Allan Paivio's response to Delprato's review of *Mind and its evolution: A dual-coding theoretical approach*

Professor Delprato's review focuses on comparisons of *Mind and Its Evolution: A Dual-Coding Theoretical Approach* with Kantor's and Skinner's behavioristic analyses of "mentalistic" phenomena, touching as well on other cognitive theoretical approaches to the key issues. I associated Kantor's name with organismic psychology but knew less about the details of his approach than I knew about Skinner, whom I discussed in *Mind* and earlier writings. Kantor and Skinner held similar positions on covert behaviors that are compatible up to a point with dual coding theory (DCT), particularly in that they reject explanations in terms of mystical processes that are basic concepts in other contemporary cognitive theories. Because of these agreements, my response to Delprato's review is more of an elaboration than a rejoinder to his interpretations of basic issues discussed in *Mind*. I address three issues in particular: (a) Delprato's interpretation that *Mind* is mainly about memory and imagery, (b) the relations between DCT and other current varieties of cognitive theories, and (c) how DCT and the two behaviorist approaches dealt with imagery and other private events.

Memory and Imagery as *Mind* Themes

Delprato appropriately identifies memory and imagery as the running themes of *Mind.* Memory is interpreted as the overriding cognitive and behavioral adaptive mechanism that has enabled humans and other animals to survive and thrive throughout their evolutionary history. More specific adaptive functions, identified as evaluation, anticipation, motivation (and emotion), problem solving, and communication, are all based on memory. Organisms must remember the past to evaluate the usefulness of current objects and events, anticipate future ones, satisfy needs, solve problems, and (in the case of humans) empower language. Moreover, the covert representational ("mental") structures and processes that define DCT are built from memories and promote their own growth, a kind of cognitive bootstrapping that has gone on phylogenetically as well as ontogenetically. This vital role of memory is expressed in *Mind* by the general hypothesis that memory is the engine of cognitive evolution, driving the development of overt and covert skills that enable all creatures to survive and reproduce. Even language, the most complex human behavior, is interpreted as having originated and evolved as a mnemonic device that cues memories of past experiences currently useful to the survival of a social group.

The capacity for imagery is viewed in *Mind* as an inevitable early evolutionary development from sensorimotor and memory systems, with increasing survival value as it evolved in different species over millions

of years eventually becoming linked to human language. This conjecture is based on results of human experimental studies of imagery extended to modern descendants of other species, with further inferential bridging to their evolutionary ancestors. For example, imagery, as operationally defined by mental rotation tests, has been demonstrated in modern pigeons and presumably existed in some ancestral form of the species.

Thus memory and imagery are continuous themes across evolutionary time, as well as across diverse situations in which they serve adaptive functions. In this sense, as Delprato insisted, they are largely what *Mind* is about, although he also recognized the book's unique emphasis on the functional interplay of the verbal and nonverbal dual-coding systems that define the basic theory.

DCT and Other Species of Mentalism

Delprato correctly noted as well that *Mind* is not representative of cognitive theories that postulate mysterious mental processes that lack direct observational correlates. The most prominent theories of the latter kind are associated with computational cognitive science.

Such theories assume that performance in cognitive tasks is mediated by abstract, amodal conceptual representations such as schemata, propositions, or computational "descriptions." Modality-specific verbal and nonverbal stimulus information is assumed to be transformed into such abstractions, which serve as the basis of meaningful perception, memory, and thought. The origins of such concepts can be traced directly to Plato's theory of ideas as modified by Kant, Descartes, and others—in my view, a flawed and diversionary legacy to modern cognitive science. In contrast, the mentalism of DCT is thoroughly objective in that the assumptions and hypotheses concerning internal processes are tied directly to empirical correlates. I once referred to this approach as "neomentalism," or behavioral mentalism (Paivio, 1975), defined as the objective study of the structure, functions, and development of mental representations and processes. This corresponds partly to the Kantorian interbehaviors (implicit mediators) and Skinnerian private events emphasized by Delprato—partly, because DCT emphasizes stimulus properties of private events more than do the behaviorist theories (more about that presently). Additionally, Skinner specifically rejected the notion of mind even as inferred from behavior of other individuals. In any case, DCT-defined neomentalism surely would be viewed as an oxymoron by most behaviorists, and even mainstream cognitive psychologists have not wholeheartedly embraced the DCT approach (e.g., a cognitivist critic once referred to me as "this behaviorist who calls himself a cognitive psychologist"). DCT behavioral mentalism is, therefore, a maverick in relation to most contemporary brands of cognitivism as well as behaviorism. It is important to recognize, however, that DCT and other varieties of mentalism share the assumption that covert structures and processes are in part functionally autonomous. That is, they have causal effects on behavior that are difficult to trace directly to either historical factors responsible for their formation or current situational factors that trigger their activation. Classical behaviorist theories, on the other hand, either deny or are silent about the possibility that images or other covert processes can have autonomous causal effects on overt actions.

DCT and Varieties of Behaviorism

Delprato tells us, "In Kantor's system, images represent a multi-leveled class of vestigial responses, responses left over from previous primarily perceptual interactions. . . .Thus, an image event represents a form of reinstatement of a preexisting interbehavioral field . . . a functional stimulus-response event [that] permits a form of reliving a prior perceptual episode. . . . [Such] image responses . . . are continuous with perceiving responses [but] more detached from original stimuli than are ordinary perceiving responses" (p. 271). So far so good, but there is no indication here that such reinstated interbehavioral fields have a life of their own in which the detached stimulus-response events can be autonomously transformed or manipulated to generate solutions to novel problems. I mention relevant evidence after considering Skinner's similar analysis of imaging as operant seeing.

On October 16, 1975, I sent B. F. Skinner a copy of the "Neomentalism" article already mentioned, accompanied by a letter (Appendix A) in which I affirmed my agreement with (a) his critique of introspective and rationalistic approaches to the analysis and explanation of behavior, and (b) his claim that the ultimate causes of behavior are environmental and historical. However, I disagreed with his views that private events play no causal role in behavior and that inferring the properties of such events from the behavior of others retards the development of a true science of behavior. I received a response from him dated October 21, 1975. His letter is reproduced here (Appendix B), because it conveniently summarizes his position on the basic issues concerning private events, including imagery, already discussed above in relation to DCT and Kantorian interbehaviorism. The following are points on which there are agreements and disagreements between both behaviorist approaches and DCT.

There is agreement across the board that interbehaviors, private events, and DCT "mental" processes derive from and retain essential properties of perceptual and motor responses to explicit stimulus events. Thus visual imagery is essentially perceptual activity or seeing in the absence of the original stimulus. This interpretation agrees with those of imagery proposed long ago by classical scholars and modern experimental psychologists. It does not square with computational cognitivism, which interprets perception and imagery alike in terms of abstract computational descriptions.

Second, whereas cognitive representations and memory are core concepts in DCT, they are completely rejected by Skinner (see his letter) and their status is uncertain in Kantor. However, it turns out that Skinner's analysis is paradoxical in that while he denied that seeing an object results in a bodily representation or copy of the object, he also proposed that in imaging, one can "see the object with one's eyes closed." The paradox is that seeing involves a seen object, so that imaging must also involve some surrogate of the object. The Skinnerian surrogate object presumably entails reinstatement of a significant portion of the seeing response pattern, a portion sufficient for "recognizing" that the imaginal seeing response is the same as, or similar to, the seeing response to the perceptual object. By definition, the cue-reinstated seeing response is a memory event, so that the Skinnerian response description and the cognitive representational memory description of imaging could be taken as paraphrases that refer to the same phenomenon. A crucial difference is that the cognitive representational analysis assumes

that both stimulus and response properties of seen objects are internalized, whereas the Skinnerian analysis emphasizes only the internalization of response patterns that originally occurred to the seen objects.

However, even Skinner could not completely avoid referring to covert stimuli. An example is his analysis of private problem solving (Skinner, 1953). It involves a classical cube visualization task in which one (a) visualizes a solid cube whose surface is colored red, (b) visualizes cutting it into 27 smaller cubes by making two parallel cuts on each surface, and (c) answers how many small cubes have one, two, three, or no surfaces colored red. Skinner states that "one may see the larger cube, *cut* it covertly, *separate* the smaller cubes covertly, *see* their faces, *count* them subvocally, and so on, seeing the result in each case, until the solution is reached. Presumably much of the covert behavior is similar in form to the overt manipulation of pencil and paper. The rest is discriminative behavior in the form of seeing, numbers, letters, signs, and so on, which is similar to the behavior which would result from overt manipulation" (1953, p. 273). Skinner could have described all of the above more awkwardly in terms of covert seeing (and other) responses, but his actual description does not differ from one that would result from representational memory theories, such as DCT, which explicitly assume that the covert processes that define imagery include stimulus properties as well as response properties.

The Kantorian analysis as summarized by Delprato similarly involves explicit rejection of the idea of images as substantive representations. Kantor referred to them instead as representative implicit responses, precurrent responses, or interbehaviors that constitute acts that we ordinarily refer to as memory images of objects or events. As in the case of Skinner, however, the precurrent response pattern (induced, for example, by the object name) would have to be sufficiently similar to the object-induced response pattern to permit recognition of similarities and differences between imaged and perceived objects. The response interpretations of imagery by both Skinner and Kantor become especially limiting when we consider the possible functional autonomy of covert processes emphasized in *Mind*.

The basic DCT assumption is that evolution produced organisms that can internalize the experienced world of objects, events, and activities, ultimately including language. Moreover, this internal world has a functional life of its own in the sense that all cognitive skills entail an interplay between different modalities of functionally interconnected "private" nonverbal and verbal events, guided by input from initiating stimulus events and feedback from the resulting overt activities. The interplay of the different kinds of private events can mediate novel responses that are not directly traceable to their explicit perceptual sources. In contrast, Kantorian interbehaviors and Skinnerian private events seem not to have comparable autonomous causal power in any explicit sense. Delprato's description of Kantor provides no evidence that imagery, construed as a reinstatement of a preexisting interbehavioral field, can mediate novel behaviors as compared with behaviors that mimic those that previously occurred to the original stimulus event. Skinner even more explicitly denied autonomous causal power to covert processes in his theoretical writings, a point I mentioned in my 1975 letter to him (see Appendix A). He did not comment on that point in his letter to me, but his writings reveal that he implicitly assumed such causal power in his informal analyses.

Skinner (1953) asserted that the private event "is at best no more than a link in a causal chain, and it is usually not even that. We may think before we act in the sense that we behave covertly before we behave overtly, but our action is not an 'expression' of the covert act or the consequence of it. The two are attributable to the same variables" (p. 279). However, we find evidence of his informal acceptance of autonomous covert causality in his comment that in solving the cube visualization problem described above, "the private response may produce discriminative stimuli which prove useful in executing further behavior of either a private or public nature" (1953, p. 273). That interpretation is further supported by his description of autonomous covert processes in his own creative thinking. The telling incident is based on a historical account (Bjork, 1993, p. 122, ff), which I summarized as follows in chapter 18 of *Mind* among other examples of dual coding processes operating in the work of creative geniuses in different domains:

> On a train trip to a convention in 1940, [Skinner] wondered whether a technology could be created to stop bombers before they delivered their deadly cargo. "I was looking out the window as I speculated about these possibilities and I saw a flock of birds lifting and wheeling as they flew alongside the train. Suddenly I saw them as 'devices' with excellent vision and extraordinary maneuverability. Could they not guide a missile?" The idea was that birds might be trained as navigator-bombardiers during WW2. This idea eventuated in a workable guidance system. Pigeons were first reinforced to peck at a visual target in the nose cone. The behavior controlled a guidance system that kept the missile on target. Use of two pigeons corrected for errors made by either one. Laboratory experiments showed that the system was successful and practical but the defense department found the idea bizarre and it was never implemented. In any case, it was made obsolete by newer electronic guidance systems. The relevant point, however, is that Skinner engaged in analogical thinking based on imagery triggered jointly by his verbal speculations and the birds he saw—in brief, dual coding activity (*Mind*, p. 421).

Note especially that the only explicit activity mentioned by Skinner was seeing the flock of birds. The rest of his introspective analysis was about the interplay of covert verbal processing and imagery, which resulted in a covert solution to a covertly experienced problem. The end result was an explicit solution in the form of successful implementation of a pigeon-controlled missile guidance system. Skinner's description of the covert creativity is essentially equivalent to a DCT description in terms of interactive imaginal and verbal representational processes.

I comment next on the relevance of neuropsychological data to the above issues. Skinner maintained that physiological evidence would contribute to the development of a science of behavior only when such evidence directly reveals what is going on in the brain during reinforcement-contingent covert responding. This view is expressed in his letter to me. However, relevant evidence has long been available from neuropsychological deficits resulting from focal brain lesions, and has increased explosively with developments in techniques for recording brain activity while subjects perform various cognitive tasks. As Delprato noted, such evidence is discussed in *Mind.*

The important point is that from the DCT perspective, the brain data are remarkably consistent with the multimodal dual-coding representations and processes originally inferred from behavioral data, accompanied by the implicit understanding that their brain correlates will eventually be identified. More specifically pertinent here is what the brain data have to say about behavioristic covert processes.

The data reveal neural activity in brain locations and pathways that correspond to covert stimulus and response events, as will as associative connections between them. For example, in regard to Kantorian or Skinnerian seeing responses, different areas are activated when one sees and recognizes pictured objects and when one imagines the referent objects in response to words.

These stimulus-evoked events are followed by activation of neurons in language-related premotor and primary motor areas when one names or describes the picture or the imaged object. Other brain locations and pathways are activated when one reads (recognizes and pronounces) printed words. Still other locations and activation patterns are found for auditory and somesthetic experiences with objects and their verbal descriptions. Much remains to be learned about such neural correlates of cognitive task performance, but what is already known clearly supports the idea of partly autonomous interplay of multimodal nonverbal and verbal representations and processes as conceptualized in DCT. The data also are an objective basis for interpreting behavioristic covert processes or private events, provided that the interpretations include internal stimulus as well as response events. Referring to such events as interbehaviors or covert operants is insufficient unless one stretches the concept of response to include activation of sensory receptors, sensory neurons, and association neurons as well as motor neurons. Moreover, by whatever name, all such private events entail activation of memory representations when the perceptual objects are absent.

A final important point, related to the issue of functional autonomy of covert behavior already discussed, concerns the heuristic or productive value of DCT and behavioristic theories. All scientists know that productive theories not only interpret observed phenomena but also generate testable predictions designed to yield new factual knowledge about a phenomenal domain. The DCT explanations of memory, language, problem solving, and so on have always been intended to be predictive and empirically testable. The tests have involved comparisons with alternative theories over a period of more than 40 years. By 1983, DCT-related research had generated 60 independent new findings uniquely consistent with DCT assumptions and hypotheses, and inconsistent with alternative single-code interpretations based on computational/cognitivist or covert verbal-behavioral entities. For example, the memory advantage for concrete as compared with abstract language, mentioned by Delprato, is best explained by the DCT hypothesis that verbal and imaginal memory codes are functionally independent and additive in their effect on recall (detailed summaries of these and other hypotheses and findings can be found in chapter 4 of *Mind).* Additional evidence continues to emerge, especially from neuropsychological studies (e.g., chapters 7 and 8).

In contrast, the Kantorian and Skinnerian theories of covert behavior have been mainly interpretive rather than predictive theories designed to expand our understanding of the covert entities and processes. Their interpretations of imagery and covert verbal behavior are based primarily

on analogies between overt and covert behaviors, which is acceptable as an initial hypothesis, but they have not inspired systematic research programs designed to explore the implications of the covert events for a broad range of empirical phenomena. Such a program would require an operational approach using different empirical indicators of the private events, such as comparisons of the effects of pictures and imagery instructions to test the Skinnerian hypothesis that both evoke similar "seeing responses," varying only in ease of arousal (see his letter, Appendix B).

The Skinnerian perspective has inspired selective studies of covert behavior. Probably the first of these was Skinner's own 1936 study of "latent speech" using his verbal summator technique in which participants reported hearing meaningful speech sounds while listening to meaningless sequences of vowels. His 1957 book *Verbal Behavior* motivated research based on his classification of the various verbal and situational determinants of verbal behavior, but his analyses and related research by others focused on overt rather than covert variables. For example, tacts refer to verbal responses that make contact with nonverbal objects, essentially naming responses. This corresponds with one aspect of what in DCT is described as nonverbal-to-verbal referential processing. Other important aspects of the DCT analysis include referential processing that is entirely or partly covert and occurs in both directions, nonverbal to verbal and vice versa. For example, we routinely name or describe people, objects, or situations from memory images of the nonverbal referents. We also image to explicit names or descriptions, or engage in both directions of referential processing entirely covertly—described earlier as the interplay of imagery and verbal systems. Numerous examples can be found throughout the *Mind* book. There are no parallels to such complex covert "tacting" in Skinner's *Verbal Behavior* nor in research stimulated by it.

Other notable instances of selective studies of covert processes, implicating both nonverbal and verbal processes (hence dual coding), are extensions of behavioristic principles to behavior modification using imagery techniques. Familiar examples are Wolpe's (1958) systematic desensitization treatment for phobias and Cautela's (1967) covert sensitization treatment of negative behaviors, both of which interpret verbally guided imagery effects on target behaviors in terms of conditioning of covert stimuli and responses. Such procedures have resulted in behavioral changes that suggest that the covert treatment effects generalize to overt behaviors in relevant situations, thus indicating that the covert events have autonomous causal power. These applications assume that the procedures entail both Pavlovian and operant conditioning mechanisms, thus differing from Skinner's emphasis on operant conditioning in his discussions of imagery as seeing with your eyes closed.

I have said that the behaviorist theories of covert processes have more often been interpretive than empirically tested. The proportions are the opposite in the case of DCT, which has focused on experimental tests of its assumptions and hypotheses. The empirically supported principals were also extended to interpretations that are not directly testable in the case of mind evolution, although even here the DCT speculations rely on inferential bridging from behavioral cognitive skills of modern humans and other species to their evolutionary ancestors. Similarly, the DCT analyses of "geniuses and their domains" (chapter 18), while mainly interpretive, were also supplemented by objective questionnaire and performance data obtained from creative individuals in various domains.

Acknowledgment

References

BJORK, D. W. (1993). *B. F. Skinner: A life*. New York: Basic Books.

CAUTELA, J. R. (1967). Covert sensitization. *Psychological Reports, 20*, 459–468.

PAIVIO, A. (1975). Neomentalism. *Canadian Journal of Psychology, 29*, 263–291.

SKINNER, B. F. (1936). The verbal summator and a method for the study of latent speech. *Journal of Psychology, 2*, 71–107.

SKINNER, B. F. (1953). *Science and human behavior*. New York: Macmillan.

SKINNER, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.

WOLPE, J. (1958). *Psychotherapy by reciprocal inhibition*. Stanford, CA: Stanford University Press.

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Appendix A: Photocopy of the Author's Letter to B. F. Skinner

October 16, 1975

Professor B. F. Skinner
Department of Psychology
Harvard University
Cambridge, MA 02138
U.S.A.

Dear Professor Skinner:

Enclosed is a copy of my Presidential address to the Canadian
Psychological Association last June. I'm sure that the title and content are
anathema from your viewpoint. For my part, I have been greatly influenced
for many years by your arguments regarding a science of behavior. I find it
easy to agree with your critique of introspective and rationalistic
approaches to the analysis and explanation of behavior. I agree also that
the ultimate psychological causes of behavior are environmental and
historical. But I do not agree that private events play no causal role in
behavior, nor that attempts to infer the properties of such events from
behavior retard the development of a true science of behavior. These are
among the points I try to make in my paper. No doubt you have heard them
many times in one form or another.

One other point: I question my own wisdom in using a title like
"Neomentalism," for reasons expressed briefly in the last paragraph of the
paper. I hope that the title is not so diversionary that readers miss my
point.

Yours sincerely,

Allan Paivio
Professor

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Appendix B: Photocopy of B. F. Skinner's Letter
in Response to the Author's Letter (Appendix A)

HARVARD UNIVERSITY
DEPARTMENT OF PSYCHOLOGY AND SOCIAL RELATIONS

WILLIAM JAMES HALL
33 KIRKLAND STREET
CAMBRIDGE, MASSACHUSETTS 02138

October 21, 1975

Professor Allan Paivio
Department of Psychology
The University of Western Ontario
London 72, Canada

Dear Professor Paivio:

          I enjoyed your paper but do not feel that you
have correctly represented my position on imaging.
There is a great difference between conditioned seeing
in the Pavlovian sense and operant seeing as I developed
it in Chapter 17 in Science and Human Behavior. In my
paper Behaviorism at Fifty, a copy of which I enclose,
I rejected the operational position. The main point, I
think, is that I do not believe that at any time are there
"representations" in the body. When a person looks at an
object he does not make a copy of it. He sees it. That
behavior is no doubt puzzling to all of us and it can be
explained I believe only by looking at the contingencies
of survival and the contingencies of reinforcement which
have generated it (until the physiologists really get
down to details and show us what is going on inside as
a result of those contingencies). The easiest way to
see an object is to look at it. Not quite so easy is to
look at a picture or model. One can also see the object
with one's eyes closed. I submit that the same behavior
is involved in all three cases but is executed with
greater precision in the first. I regard the whole
cognitive metaphor of the storage of memories whether
as images or in some encoded form as a great mistake.
One does not recall a memory by looking for it in a
storehouse, one recalls by engaging in the same behavior.
Techniques for recalling a name are not techniques of
search but techniques of prompting and probing as I have
pointed out in my book Verbal Behavior.

          I think all your experiments -- and they are
fascinating -- can be reinterpreted simply as differences
in the facility with which we see things rather than as
the facility with which we find things stored in memory.
The key phrase in my article is that seeing does not

- 2 -

require a thing seen. But things are helpful. Pictures
are more helpful than words, the things themselves are
more helpful than pictures. In any case it is the
behavior of seeing that is at issue and I can only define
that as what happens when one responds to a stimulus
presentation under contingencies of reinforcement (ignoring
for the moment some slight tendency to see things as the
result of contingencies of survival in the evolution of
the species). If seeing something is highly reinforcing
I will seek out things to see or have models and pictures
around me or see them in what we call fantasy. It is
the same behavior under a variety of different circum-
stances. The mistake is to suppose that the presenta-
tion is stored and occurs as a re-presentation. The
neurologists will have a rough time of it if they try to
find stored memories in the form of images. They will
eventually succeed if they look for the behavior of
imaging, which is the same as the behavior of perceiving
except that in the latter case a thing perceived is
present.

Perhaps the length of this letter, which is
quite unusual for me, will suggest to you how much I
enjoyed your paper.

Yours sincerely,

B. F. Skinner

B. F. Skinner

BFS:ah