An Educational Psychologist's Perspective on Cognitive Neuroscience

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Schunk, D. H. (1998). An educational psychologist's perspective on cognitive neuroscience. *Educational Psychology Review, 10,* 411-417.

Abstract:
Byrnes and Fox present a thoughtful article on a neglected but important topic for educational psychologists. Some major contributions are their emphasis on the need for consistency in educational theory and neuroscience research, the lack of automatic correspondence between neuroscience research and educational applications, the need for educator awareness of neuroscience research, the importance of development, and the influence of early education. Limitations of the neuroscience perspective for education include inadequate examination of contemporary theories of learning and motivation, the generality of cognitive processes, the influence of student beliefs, and the role of self-regulation. Suggestions for future research are given.
KEY WORDS: learning; motivation; self-regulation.

Article:

INTRODUCTION

The role of cognitive neuroscience in educational psychology is a neglected but significant topic. Byrnes and Fox (1998) summarize an impressive body of research and reach thought-provoking conclusions. It behooves researchers and practitioners not only to be informed of this literature but also to use it to help guide their thinking about teaching and learning.

In this article, I discuss some of the contributions of the Byrnes and Fox article to educational psychology. I then offer some limitations and mention issues for further research. I am encouraged by the spirit of the Byrnes and Fox article, and I believe that collaboration between educational psychologists and cognitive neuroscientists represents an important new direction.

CONTRIBUTIONS OF COGNITIVE NEUROSCIENCE

Space limitations preclude my mentioning all of the ways that Byrnes and Fox have contributed to our understanding of the role of cognitive neuroscience in educational psychology. In this section, I focus on five of their major points: the need for consistency in educational psychology theory and neuroscience research findings, the lack of correspondence between neuroscience findings and educational applications, the need for awareness among psychologists of neuroscience research, the emphasis on developmental processes, and the influence of early education.

Consistency of Theory and Research

Byrnes and Fox are on target with their contention that theories of motivation and learning should be consistent with cognitive neuroscience research findings. Inconsistency often is a problem within educational psychology. Many information-processing theories, for example, posit that information is operated on in sequential fashion; however, much research shows that learning is complex and can involve processes operating simultaneously (Schunk, 1996). Thus, while students work on an academic task they may be performing mental operations, evaluating their learning progress, and experiencing feelings of satisfaction.

Cognitive neuroscience shows that we can distinguish domain-specific from general processes. Although this issue has been discussed in educational psychology for years (Pintrich and Schunk, 1996; Schunk, 1996), it is noteworthy that of late researchers are focusing less on debating whether there are general and domain-specific processes and more on determining which processes fall into which category.

Lack of Correspondence Between Neuroscience and Applications

Byrnes and Fox contend that there is no automatic correspondence between neuroscience findings and educational applications. Educators often make the mistake of overgeneralizing research findings. The attention given to right brain—left brain research led many educators to recommend that teachers determine the dominant hemisphere for their students and teach accordingly (e.g., use more visual materials with right-brain students and more verbal explanations with left-brain students). There is a need to be judicious in translating research findings into practice.

Although there is evidence to support hemispheric asymmetry (Rohn, 1995), Byrnes and Fox make it clear that cognitive processes can operate in multiple places. Regardless of perspective, it is good teaching advice to appeal to different sensory modes. Thus, a geography unit might contain visual information (pictures, videos, slides), as well as verbal material (written descriptions). Multiple modes of presentation are especially helpful when students have difficulty comprehending material presented in a particular fashion.

Awareness of Neuroscience Research

A major contribution of the Byrnes and Fox article is that it helps to foster awareness of cognitive neuroscience research among educators. We are probably no different than other professionals in the sense that typically we read little material outside of our discipline. Nor are we usually exposed to this literature in college courses. Most educational learning texts do not include a chapter on cognitive neuroscience (Gredler, 1992; Ormrod, 1995; Schunk, 1996), and few instructors supplement their courses with this unit due to such factors as insufficient time to cover the material, inadequate understanding of cognitive neuroscience among instructors, and the belief that neuroscience has little relevance to education. Educational psychologists would benefit from a basic understanding of neuroscience, along with the appropriate cautions noted by Byrnes and Fox at the end of their article.

Emphasis on Developmental Processes

A strength of neuroscience research is its emphasis on developmental processes. Although educational psychologists generally understand that teaching and learning must be viewed in light of students' developmental levels, the links between development, teaching, and learning, often are not obvious to students. Thus, in many teacher education curricula, courses in development are taught separately from methods courses, often outside of education (e.g., by psychology departments). As new initiatives are incorporated into curricula (e.g., inclusion, technology), the emphasis on development is further weakened as educators struggle to keep preparation programs at a reasonable number of credit hours. Prospective teachers benefit from a solid grounding in developmental processes and exposure to literature linking development with classroom experiences (Eccles *et al.*, 1993).

Influence of Early Education

Finally, I believe cognitive neuroscience makes a strong statement on the importance of early education. Most learning and motivation research is done at the K-12 level; research on preschool education is scant by comparison. Such research would provide a much clearer picture of the role of *readiness*, a notion frequently invoked to delay teaching of content. Bruner (1960) contended that any content can be taught in meaningful form to learners of any age (often misinterpreted to mean that learners of any age can be taught anything). In turn, he advocated *revisiting the curriculum:* leaching content to children in a simple fashion and in a more-complex way at later stages of development. Unfortunately, this notion often has been ignored by advocates of readiness, who assume there is a proper time to teach particular content. Cognitive neuroscience provides justification for intensified research with young learners to assess what they are capable of learning.

LIMITATIONS AND FUTURE RESEARCH

Although I am impressed with the many insights in the Byrnes and Fox article, I believe there are some limitations and points requiring clarification, which in turn suggest future research directions. The areas I discuss are contemporary learning and motivation theories, domain-general processes, student beliefs, and self-regulation.

Contemporary Learning and Motivation Theories

Byrnes and Fox state that the only contemporary theory that is consistent with neuroscience research is Adams's (1990) theory of reading. A closer inspection of the literature, however, reveals several theories whose tenets are consistent with neuroscience.

For example, Bandura's (1986, 1997) social cognitive theory views human functioning as a series of reciprocal interactions—between personal (e.g., cognitions, affects), behavioral, and environmental elements—which capture the complexity notion of neuroscience. Pintrich and his colleagues (Pintrich, 1989; Pintrich, Marx, and Boyle, 1993; Pintrich and Schrauben, 1992) contend that cognitive and motivational factors interact to influence learning. I also have written on how the interplay of instructional practices and student beliefs and skills affects student achievement (Schunk, 1989, 1991).

Other similarity between neuroscience and theories of learning and motivation is seen in the area of goal setting. Byrnes and Fox discuss how neuroscientists have revealed two distinct neurological paths in animals that correspond to the motivational constructs of "wanting" and "liking." These constructs typically are not distinguished in theories of motivation that lack a neuroscientific basis. In fact, cognitive theories of motivation postulate that people pursue goals that are important but not necessarily liked; however, the perception of progress toward the goal, along with goal attainment, can produce satisfaction (Bandura, 1988; Locke and Latham, 1990; Pintrich and Schunk, 1996; Schunk, 1990). These points underscore the need for educational psychologists and neuroscientists to be mutually informed of each other's work.

Domain-General Processes

The discussion by Byrnes and Fox of domain-general and domain-specific processes is useful. Interestingly, however, the distinction often becomes muddy. Learning and motivation researchers are discovering that many cognitive and motivational processes operate in much the same fashion across domains (Pintrich and Schunk, 1996; Schunk, 1996). For example, Byrnes and Fox note that the acquisition of reading and mathematical competence is domain-specific. From an educational perspective, however, reading is a component of literacy, which involves written and spoken communication and comprehension. Literacy acquisition cuts across most content areas, and is clearly seen in the whole language approach involving integrated curricula. Mathematical reasoning and problem solving skills are likewise involved in other areas (e.g., social problem solving, self-regulation). Thus, even domain-specific skills may operate broadly, which research will help to clarify.

Student Beliefs

The neuroscience emphasis on cognitive processes tends to underestimate the role of student beliefs, which have cognitive and affective components (Bandura, 1997; Meece, 1991; Weinstein and Mayer, 1986). Research in various domains shows, for example, that *self-efficacy* (perceived capabilities) predicts learning and achievement better than does prior performance and that self-efficacy is not an automatic reflection of performance (Schunk, 1991). Schunk and Hanson (1985, 1989) found that observations of similar peer models or of one's own successful performance raised achievement and self-efficacy for learning beyond the effects due to the performance itself. Neuroscience research methods should prove helpful in showing how beliefs and skills interact in reciprocal fashion as postulated by Bandura (1986).

Self-Regulation

Finally, any contemporary psychological theory should deal with *self-regulation,* or one's planned efforts to direct one's thoughts, feelings, and actions, toward attainment of goals (Zimmerman, 1989, 1994). Unlike the behavioristic theories that held sway for many years, contemporary theories of learning and motivation

postulate that students are mentally active and do not automatically process information as presented by teachers (Pintrich and Schunk, 1996). Theory and research on self-regulation emphasize that students often construct their own effective methods for learning and exert control over their motives, outcomes, and social and environmental resources (Zimmerman, 1994). Educational research on self-regulation is accelerating rapidly, and neuroscientific research could further elucidate the operation of self-processes during learning.

CONCLUSION

I commend Byrnes and Fox for this timely piece, which not only is informative but also may help to build communication across disciplines and lead to collaborative efforts. As an educational psychologist, my hope is that researchers continue to address the issues Byrnes and Fox raise at the end of their article, along with the other questions I have mentioned.

REFERENCES

Adams, M. J. (1990). *Beginning to read,* Harvard University Press, Cambridge, MA. Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory,* Prentice Hall, Englewood Cliffs, NJ.

Bandura, A. (1988). Self-regulation of motivation and action through goal systems. In Hamilton, V., Bower, G. H., and Frijda, N. H. (eds.), *Cognitive perspectives on emotion and motivation,* Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 37-61.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* Freeman, New York. Bruner, J. S. (1960). *The process of education.* Vintage, New York.

Byrnes, J. P., & Fox, N. A. (1998). The educational relevance of research in cognitive neuroscience. *Educ. Psychol. Rev.* 10: 297-342.

Eccles, J., Midgley, C., Wigfield, A., Buchanan, C., Reuman, D., Flanagan, C., and MacIver, D. (1993). Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and families. *Am. Psychol.* 48: 90-101.

Gredler, M. E. (1992). *Learning and instruction: Theory into practice* (2nd Ed.), Macmillan, New York.

Hohn, R. L. (1995). *Classroom learning and teaching.* Longman, White Plains, NY.

Locke, E. A., and Latham, G. P. (1990). *A theory of goal setting and task performance,* Prentice Hall, Englewood Cliffs, *NJ.*

Meece, J. L. (1991). The classroom context and students' motivational goals. In Maehr, M. L., and Pintrich, P. R. (eds.), *Advances in motivation and achievement* (Vol. *7),* JAI Press, Greenwich, CT, pp. 261-285.

Ormrod, J. E. (1995). *Human learning* (2nd Ed.), Merrill, Englewood Cliffs, NJ.

Pintrich, P. R. (1989). The dynamic interplay of student motivation and cognition in the college classroom. In Ames, C., and Maehr, M. L. (eds.), *Advances in motivation and achievement* (Vol. 6), JAI Press, Greenwich, CT, pp. 117-160.

Pintrich, P. R., Marx, R. W., and Boyle, R. (1993). Beyond "cold" conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Rev. Educ. Res.* 63: 167-199.

Pintrich, P. R., and Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom tasks. In Schunk, D. H., and Meece, J. L. (eds.), *Student perceptions in the classroom Lawrence* Erlbaum Associates, Hillsdale, NJ, pp. 149-183.

Pintrich, P. R., and Schunk, D. H. (1996). *Motivation in education: Theory, research, and applications.* Merrill, Englewood Cliffs, NJ.

Schunk, D. H. (1989). Self-efficacy and achievement behaviors. *Educ. Psychol. Rev.* 1: 173-208. Schunk, D. H. (1990). Goal setting and self-efficacy during self-regulated learning. *Educ. Psychol.* 25: 71-86.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educ. Psychol.* 26: 207-231. Schunk, D. H. (1996). *Learning theories: An educational perspective* (2nd Ed.), Merrill, Englewood Cliffs, NJ.

Schunk, D. H., and Hanson, A. R. (1985). Peer models: Influence on children's self-efficacy and *achievement. J. Educ. Psychol. 77:* 313-322.

Schunk, D. H., and Hanson, A. R. (1989). Self-modeling and children's cognitive skill learning. *J. Educ. Psychol* 81: 155-163.

Weinstein, C. E., and Mayer, R. E. (1986). The teaching of learning strategies. In Wittrock, M. C. (ed.), *Handbook of research on teaching* (3rd Ed.), Macmillan, New York, pp. 315-327.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *J. Educ. Psychol* 81: 329-339.
Zimmerman, B. J. (1994). Dimensions of academic self-regulation: A conceptual framework for education. In Schunk, D. H., and Zimmerman, B. J. (eds.), *Self-regulation of learning and performance: Issues and educational applications,* Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 3-21.