

# Brains and the Dynamics of “Wants” and “Cans” in Learning

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**ABSTRACT**—Immordino-Yang’s description of the unexpected recovery of 2 boys with severe brain trauma is an example of the interplay between the plasticity of the brain and the plasticity of the context. It highlights the dynamics of “wants and cans” and the specific role of motivation in this dynamic. As an example of how this dynamic can evolve in different directions, we focus on learning trajectories of children with developmental psychopathology using a model of the process of social interaction to explain the interplay between behavior and performance on short-term and long-term timescales. The idea is that the flexibility of the short-term process allows for a particular quality of teaching and learning and helps explain highly unexpected developmental trajectories such as those described by Immordino-Yang (2008). The explanation of the long-term outcomes of the educational process lies not in the determinism of the (dysfunctional) brain but in the positive characteristics of interacting creative minds.

## AN EXAMPLE IN PRACTICE

The Meerkats is the proud name of a class in a school for special education in the Netherlands. Twelve pupils are between 9 and 10 years of age and have been diagnosed with attention deficit hyperactivity disorder (ADHD), pervasive developmental disorder—not otherwise specified, and comparable indications. Because they have accumulated serious difficulties as well as individual differences in mathematics knowledge, lessons are based on individual instruction and practice. Here is a typical scene from a mathematics lesson.

After the workbooks and notebooks have been handed out and everybody has put his green-red block<sup>1</sup> on the desk, it takes a while before pupil W.—who has been diagnosed with ADHD—has finished his chat with pupil T. Urged by

the teacher, W. finally opens his mathematics book and notebook. After a delay due to missing ancillary material—a box of blocks—W. is finally ready to get started. Instead of turning to his assignment, W. begins with operation “how do I inadvertently get a block on the ground so that I do not have to start the math.” W. pushes a block over the rim and then begins an elaborate rescue operation. The finding of the block is an occasion for W. to deliver an ample report of the event to his neighbor, which causes the teacher to reprimand and correct him. After pulling a wry face and staring a while into the void, W. finally begins his assignment. Then, the mathematics lesson’s alarm clock, which is set to 25 min sharp, goes off, and W. has succeeded in doing no mathematics at all. After a year of mathematics instruction, W. has made no progress on the educational tests, which sets the lag with his fellow students now to 2 years, which makes it increasingly more difficult for him and his otherwise competent and motivated teacher to make up his arrears.

The story provides an example of the interplay between the short-term and the long-term dynamics of want-and-can, that is, of the interplay between concerns, interests, the associated emotions, and evaluations on the one hand, and of the means for realizing those concerns and interests, that is, skills, knowledge, and the learning brain on the other.

## IS THE BRAIN TO BLAME?

It is easy to blame W.’s ADHD for his delay in mathematics and his problems in school and still more easy to blame W.’s brain for the problems, because it is likely that W.’s ADHD is associated with particular properties of his brain (e.g., Krain & Castellanos, 2006). In her article, Immordino-Yang (2008) shows how two children with severe brain trauma surprisingly recover and finally come to skills that exceed all preliminary expectations. These two cases provide a perfect example of the interplay between the plasticity of the brain and the plasticity of the context. Immordino-Yang (2008) states, for instance, that the two children transformed the nature of the processing problem itself to suit the existing strengths of their remaining hemisphere (p. 50).

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The cases provide also a striking example of how the dynamics of want-and-can can run very differently from, crudely saying, “brain-based scenarios.” Immordino-Yang (2008) makes clear that the children are highly motivated to overcome their limitations and are supported by an equally motivated environment that invests all available resources to help the children learn as much as possible, and at the end of the day, there seems to be a lot possible. It would, however, be overly simple to conclude that one must only increase the children’s and teachers’ motivation in order to reach comparable miracles as in the case of Nico and Brooke. Motivation, whatever it means, is not an independent variable that one can draw from at will. Motivation is part of the dynamics of want-and-can. By way of commentary, we will try to show how the dynamics can evolve very differently, notwithstanding the evident motivation and educational skills of the teachers.

#### THE FUNCTIONING OF CHILDREN WITH DEVELOPMENTAL PSYCHOPATHOLOGY IN THE CLASS: A DYNAMIC SYSTEMS APPROACH

The motivation for introducing developmental psychopathology in our discussion comes from a study that we are conducting. Its aim was to contribute to building a theory about complex socially situated learning processes by focusing on process characteristics of normal and problematic learning trajectories. By comparing both, more insight can be gained into how to support learning processes to let them evolve as optimally as possible under the constraints and opportunities of the given teaching-learning system.

#### Psychopathology and Dynamic Systems

Why do we study problematic learning trajectories in children with psychopathology instead of just focusing on the typically developing children? The first reason lies in the explosive growth of children with behavioral and psychiatric problems in primary education in the Netherlands, causing increasing difficulties for teachers to establish effective teaching-learning interactions, partly because the biologically grounded problems of these children are likely to negatively affect the teacher’s feelings of self-efficacy as regards teaching (Ballet & Kelchtermans, 2004; Ballet, Kelchtermans, & Loughran, 2006; Hover, 2006).

Second, especially in this group of children, the interplay between motivational, self-regulatory skills and specific (brain-based) impairments in functioning (wants and cans) seems to be leading to unwanted, dysfunctional attractor states in teaching-learning processes, causing most of these children to academically perform much poorer than could be expected on the basis of their intellectual skills (or impairments in these skills) only (Algozzine, Serna, & Patton, 2001; Pianta, 2006).

Based on our dynamic systems approach, we see teaching-learning processes as emergent phenomena, that is, as patterns that self-organize out of the multitude of conditions, causes, constraints, and opportunities present in the system consisting of the child, with its particular problems and impairments, the teacher, the curriculum, the school, and so forth. Dynamic systems theory (van Geert & Steenbeek, 2005) is a general approach that focuses on the mechanisms of change in the major variables that characterize a system. For instance, what makes the current level of mathematics understanding in a child change, with a particular rate and direction? Dynamic systems theory tries to specify the basic mechanism of such change and then applies it to the level of mathematics understanding in an iterative, that is repeated, fashion: What is the next step of the child’s mathematics understanding, and then, by applying the same mechanism, what is the next step after that, and after that?

The theory thus tries to reconstruct a trajectory of changes or the set of possible or most likely trajectories. These trajectories spontaneously emerge under the control of all the variables and factors involved, and even under relatively strictly organized curriculum conditions, the actual trajectories—as they appear to the teacher and the student—are the result of self-organizing processes. Self-organization often means that the process spontaneously evolves toward a self-sustaining situation, which is difficult to change once it has established itself. These self-sustaining patterns are called the attractor states or attractors of the system.

#### A Dynamic System Model of Social Interaction in Teaching-Learning Contexts

Immordino-Yang and Damasio (2007) state that “the relationship between learning, emotion, and body state (runs) much deeper than many educators realize.” The reason why a particular student makes a mathematics assignment has “a powerful emotional component and relate(s) both to pleasurable sensations and to survival within our culture” (p. 4). What is the role of emotion and motivation in the learning problems of children with developmental psychopathology? The study carried out by the current authors focuses on the socially situated dynamics of cognitive learning. It is a naturalistic and time-series empirical study in which five students in special education and five students in regular education are followed over a 2-year period. The aim was to understand process characteristics of problematic and normal learning trajectories. In contrast with Immordino-Yang (2008), who is looking for “basic principles governing the organization of children’s brain and cognitive development in relation to experience” (p. 5), our research starts from the opposite side, namely from the child’s actions, concerns, emotions, and experiences in the context of daily school life.

We base our study on a dynamic systems model of the process of action and social interaction (Steenbeek & van Geert, 2005, 2007, 2008; van Geert & Steenbeek, 2005). First, the model discerns two components. The *first* is self-regulation and internal homeostasis. It is governed by the dynamic relations between goals (which often take the form of largely unconscious intentions, concerns, or interests), actions aimed at reaching the goals and the skills required to do so, and the emotional appraisals of the context related to the realization of the concerns. It relates to Immordino-Yang’s link between emotions and cognition. The second is the *social* component, that is, the valence of the social context as a drive for specific action. It involves emotional expressions signaling concerns and appraisals to social interaction partners and automatic social processes in the forms of behavioral or emotional contagiousness. In our dynamic model of interaction (Steenbeek & van Geert, 2005, 2007, 2008), the effective support of the social environment (Immordino-Yang, 2008, p. 40) depends not only on what the environment actually does but also on the child’s assignment of a specific value or valence to this particular environment.

Second, our model makes a distinction that is important for understanding the dynamics of mind, brain, and behavior, which is the distinction between short-term and long-term dynamics and the nature of the relationships between the two. A child’s main concern in a concrete situation—for instance, the child’s concern to escape from making the assignment—is an example of a short-term parameter, contributing to the short-term dynamics of the unfolding activity during the mathematics lesson. The self-organization of such a concrete concern is governed by long-term parameters, that is, the child’s habits, skills, perceived competence, and so on. The long-term parameters change as a consequence of experiences and actions, which take the form of changes in the brain that amount to interactive specialization (Johnson, 2000; see also Fischer, 2007; Nelson, 1999; Stiles, 2001). It is likely that this specialization involves not only the storage of skills but also that of habitual interests and concerns and related emotional and appraisal patterns. The long-term parameters do not operate in a deterministic fashion: What happens in a concrete situation depends on the interplay between the long-term parameters and the short-term affordances of the situation, for example, the actual mathematics lesson. The notion of interplay thus implies a certain flexibility of the short-term process, and it is this flexibility that allows for teaching and learning and for highly unexpected developmental trajectories such as those of Nico and Brooke. In short, what we need is a dynamic framework for understanding relationships between brain and education (Fischer, 2007). We need it not only for understanding the dynamics of developmental disorders (e.g., Sagvolden, Aase, Johansen, & Russell, 2005) but also to understand the dynamics of remarkable recovery, as in the cases described by Immordino-Yang (2008).

How does one get a grip on this “dynamic framework,” starting from educational practice? In order to accomplish this goal, we think it is necessary, first, to study children’s real-time class performance, task behavior, verbal and nonverbal expressions, and emotions during real instruction in the class by their teacher. Second, the patterns of action need also to be studied as they change or consolidate over developmental time.

**MATHEMATICS PERFORMANCE, TASK BEHAVIOR, AND INDIVIDUAL INSTRUCTION: AN EXAMPLE OF THE DYNAMICS OF SELF-REGULATION**

Our data show that every pupil makes about a constant number of assignments per lesson irrespective of the pupil’s level in the workbook. This number is far below the number of assignments they could make under the given circumstances and less than that their peers could make in regular education, which explains that their educational delay—which at their age of 9–10 years amounts to a delay of about 2 years—is constantly increasing.

Each pupil has a specific profile of on- and off-task and asking and getting help (see Figure 1 for an example). It is striking that during an individual instruction session, the teacher is highly active and structuring the task, whereas the pupil remains highly passive.

As regards class management, the emphasis lies clearly on the pedagogical climate, not on the didactics. Pupils must be quiet and (apparently) busy with their own work. They are not allowed to consult with their peers. If they get stuck with their assignment, they must indicate that they need help from the teacher by turning their message block to the green side. The teacher provides strictly individual help. Pupils tend to make their own use of this system in order to regulate—more precisely decrease—their pace, level of effort, and contacts with the teacher.

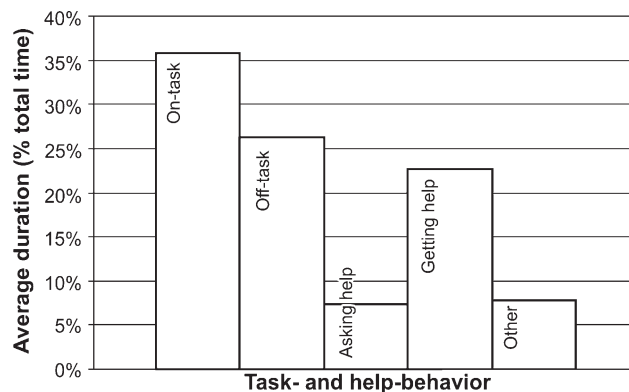


Fig. 1. W.’s profile of task and help behavior averaged over about a year of mathematics lessons.

### The Pupils' Perception of the Learning Task

An important statement of Immordino-Yang (2008) is that “new learners may actually be transforming the intended problem into something new, implying a need for careful attention to learners’ perception of the educational problems put to them, as well as a need to design learning environments that capitalize on this process” (p. 38). Our observations suggest that the children from our study have transformed the mathematics lesson into solving the problem of how to do as little mathematics as possible. They have defined this problem in the context of their teacher’s providing a highly structured individual teaching environment. The pupils succeed in putting the responsibility for the actual solving of the (nontrivial) mathematics problems to the teacher. Their positive emotional appraisals of the context are thus not related to the mathematics problem per se and thus do not contribute to enhancing their perceived competence in mathematics as such.

The pupils’ perception of the learning context can be explored in the form of open chats with an adult who shows an interest in their personal feelings. The second author videotaped a number of interactions she had with the pupils. She observed that the children had little difficulty conveying their perceptions and evaluations of the mathematics tasks to her and thus learned a lot about the children’s motives.

### Is the Teacher to Blame?

The observations we made in the special education class are not the result of incompetent and unmotivated teachers and bad practice. To the contrary, the teachers are highly competent and motivated and follow the school’s pedagogical protocol of highly structured and individual teaching, which is presented as an evidence-based approach to teaching children in this particular branch of special education. There is ample professional pedagogical support. And yet, the pupils are not making the progress in mathematics they should make and have transformed the problem into the opposite of what the teachers intend. What has happened here is that the system of pupil–teacher interactions has evolved toward a relatively stable attractor state in which the pupils’ main concern is “not to do math” and the main emotion is the fear of getting involved into difficult assignments that evoke negative emotions of uncertainty and other negative self-conscious emotions.

In an earlier section, we asked whether the brain is to blame for the children’s developmental disorder. A comparable question could be: Is the teacher (school, curriculum, etc.) to blame for the fact that the children are not functioning better within the constraints of the disorder? The answer is similar to that given earlier: What we are witnessing here is the result of dynamic processes on the developmental and the action timescales, leading to habitual patterns of action, emotion, and learning that are relatively stable and not easy to change, even if they themselves are the result of a process

and in no way “predestined,” neither by the brain nor by the context.

In order to make a start with eventually changing this undesired attractor dynamics, it is worthwhile to talk with the teachers about their own perceived competences as regards the teaching of this special group of children and to make explicit their values, beliefs, and attitudes. Just as with the pupils, who have developed a fear of the failure they expect to experience if they really focus on their mathematics problems, teachers may have developed a fear of failure if they treat the children in ways that are not the ones they are used to and that are supported by what they know about these children in general and about how they learn and develop.

## CONCLUSIONS

The fascinating thing about Immordino-Yang’s (2008) study is that she has shown a dynamics involving brains, intentions and concerns, emotions, social interactions, and effort that has led to an unexpected compensation for the major brain handicap that both boys suffered. By way of comparison and contrast, we have discussed our own study of children whose brains are considerably more similar to those of typically developing children but who nevertheless move toward a more negative attractor state in their learning and teaching. In both cases, understanding the process requires understanding the dynamics of the interplay between pupil, teacher, and teaching–learning context. This understanding requires that we make a distinction between the short-term dynamics of action and the long-term dynamics of teaching, learning, and development and of the way these timescales interact. In line with Immordino-Yang’s article, it is important to conclude that the explanation of learning and development lies not in the determinism of the (dysfunctional) brain but in the joy of interacting creative minds. It is the pleasure in one’s educational accomplishments—of the student as well as of the teacher—that determine to what extent the particularities of the student’s brain will be dictating the long-term outcomes of the educational process.

## NOTE

- 1 With this block, pupils indicate if they need help from the teacher—green on top—or if they want to work alone and do not want to be disturbed by questions—red on top.

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