Understanding Interference and Inhibition Processes from a Motivational and Self-Regulated Learning Perspective: Comments on Dempster and Corkill

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Interference and inhibition processes as discussed by Dempster and Corkill (1999) are useful on two levels: first, metaphorically in terms of general themes for educational psychology, and, second, in terms of psychological mechanisms for understanding learning. At the same time, there are a number of issues that must be addressed in future theory and research before interference and inhibition processes can be accorded a primary explanatory role in models of learning, including the operation and sequencing of interference and inhibition processes in relation to other cognitive, motivational, and self-regulation processes; the definition and construction of the relevant–irrelevant information dimension; the role of interference and inhibition in the active selection of goals, strategies, and behavior; the stability and trait-like nature of interference and inhibition; the range of generality and applicability of interference and inhibition in relation to all other aspects of learning and behavior; and the utility and power of interference and inhibition as explanatory constructs.

Dempster and Corkill (1999) have certainly made an important contribution to the educational psychological literature in their review of the processes of interference and inhibition and the role these processes play in memory, cognition, intelligence, reasoning, and self-regulated learning. The

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authors have marshaled evidence from quite diverse areas of research to demonstrate the importance of both interference and inhibition processes for understanding cognition and behavior. The constructs of interference and inhibition are useful on two levels: first, on the metaphorical level in terms of general themes for educational psychology and second, on the theoretical level in terms of defining basic psychological mechanisms and their physiological underpinnings that must constrain all psychological constructs.

I have been asked to comment on their review given my research and perspective on motivation and self-regulated learning. First, I comment on interference and inhibition processes from this perspective and suggest that consideration of these processes can help us understand self-regulated learning both metaphorically and theoretically. At the same time, however, I suggest that these processes are not the only important constructs to consider in psychological models and that motivation and active self-regulation are still key constructs. Finally, I raise some general questions about interference and inhibition processes that need to be clarified in future theory and research.

First, in terms of application to self-regulated learning, Dempster and Corkill basically offer two general suggestions, one concerning the role of negative affect and negative cognitions in self-regulated learning and one involving a broader role of inhibition and interference in the selection of goals, strategies, and behavior. In considering the role of negative affect and cognitions, Dempster and Corkill rightly point out that there are a number of models of anxiety and emotions that suggest how negative affect can interfere with attention, cognition, and learning. In addition, many of these models propose that the negative self-referent cognitions that can accompany negative emotions like anxiety also can interfere with cognitive processing. At the metaphorical level, Dempster and Corkill have aptly characterized these models of anxiety in terms of their reliance on a general theme of interference.

For example, some models assume individuals have a limited cognitive capacity and that anxious and negative self-referent thoughts use up some of that capacity, making less of it available for the task at hand and thereby "interfering" with attention and cognitive processing (see Tobias, 1985). Other models suggest that individuals use both cognitive and metacognitive strategies (e.g., Benjamin *et al.,* 1981) as well as motivational and volitional strategies (e.g., Boekaerts, 1993) to cope with test anxiety and the associated negative affect and cognitions. These models propose that individuals who lack or do not use these self-regulatory strategies show the most debilitating effects of test anxiety and that all individuals can use these self-regulatory strategies to help them overcome or compensate for the problems of test anxiety. In addition, there are models (e.g., Kanfer and Ackerman, 1996;

Tobias, 1985) that attempt to synthesize both the cognitive capacity and the self-regulatory strategy models of test anxiety.

Given these explanatory mechanisms, Dempster and Corkill are correct in noting that these models rely on the general idea that test anxiety "interferes" with performance by increasing the demands on cognitive and attentional resources and that various self-regulatory strategies can be invoked to "inhibit" the negative affect and self-referent thoughts that are generated by test anxiety. However, moving beyond this metaphorical level, Dempster and Corkill also imply that there is an even more basic psychological mechanism that underlies the problems associated with test anxiety. They suggest that resistance to interference is a basic cognitive process that complements the capacity and strategy mechanisms proposed by other models. Resistance to interference in their model involves the ability to ignore or resist or inhibit irrelevant or off-task information and behaviors while doing a task (Dempster and Corkill, 1999). They suggest that this basic process of resistance to interference depends on the operation of the frontal lobes and operates in a more associative manner and can't be explained in term of other cognitive processes (i.e., lack of resources or cognitive and volitional control strategies).

In this model, as I understand it, as an individual begins a task, a variety of relevant and irrelevant information to the task is activated and the resistance to interference process helps the individual focus on the relevant information and behaviors and ignore the irrelevant information and inhibit inappropriate behaviors. In addition, it seems to me that this process is fairly "automatic" and not necessarily under the conscious control of the individual. Moreover, individuals who have trouble attending to the relevant information are somehow deficit in their ability to resist or inhibit the irrelevant information. In the special case of negative affect and anxiety, the irrelevant information includes negative thoughts and doubts about one's ability to do the task as well as negative affect about the task. For individuals who do not have the ability to resist these negative thoughts and affect, there is then interference with performance of the task, regardless of capacity constraints or strategy use. In this sense, test anxious individuals are redefined in terms of their lack of ability to resist interference, not in term of their lack of strategies or in terms of limitations in working memory capacity. Of course, the resistance to interference model would allow that test-anxious individuals, or perhaps a better term in this model, "deficient interference resisters," could benefit from the use of various cognitive, motivational, and volitional control strategies to help them cope with their interference problems. However, in this model the initial source of the test anxiety problem is the lack of capability to resist interference, not the lack of

strategies, although strategies could certainly be invoked to compensate for the problem.

This basic psychological mechanism of resistance to interference can certainly be used to explain some of the difficulties of test anxious individuals, but it is not clear that it can be used to explain all the differences. First, there is evidence that there are at least two types of test-anxious individuals and that they differ in terms of their problems at the encoding and retrieval stages (e.g., Naveh-Benjamin *et al.*, 1987). The group that has difficulties at the retrieval stage, during the actual testing situation when they retrieve irrelevant information including negative self-referent thoughts, do seem to fit the resistance to interference explanation. On the other hand, Naveh-Benjamin *et al.* (1987) found that the other group of students had problems at the encoding stage, when learning the material in a nonevaluative situation. These students had difficulties organizing the material and did not use very effective cognitive strategies. This group's lack of effective strategies resulted in poor encoding of the material and led to retrieval problems during testing, suggesting an important role of strategies early on in the process of learning.

Of course, from an interference perspective, one could argue that this group, at the encoding stage, also was unable to resist irrelevant information and that irrelevant information was then encoded early in the learning process and then retrieved at testing, resulting in poor performance. This raises questions about the operation, sequencing, and interaction of these different psychological mechanisms such as resistance to interference, capacity, and strategies that need to be addressed in empirical research. Nevertheless, it still seems that strategies can play an important role in explaining the detrimental effects of test anxiety. Accordingly, although resistance to interference may be useful as a metaphor for understanding anxiety, there is still a need for theoretical models and empirical research that examine at the psychological level how learner's resistance to interference and their use of various cognitive, metacognitive, and volitional strategies interact with limited capacity resources in order to explain the role of anxiety in learning.

Moving beyond the specific case of negative affect and anxiety, the resistance to interference model raises several general issues that have implications for models of motivation and self-regulated learning. First, as with anxiety, the resistance to interference model seems to assume that all problems of self-regulation are a function of the a priori basic cognitive primitive of the ability to resist interference. That is, if an individual is able to resist interference from irrelevant information and inhibit various prepotent responses, then there is no need for self-regulation or self-regulatory strategies. Again, at the metaphorical level, this seems reasonable.

Individuals clearly do not need to self-regulate all the time and there are many occasions when the system functions automatically without active, conscious control and self-regulation. In addition, there are certainly occasions when the system "breaks down" (because of physiological damage to the brain or psychologically when irrelevant information is accessed or "disturbing" cognitions and emotions are activated) which require various self-regulatory processes to be used for more adaptive functioning. However, I do not think it is clear that self-regulatory strategies are used only when the system "breaks down" or used only after the resistance to interference mechanism has operated. I think they can be used in a more proactive manner, rather than just as reactive strategies called into play when resistance to interference is low.

This brings up the issue of the sequencing and operation of these various mechanisms again and raises questions at the psychological level in terms of the actual specification of explanatory mechanisms. The mechanism of resistance to interference does provide a good way to explain how information and knowledge is accessed relatively automatically and helps to define the task or situation for the individual. This is a welcome addition to models of self-regulated learning, which have tended to ignore issues of how prior knowledge interacts with self-regulatory processes. In addition, as Dempster and Corkill suggest, it could be one reason individuals access irrelevant goals and strategies in different situations rather than more adaptive goals and strategies. In this way, it may be similar to the activation of self-schemas which include various motivational and cognitive components (Garcia and Pintrich, 1994).

At the same time, however, the construct of resistance to interference does not adequately address how irrelevant information is defined. It seems to be defined in terms of task characteristics, although it is not really made clear by Dempster and Corkill (1999). From a motivational and self-regulatory perspective, it may be that the relevant–irrelevant dimension is defined in terms of personal goals and motivation. For example, if a student is operating under a performance goal focused on relative ability and besting others, then information regarding how well others are doing is relevant. On the other hand, for a student focused on a goal of mastery and learning, then how well others are doing is irrelevant information vis-à-vis this goal (Ames, 1992; Wolters *et al.*, 1996). The same argument could also be made for various other motivational constructs such as efficacy, interest, and task value. That is, students who vary in their self-efficacy may seek out different kinds of information in the task, with low-efficacy individuals focusing on task difficulty cues and high-efficacy individuals focusing on the challenge of the task. The same process could operate with students who vary in their interest and value for the task.

These simple examples of how motivational goals or other aspects of personal motivation can help to define what is relevant or irrelevant information for an individual reflect a more constructivist perspective on self-regulated learning than is represented in the resistance to interference model. The inclusion of motivational constructs as a parameter that influences the processing of information in terms of relevance suggests that there is more of a role for the individual's active construction of the task and situation. Ever since the "New Look" in perception and social psychological research in the 1950s, there has been a recognition that we need to include the person along with his or her motives, goals, and expectations as part of our understanding of even such basic processes such as perception (Hilgard, 1987). This somehow seems lacking in the interference models, which, at least metaphorically, seem to imply less constructivist and more passive and reactive individuals who are dependent on the ability to resist interference and inhibit irrelevant information and inappropriate behaviors, at least as they initially confront a task.

Moving beyond the metaphorical level, the consideration of the role of motivational constructs suggests that the operation of the interference or inhibition mechanisms may be different or depend on the individuals' goals and other motivational beliefs. If this is so, then the assumption that resistance to interference is the first mechanism to operate as an individual engages in a task may have to be reconsidered. A motivational analysis suggests that goals and motivational beliefs may be operating simultaneously and that the relations are reciprocal, rather than motivation and self-regulation coming into play after interference or inhibition processes. Again, there is a need for much more empirical work with students on academic tasks to investigate how these different processes might operate together to influence academic learning.

Besides these issues regarding sequencing and operation, Dempster and Corkill suggest that interference and inhibition processes can help us understand how an individual selects strategies and behavior. I agree with them that the issue of selection is one of the most important issues for any psychological theory, but I am not sure that interference and inhibition processes are the main mechanisms for selection. In terms of research on motivation in general, selection of behavior has typically been the driving question that motivational theories are designed to explain. In this sense, there are a number of motivational mechanisms, such as goals, needs, interests, values, and so forth, that have been used to help us explain why someone chooses to engage in specific activities in contrast to other activities (Pintrich and Schunk, 1996). More specifically, research on academic motivation has shown that motivational goals can have an important influence on the selection and use of various cognitive and self-regulatory strategies.

Individuals who are operating with a mastery goal tend to select different strategies than those operating with a performance goal (Dweck and Leggett, 1988; Pintrich and Schunk, 1996).

In addition, there are other cognitive models that stress the selection of strategies, but rely instead on a general evolutionary metaphor that includes variation in strategies, adaptive selection among these various strategies, and continuous change coupled with increasing adaptiveness over time in the use of strategies (e.g., Siegler, 1996). This evolutionary metaphor also might provide some suggestions on how to define the relevant–irrelevant dimension in terms of general adaptiveness of strategy use and behavior over time. Moreover, Siegler's (1996) ACSM model relies on more standard psychological mechanisms such as strategy use, knowledge base, and speed and accuracy information that modify the database of knowledge, strategies, and their interaction, although it does include an important role for associative learning, not unlike interference models. Finally, again from a more metaphorical perspective, selection of strategies and behavior implies a more "active" choice by the individual, rather than a more passive mode of automatic resisting or inhibiting prepotent responses.

A final issue from a motivational and self-regulatory perspective concerns the conceptualization of resistance to interference as an important developmental and individual difference variable. Although there are certainly developmental aspects of resistance to interference that can be tied to the development of the frontal lobes, I am not sure about the status of resistance to interference as a stable personal trait or individual difference. At one level, it seems that resistance to interference is assumed to be a stable individual difference variable given its strong links to an individual's brain functioning, especially in the case of individuals with physiological damage to the brain. At the same time, it seems that there can be situational differences in how individuals react to different situations, even in the special case of high-test anxious students, who do not show deficits in performance in nonevaluative situations. It is not clear how this situational variability and contextual sensitivity is handled in a resistance to interference model, especially if this ability to resist interference is a general stable trait tied closely to specific structures in an individual's brain. From a motivational and self-regulated learning perspective, some models suggest that depending on the context and the personal goals activated in the context, individuals' use of various self-regulatory strategies will vary. In this case, these models seem to be able to handle more easily the situational differences in the specific case of a high-test anxious person's performance as well as other more general examples of situational differences in individuals' behavior.

This issue of trait versus situational specificity of behavior is a long-

standing conundrum in psychology in general and educational psychology, in particular, and there is no single solution or model that can incorporate both intraindividual consistency and situational specificity (Pintrich, 1994; Snow *et al.*, 1996). It may be that individual researchers have to make choices about what level of specificity they find most useful given their research questions and area of study. For example, Snow *et al.* (1996) suggest that there is a hierarchy of different levels of referent generality that ranges from personality types and traits at the top, which are very general and are assumed to cut across most situations, to very specific responses and states that are very context dependent. In the middle of their hierarchy are various strategies and tactics as well as motivational orientations which can show some intraindividual consistency as well as situational specificity. These different levels of constructs can then be linked to a number of different achievement or learning outcomes, which also could be at different levels of specificity (Snow *et al.*, 1996).

It seems to me that resistance to interference may be closer to the top of this hierarchy in terms of being a more stable individual difference somewhat similar to temperament or one of the five main traits or factors that consistently emerge in factor analytic personality research such as impulsivity versus control and constraint. In fact, the relations of temperament and the personality trait of impulsivity to affect, other aptitudes, and various learning outcomes (see Snow *et al.*, 1996) do seem to parallel some of the findings discussed by Dempster and Corkill. This may be another connection that Dempster and Corkill want to pursue in terms of how their more "cognitive" construct of resistance to interference is linked to more "personality" constructs such as the trait of impulsivity. In turn, these constructs such as general traits may be best linked to outcomes at a fairly high level of generality such as overall achievement, intelligence, and performance on decontextualized laboratory tasks. In contrast, more context-specific constructs such as prior knowledge, self-regulatory strategies, and motivational goals may be better linked to more contextualized and specific academic performance.

Certainly, in the personality literature the same argument has been made that general traits are relevant for the selection of behavior and the prediction of general life outcomes but that more contextualized constructs such as knowledge, strategies, and goals are also important to consider in terms of predicting individuals' behavior and life outcomes (Cantor and Kihlstrom, 1987). In fact, in this personality literature, the personality traits are often seen as one general "personal" factor that influences individuals' more contextualized goals, knowledge, and strategies, but it is these goals, knowledge, and strategies that mediate any relation between general traits and overall behavior and life outcomes. In other words, the contextualized

goals, knowledge, and strategies are the important mediating and linking variables, not the general traits.

In the same manner, there is no denying the fact that general personality traits and styles can be linked to academic learning and performance (Snow *et al.*, 1996). However, paralleling the personality research, it may be that most of the effects of general traits on academic outcomes are mediated by more local and contextualized constructs such as knowledge, motivation, self-regulatory strategies, and affect. Of course, this is an empirical question and I look forward to more research on the mediating effects versus direct effects of resistance to interference and other motivational and self-regulatory variables on academic outcomes. At the same time, from a strictly pedagogical perspective, if traits are stable and relatively unchangeable, then it may not be very worthwhile to make them the focus of educational interventions. In contrast, knowledge, motivation, self-regulatory strategies, and affect are usually considered changeable and seem to be more amenable to instructional interventions. I think that this general focus on more malleable psychological constructs offers more hope to teachers and can motivate them to persist in the face of their daunting task to educate all students.

A consideration of the stability of our constructs raises a very general issue regarding the utility of the resistance to interference construct that goes beyond a consideration of motivation and self-regulated learning. As with general trait models of personality such as the factor analytic work on the five main personality traits, a reader is often left with the question, "So, is there anything that is not explained by this model?" In the personality case, the five general factors or traits are supposed to explain much of the variance in an individual's behavior across situations and over time. In the same manner, I had this exact thought after reading Dempster and Corkill's article in terms of their use of the general constructs of interference and inhibition to explain a great diversity of behavior including memory, intelligence, logical and mathematical reasoning, reading comprehension, and strategy use. In some ways, the model may overgeneralize the constructs of interference and inhibition. Again, at a metaphorical level in terms of general themes, I think that the constructs may be useful for educational psychologists as they think about the various processes involved in academic learning. However, I think that learning is very complex and that one general construct, whether it be intelligence, motivation, or interference, is not enough to do justice to the complexity of the phenomenon. Psychologists need more specific psychological constructs, which can certainly include resistance to interference, but can also include other constructs that have cognitive, motivational, self-regulatory, and affective components.

Beyond this issue of the generalizability of the constructs, researchers need to consider whether interference and inhibition are truly explanatory constructs or just descriptive constructs or general themes. As Siegler (1996) notes, there are many constructs that have been proposed as mechanisms of change such as equilibration, accommodation, assimilation, conceptual restructuring, zone of proximal development, and scaffolding, but it is not clear if these really "explain" change and development or just describe various processes. In the same manner, it is not clear if interference and inhibition really explain selection of behaviors or just describe certain cognitive activities and processes. Of course, description is very important, and interference and inhibition are certainly in good company if included with equilibration, accommodation, and so forth. Moreover, the theoretical and empirical difficulties in using all these constructs to explain learning and development, not just interference and inhibition, signify how difficult it is to develop explanatory mechanisms from any theoretical perspective in psychology. It may be that psychological models always will be limited in their explanatory power and that this realization motivates some of the turn to more physiological models of brain functioning. In any event, it seems that more specificity in the models of the various mechanisms is needed and that one general mechanism such as equilibration or interference or inhibition will not be sufficient for explaining all behaviors. These general mechanisms may be helpful, maybe even necessary, but not sufficient, and other mechanisms that include constructs such as capacity, self-regulatory strategies, motivation, and affect are also necessary.

In summary, the constructs of interference and inhibition are certainly useful as general metaphors or themes to think about as educational psychologists attempt to understand learning in educational settings. Moreover, it seems important to consider the role of more specific psychological mechanisms such as resistance to interference as part of a general nomological network for examining the problems of motivation, cognition, and self-regulated learning. At the same time, I am not sure that mechanisms such as resistance to interference should be given primary or central explanatory status in models of self-regulation until there is much more empirical research on their relations with other constructs such as motivation, strategy use, and affect. This will require a concerted research effort with primary attention to issues of construct validity in the measurement of all these different mechanisms and structures because many of their features and hypothesized functions are very similar. To this end, however, Dempster and Corkill have provided a number of good sites to begin this research, and in this sense, like all productive models, their work is generative for the field of educational psychology.

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