is reached. The classic computer metaphor, by which cognitive psychology has been guided during the last decades, does not answer all the questions about the way of human thinking and problem solving (Still & Costall, 1991; Verschaffel & de Klerk, 1990, p. 249; see also Lamberts, 1990; Roelants, 1990, who also mention the impact of the influential work of the "computationalists" Newell & Simon on the development of the information processing approach as a paradigm).

This computer metaphor implies: "that input-information is transformed into output-information by means of a sequence of formal operations in a representative cognitive system. The conditions of this system can be considered physical instantiations of information ..., and changes in conditions embody transformational operations" (Lamberts, 1990, p. 251). From this and from the experiment of Searle: the chinese room (Searle, 1980; cf. Boden, 1990, chap. 3; Graham, 1993), it appears that the process of thinking is the performance of a sequence of operations on physical aspects of meaningful symbols, that is to say, on physical forms. According to this view, thinking has nothing to do with semantics, but only with syntax (Lamberts, 1990; Roelants, 1990, p. 292; Shannon, 1991, p. 247-249). That is to say, the computer is not able to give sense, to give significance to objects and situations.

The role of giving significance, at least in perception, appears clearly from what happens at the reversal of ambiguous figures.
In the reversal from vase to two faces in the ambiguous figure vase-and-two-faces, the physical situation, the form, remains the same; nevertheless a change takes place in content, in meaning, that is to say, in significance. In mechanistic, computer-like thinking, however, it is not the content (meaning, significance), such as the music or the color, but the form, code (musical note, wavelength) that constitutes thinking (Hodgson, 1991, p. 100-110): "music is not just patterns, it is patterns of sound" (Hodgson, 1991, p. 109).

The view that human thinking is not mechanistic, implies that man is thought of as a creature with both physical and psychological features, as a psychological-physical unity, as the double aspect theory states (Coolen, 1990, p. 139; Hodgson, 1991, p. 61-62, 394; Meysing, 1990, p. 21-22; Roelants, 1990, p. 295, 297). In this view, the psychological aspect cannot be held as identical with, or as an epiphenomenon of, the physical (Hodgson, 1991, p. 3-7, 58-61, 425-427). "What we call body and what we call soul are abstractions, aspects of one unitary reality and process" (Leibniz, in Hodgson, 1991, p. 382).

Summarizing and concluding: the use of the computer metaphor is fundamental in the information processing approach. This means that the information processing approach is a theory of a formal, rule-guided, that is to say, mechanistic, physical process of thinking.
Consequently, in the information processing approach thinking has nothing to do with meaning; it does not refer to content. It does not have any significance in itself. Thinking is not a "mental event" (Hodgson, 1991).

From the viewpoint of thinking as a mental event, some authors have formulated concrete defects in their criticism of the mechanistic conception of thinking.

**Defects of thinking as a mental event**

The literature concerning the conception of thinking as a mental event can be categorized into four themes: thinking is contextual, holistic, intentional, and embodied. Attention will be payed to each of these themes.

**Thinking is contextual and holistic**

From the viewpoint of the holistic vision, the physician's diagnosis of a patient is not primarily a sequential, step by step, logical procedure, as Simon (1987, p. 482-483) states. The solution is achieved by a sudden restructuring, not by a sequential, logical, though shortened, procedure. Also the reaction "pillow for a robot" to the Unusual Uses-item "give as many uses of a brick as you can" does not come about as a result of sequential, logical thinking, but suddenly "is there". The same applies to the solution to "Gestalt" problems, like Maier's (1931) famous two string problem. How can this be explained?

Perception and thinking occur in situations which lead us from the indeterminate whole to the characteristics of the object (holism). For example, first we recognize the face of a person who is well known to us and only later on we do see certain details of his face, such as his brown eyes and the shape of his nose (Hodgson, 1991, p.35-36, 56-57, 142; Roelants, 1990, p. 297). In human perception and thinking, it is essential that a part is defined in terms of the whole: "mental events are irreducibly holistic" (Hodgson, 1991, p. 57). That is to say, the whole has emergent properties, which are not merely the result of the properties of the parts which make up the whole. First the whole is there, the parts are derived from it (Morris, 1991, p. 128, 132). Contrary to this, in the "perception" of a robot or computer, the whole is composed of elements which are defined beforehand and which are independent of each other: "perception" is sequential. Therefore, composing parts in human perception and thinking may not have the same sense as composing parts of physical objects.

Further, perception and thinking will be influenced by a background which can be referred to as an indefinite boundlessness; as unarticulated, as not formalized (Coolen, 1990; Hodgson, 1991, p. 107; Merleau-Ponty, 1945; Roelants, 1990, p. 295; Swart, 1990, p. 45), but just making formulations possible (Reed, 1991, p. 179). The boundlessness of the context
becomes apparent from changes occurring in the meanings of words in idioms, and in the origin of new words and expressions.

Thinking is not rule-following, but intentional

The adherents of man as a machine reduce intentionality to "as if intentionality" (Graham, 1993; Hodgson, 1991, p. 190-192; Morris, 1991, p. 127-128; Roelants, 1990, p. 295-298; Shanon, 1991, p. 253, 255). That is to say, opinions and desires are attributed to the system (man or machine), but the system does not really have these opinions and desires. Intentionality is only interpretation of intentionality (Meysing, 1990, p. 234-239).

However, there are strong arguments against this position. If wishes and opinions do not really exist, but only in our mind, where does the ability come from to attribute wishes and opinions to something, for instance, a computer? (Graham, 1993; Hodgson, 1991, p. 38-40, 58; Meysing, 1990). Intentionality is an essentially psychological characteristic (Meysing, 1990, p. 24-25, 240).

The embodiment of thinking

According to Cobb (in de Klerk & Verschaffel, 1990, p. 305), computer simulation programmes within the area of mathematics have led to: "a separation of conceptual thought from sensory-motor action." (italics added; Shanon, 1991, p. 245-246); that is to say, to "disembodied processes" (Ohlsson, in de Klerk & Verschaffel, 1990, p. 305). And: "computer models do not account for intuition and kinaesthetic experiences in solving mathematical problems" (italics added; Verschaffel & De Corte, 1990, p. 267).

These four characteristics of human thinking can be integrated by the concept "le corps" (the body as a physical-psychic organism) of Merleau-Ponty (1945), as will be shown by the next abstract1. Human beings who flee when in danger do so because of the irreflexive, immediate perception of the situation. The behavior does not happen as the result of a reasoning process, owing to our consciousness of the situation. Instead, the behavior takes place because "le corps" attaches significance to the situation as frightening, and this happens irreflexively, unconsciously. Giving sense is not thought, but lived. "Le corps" is a mysterious, irreducible origin of significants, which lies at the root of perception and movement (embodiment), that is to say, of behavior.

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1This abstract has been taken from a dutch interpretation of the philosophy of Merleau-Ponty by Brus (1958; 1964), who has predominantly made use of "Phenomenology de la Perception".
There is an intimate communication between "le corps" and the world, which implicates that there is no subject opposed to an object, as in common reasoning, but a unity of sense. The significance which "le corps" realizes in its communication with the world not only concerns the vital world, such as hunger/eating, danger/flight, but also the cultural world. Furthermore, the unconscious, immediate, irreflexive perception in the intimate communication between "le corps" and the world, does not imply a constitution of the object, but just a being present at the object. The consequence of this intimate communication between "le corps" and the world is that sign and significant cannot be distinguished. This can be shown by the way we listen to a piece of music. The musical significance of a sonate cannot be distinguished from the sounds which constitute this sonate (holism).

"Le corps" remains present, even in our brightest reflexive acts. In every expression all other significances are present in a perspective, an horizon; and ultimately rooted in "le corps" (context).

Before solving the problem, the intimate communication of "le corps" and the world realizes an emptiness which nevertheless is full, determined; an intention which does not realize itself. The transition from speechless intention to an idea means that sign and significant are born in one and the same act of consciousness.

The mentioned defects of mechanistic thinking give an indication of the formulation of an alternative for the information processing approach to the explanation of the production of ideas and the solution to "Gestalt" problems as good as, or even better than, the information processing approach. The development of such a theory is the subject of the next paragraph.

The intuition-based theory of ideational productivity

The theory to be developed in this paragraph should be devoted to restructuring the problem field if original ideas are generated or "Gestalt" problems are solved. Restructuring implies that an object or situation is given a new significance (cf. Face or two vases). This is not possible in mechanical thinking, but only in thinking as a mental event, that is to say, if thinking is meaningful thinking: thinking with significances.

Before developing the theory, a tentative description of the thinking process in a typical divergent production task will be given. This description pretends only to illustrate that thinking as a mental event, that is to say, thinking with significances, makes restructuring possible.

In the bricks item of the ideational fluency test Unusual Uses "give as many uses of a brick as you can", two essentially different responses are given (Guilford, 1967; Noddings & Shore, 1984). Some children confine themselves to traditional uses, such as building a house, a tower, and so on. They reproduce what they already know about bricks, but they do not really perceive the brick. Other children also mention these traditional uses, but original ones too,
such as gravestone for a bird, pillow for a robot, and so on. These children do not simply remember their knowledge about the use of bricks without seeing the brick, but they perceive the brick in its experienced sense qualities: coarse, red, square; that is to say, they perceive the brick authentically, unmediated, with an open mind. This gives rise to an unusual reaction as, for instance, "pillow for a robot". But how?

The way the reaction "pillow for a robot" has been achieved, can be thought of as follows:

brick: rectangular, hard: —> pillow: rectangular, soft ---- human

-----> pillow: rectangular, hard ---- robot

The pupil "feels" that the soft, rectangular pillow for a human being of flesh and blood is analogous to the hard, rectangular pillow for a mechanical being like a robot. The significance of "pillow" has been extended. New combinations of significances have taken place, in other words, restructuring which has lead to this original solution.

The concrete description of this thinking process illustrates the characteristic difference between logical operations on established, unequivocal definitions, and thinking with significances. But is it possible to formulate a theory with regard to "thinking as restructuring of significances" as distinguished from "thinking with formal unequivocal definitions"?

According to Bastick (1982), this perception of the brick in its experienced sense qualities, that is this authentic perception of the brick, can be characterized as physiognomic perception. For instance, a line-drawing is characterized as "prickly", the line drawing is perceived physiognomically.

Not only visual sensations, but also kinaesthetic experiences play a prominent role in physiognomic perception. Abstract concepts such as war, socialism and so on are ultimately rooted in perceived concrete sense perceptions, for instance, a picture of a poor miner family, the "potato eaters" by Van Gogh. (Bastick, 1982).

The term "physiognomic perception" is derived from the noun "physiognomy". Therefore, physiognomic perception can be understood as the forming of an image. The image formed by an object (brick) or situation is characterized by a non verbal, significant, subconscious simultaneousness. The italicized phrase above can be illustrated by two examples. Firstly, the simultaneousness is clear if you see a familiar face in a crowd. You know at once whom he or she is. Hence the old phrase: "a picture is worth a thousand words" (in Bastick, 1982, p. 2).

Secondly, a psychiatrist (Berne, 1949) in the USA had to ask each conscript soldier two stock questions. After some time he noticed that he already knew the answers when he turned up his eyes to put the questions to the entering soldier, and that the answers which he had in mind corresponded to the actual answers. So he prepared a systematic investigation with regard to the question: "what is your vocation?". There appeared to be a significant correspondence between guessed and actual answer to this question, especially in the case of farmers and
mechanics. The psychiatrist did not reason by means of argumentation in reaching his conclusion. The conscious, unequivocal, verbalized conclusion "this is a farmer" was drawn on the basis of the image which the psychiatrist had formed of the soldier.

Physiognomic perception, which means the forming of an image, however, is only possible if the object or situation has been perceived empathetically (Bastick, 1982). Empathy means that the subject is a part of the situation, is involved in it, participates in it; there is an unprejudiced partnership between the subject and the situation. An example derived from a frequent interactive teaching-learning situation will illustrate this.

If a pupil chats with his neighbor, the teacher can react in two ways. He can perceive the situation objectively, from the outside and, blinkered, only aim at making the pupil stop talking. He takes an obvious measure to achieve this: he hears the chatting pupil's work to involve him in the lesson. The teacher remains outside of the situation, as opposed to the teacher who perceives the situation empathetically and who is surprised about the chatting of just this pupil. He usually never talks and is always very attentive and interested. Moreover, due to posture and facial expression, the teacher obtains the impression that the initiative to chat was taken by his neighbor. After all, the pupils are more restless than usual. This teacher does not react by hearing the chatting pupil's work, but decides to ask the pupils: what is the matter? Don't you understand my lesson? Did you have a test during the lesson before? Has something happened during the interval that impressed or troubled you?

Empathetically involving oneself in the situation makes it possible to achieve the aim "stop chatting" by forming an image in which one can take account of many aspects and characteristics of the situation. The teacher does not react to a stimulus "pupil chats with his neighbor", but to an image of the situation. The teacher behaves imaginatively.

It is doubtful whether physiognomic perception can come about with a closed mind. The established significances prevent the unmediated, immediate perception which is required for physiognomic perception. An abundance of significances is possible if the situation is perceived unprejudiced, with an open mind, in physiognomic, empathic perception.

The example of the chatting pupil makes clear that physiognomic, empathetic perception corresponds to the authentic, unmediated (by explicit knowledge) open minded perception of the brick in the Brick Uses Test with which this paragraph began.

Summarizing, the physiognomic, empathic, unprejudiced, open minded perception of the situation means the forming of an image of the situation in which significances are not verbalized but are present in a subconscious, non-verbal, mode of simultaneous significances.

Nevertheless, seeing a familiar face in a crowd and the significant correspondence between guessed and actual answer to the question "what is your vocation?", Simon (1987) appears to
be right in saying that solving this type of problems can be explained by recognition of the familiar face and of the vocation of the soldier. If that is the case, the intuition-based theory of ideational productivity is redundant. It is superfluous then to appeal to an image.

However, it might be that in the example of the "chatting pupil", the teacher who does not appeal to what he has been taught to do when a pupil is chatting, restructures the situation to a more adequate behavior. According to Simon (1987), restructuring can be explained by recognition. But this will be discussed in the paragraphs below. Is forming an image a plausible interpretation of problem solving which requires a restructuring of the situation, as is the case in "Gestalt" thinking and in divergent production?

To start this investigation, let us take an example of solving a problem which without doubt requires a restructuring of the problem situation: the two string problem of Maier (1931). In a room two ropes are hanging from the ceiling. One rope is in the middle of the room, the other in a corner. On a desk are lying different, various objects, such as a scissors, hooks, pincers, and so on. It is impossible to tie the ropes together by taking the end of the rope in the corner and walking to the other one in the middle. But this problem can be solved by attaching a weight, for example pincers, to the end of the rope in the middle of the room, bring it in oscillation and catch it with one hand when it reaches the rope in the corner which you hold with your other hand.

These pincers have got a significance now which they did not have before. As mentioned before, the computer is not able to give a new significance to an object or situation. This means that the information processing approach, which makes a fundamental use of the computer metaphor, is not an appropriate theory for explaining the problem solving process. The requirement of giving a new significance to the pincers to solve the two string problem makes it impossible to solve the problem by logical reasoning, because logical reasoning presupposes unequivocal definitions of terms to operate with. So Simon's explanation in terms of recognition does not seem to be plausible.

The alternative is that the problem solver forms an image of the situation by physiognomic, empathic perception of the problem situation. In this image the knowledge about and with respect to the situation is not present in the familiar conscious, verbal, unequivocal, sequential, logic mode, but in the mode of subconscious, non verbal, simultaneous significances. A shuffling of these significances takes place during the time between the confrontation with the situation and the reaction, that is to say, during the incubation period. This shuffling of significances does not take place at random, or in an associative process (Bastick, 1982; Mednick, 1962), but is directed by the intended solution: in the case of the two string problem, attach a weight to the string hanging from the middle of the room (Selz, 1922). The result of this shuffling process is the solution. The solution "jumps" into consciousness: Eureka
Experience ("Aha Erlebnis"). In the case of the two string problem: giving a new significance to the pincers: "heavy weight". Simon's (1987) interpretation of the Eureka Experience and incubation (see Question 1, "Gestalt" phenomena), does not seem to cover the experience of the problem solver who "feels" that during the incubation period something is going on without being able to formulate it, and who experiences with intense feelings the surprise of a sudden solution "from heaven". This sudden solution corresponds to the sudden jump into consciousness of the restructuring, as a result of the shuffling of significances occurring in the subconscious.

Sometimes the adequacy of the solution is not immediately clear, as it is in the two string problem. It is necessary then to verify the solution by logical argumentation. The solution to the problem can be put to logical reasoning afterwards. In other words, the non-rational conclusion can be verified in terms of conscious, verbal, sequential reasoning, otherwise stated by way of analytic thinking, in which one term in the reasoning process has acquired a new significance.

The forming of an image, the intentional shuffling of significances, and the tentative solution, all make up intuitive thinking. It would be fine if, in the future, the two theories, information processing approach and intuition-based theory of ideational productivity, could be integrated into one theory which will confirm the statement of Poincaré: "... reason is only the servant of our intuition: ... it is by logic that we prove. It is by intuition that we discover" (Bastick, 1982, p. 2).

Conclusion

The viewpoint that the human being is a psychic-physical organism, gives rise to severe criticism of the information processing approach of problem solving. To a large degree the information processing approach is formulated as a result of the use of the computer metaphor, which reduces human thinking to a physical process. The criticism of this reduction gives rise to an alternative theory in which human thinking is considered to be a mental event: the intuition-based theory of ideational productivity. Characteristic of this theory is physiognomic and empathic perception of the problem situation, in which the distinction between subject and object is partially reduced. This means that an image has been formed of the problem situation. This image is characterized by a non verbal, subconscious simultaneousness of significances. This implies that there is no one to one, unequivocal correspondence between term or object on the one hand and significances on the other. These floating significances facilitate a shuffling of these significances in the image, directed by the intention to solve the problem, and make it possible that a new significance is attributed to an object or term in the problem situation, by which the problem is solved, that is a restructuring of the problem situation has taken place. The solution which is achieved jumps into consciousness: "Eureka Experience".
This process of physiognomic, empathic perception, leading to an image of the problem situation; the shuffling of significances, directed by the intention to solve the problem; the solution to the problem by attributing a new significance to an object or term, corresponding to a restructuring of the problem situation, forms the theoretical description of an intuitive thinking process.

If the solution to the problem by intuitive thinking is not clear immediately, verification takes place by analytic thinking, that is to say, by logical, sequential, verbal, unequivocal reasoning.

Intuitive thinking is indicated in problem situations of the type divergent production and "Gestalt". However, many problem situations have a complex character in which divergent production and "Gestalt" are more or less a part of the total problem solving process.

**Discussion**

It is beyond any doubt that with respect to problem solving, the information processing approach is a very dominant theory in present day society. This might give rise to the conclusion that its dominance stimulates the practitioners in school, professional and daily life to think according to this theory. In our era of Enlightenment, however, it is more likely that the information processing approach reflects the problem solving processes of the practitioners. As a consequence, the practitioners reinforce the educational scientists, and the educational scientists try to optimize the problem solving process by means of their theoretical notions. So an interaction exists between theory and practice. They strengthen each other. This means that the information processing approach has a conserving impact upon the way thinking ought to take place.

The teacher behaves according to the theory; the books contain problems and exercises which are in accordance with the theory. Thinking phenomena for which the information processing approach has not been designed, such as incubation, "Eureka Experience", and divergent production, have been explained in terms of the information processing approach. The verification of "Gestalt" problems is supposed to reflect the problem solving process (Simon, 1987; Elshout, 1976). This results in a deformed image about thinking and, as a consequence, in ineffective thinking, mostly in problem situations which require intuitive thinking, such as divergent production and solving "Gestalt" problems. Perhaps the restricted and deformed image of thinking processes can be attributed to the disappointing transfer of education.

In the middle of our century, much empirical work has been done to show that a distinction can be made between creativity and intelligence (Getzels & Jackson, 1962; Wallach & Kogan, 1965). Their work has been inspired by Guilford (1967) who introduced a factorial Structure-of-Intellect model in which divergent production has much in common with creativity, and
convergent production with intelligence. Research into creativity has yielded recommendations to stimulate creativity by suggesting particular parental and teaching learning behavior. These suggestions did scarcely result in any change in the teaching learning behavior in schools. This failing effect of the efforts of the educational scientists can be attributed partly to socio-cultural factors in our present day society; and partly to the absence of a substantial theory about the process resulting in a creative product. Guilford (1967) only mentions characteristic differences between products of intelligence - convergent thinking - and creativity - divergent thinking. He is making clear that he is only concerned with products and not with processes by talking about divergent production and not about divergent thinking.

Because of this underdevelopment of a cognitive process theory about divergent production and solving "Gestalt" problems, researchers confined themselves to educational behavior which is empirically correlated, or to ideas which are assumed to correlate with divergent production or the solution to "Gestalt" problems. For instance, the well known and often used brainstorming procedure (Osborn, 1957) to stimulate creativity is not based on scientific knowledge about the process of divergent production, but is concerned with removing blocks which are the result of a restricting climate at home and in school (Drewdahl, 1964; Krause, 1977, 1979; MacKinnon, 1966; Weisberg & Springer, 1961). Sometimes the educational ideas have an ideological character, as can be seen from the identification of selfactualisation (Maslow, 1970; Rogers, 1969) with creativity.

If recommendations about parental and teaching learning behavior have their origin in the characteristics of the process of intuitive thinking, in this case, the intuition-based theory of ideational productivity, the repertoire of parental and teaching learning behavior of stimulating intuitive thinking will possibly be enhanced. Moreover, already acquired results of empirical research from an educational perspective can possibly be provided with an interpretation in terms of the process of intuitive thinking. This contributes to the construct validity of the intuition-based theory of ideational productivity.

Empirical research which supports the validity of - the theory of - intuitive thinking, and establishes the relation between intuitive thinking and problem solving, particularly divergent production and solving "Gestalt" problems, provides strong arguments for paying attention to both analytic thinking and intuitive thinking in educational and professional activities. From this positive empirical research, it is also possible to argue that something has to be done about the image pupils and professionals have about thinking as exclusively logical, verbal, sequential thinking. In education scarcely any attention is paid to intuitive thinking phenomena and to the situations in which intuitive thinking is most adequate. This disformed image about what thinking is causes analytic thinking in situations where intuitive thinking is called for. Pupils and professionals have to learn in which situations analytic thinking and in which situations intuitive thinking is appropriate. This implies that selfregulation of the thinking process not only
concerns orientation, planning, monitoring, selfevaluation, repairing in the traditional cognitive
-information processing - sense (Baker & Brown, 1984), but also concerns the decision on
whether the situation requires an analytic or intuitive thinking process. However, learning to
think intuitively is of the utmost importance. As a consequence of the onesidedness of their
thinking process, pupils and professionals ignore or even mistrust the intuitive thinking
phenomena occurring in their minds, and even intuitive thinking as such.

Finally, if empirical research indicates that certain parental and teaching learning behavior has
a positive impact on intuitive thinking, a training can be given to stimulate intuitive thinking.

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Footnote

This abstract has been taken from a dutch interpretation by Brus (1958; 1964) of Merleau-Ponty's *Phénoménology de la perception* (1945) [*Phenomenology of perception*] (1962).