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# Change of Mind: Cognitive Flexibility in the Classroom

by Mariëtte Huizinga, Diana P. Smidts, and K. Richard Ridderinkhof

Daily life is full of changes—a change of plan, an unannounced event, an unexpected problem that needs to be solved, a new environment, or a surprise sudden opportunity. Changes call upon flexibility—one needs to abandon the current direction and adjust one's thoughts or behavior to the new situation. Flexibility is therefore essential for social and goal-directed behavior (Huizinga & van der Molen, 2011), and is considered to be one of the core executive functions (e.g., Miyake et al., 2000). In what follows, we will provide 1) an overview of scientific research into flexibility, which develops during childhood and adolescence; 2) an evaluation of problems with flexibility that children may experience in the classroom; and 3) practical guidelines and recommendations for teachers and coaches on how to deal with such problems.

The following example illustrates how flexibility is put into action in a school situation: Jim, a 12-year-old student, prepared his presentation for today really well. He is looking forward to it and is particularly curious about the reaction of his teacher. When Jim arrives at school, he discovers that there is a substitute teacher, as his regular teacher fell ill. Jim is disappointed and a bit angry, even though he is aware that his own teacher did not fall ill on purpose. Jim then overcomes his initial reaction and realizes that he can enjoy some of the things the substitute teacher is good at, such as telling stories.

Changes in the environment often involve emotional adjustment. Fear, apprehension, sadness, disappointment, or frustration may follow an unexpected change. For instance, Jim in the example above experienced disappointment and even some anger when discovering that his own teacher was not at school. Flexible adjustment to the new situation requires the reappraisal of these negative emotions and a shift to more positive thoughts or feelings (Gross & John, 2003). Jim succeeds by telling himself that his own teacher cannot help falling ill, and that the substitute teacher is also okay because of his talent for telling stories.

As children grow older, they become increasingly more proficient at adjusting to changing circumstances (e.g., Diamond, 2006). They need relatively less time to get used to new situations, and the transition consumes less of their energy. Moreover, they improve on their ability to regulate their emotions. Children gradually learn how to adjust to new circumstances, learn from earlier mistakes, and come up with alternative solutions for a problem. They become increasingly able to distribute attention and meanwhile process different sources of information (Cragg & Chevalier, 2012).

## Studying Flexibility

Researchers examining cognitive flexibility often make use of tests that require children to learn certain rules. These tests look like card sorting games where children are asked to pay attention to, for example, the shape or the color of the pictures. As soon as children have learned (and mastered) a

rule, a new, different rule is introduced. Subsequently, the children need to switch between the two rules alternatively. The ability to switch between rules indicates a child's ability to think flexibly. Thus, researchers examine children's ability to learn (and master) rules and their ability to switch between these rules (Crone, Bunge, van der Molen, & Ridderinkhof, 2006; Davidson, Amso, Anderson, & Diamond, 2006; Huizinga, Dolan, & van der Molen, 2006).

**Complex tests.** A classic test to examine cognitive flexibility is the Wisconsin Card Sorting Task (Grant & Berg, 1948; Heaton, Chelune, Talley, Kay, & Curtis, 1993). In this task, a person is presented with playing cards with pictures of different shapes (stars, squares, circles, or triangles). The pictures on the cards differ in color (red, yellow, blue, or green) and number of items (one, two, three, or four figures). The cards can be sorted in three ways: according to shape, number, or color. The person is asked to sort the cards, without being told these sorting rules in advance. Now the person needs to infer the correct sorting rule by trial and error, based on the experimenter's feedback. After each sort, the experimenter tells the person whether a sort was correct or incorrect. The first sort is always correct, whatever sorting rule the person used is accepted. For the next several trials, this sorting rule will be the rule to be adhered to. After ten consecutively correct sorts, however, the experimenter changes the sorting rule without informing the person about the rule change. The experimenter merely tells the person that the sort was incorrect, and feedback on subsequent card sorts is based on the new sorting rule. The person now needs to adjust his or her behavior by leaving the initial (and now incorrect) sorting rule and searching for a new sorting rule. The adequacy of flexible switching among sorting rules is indexed by counting the number of attempts to find a new sorting rule, the number of correct changes to a new sorting category, or, alternatively, the number of card sorts in which the person *perseverates* in sorting according to the previously correct sorting rule (i.e., the number of card sorts in which the person keeps repeating the now incorrect sorting rule). A number of studies have shown that children of about 7 years of age are able to do the Wisconsin Card Sorting Task, but they find the task very difficult (Chelune & Baer, 1986; Cragg & Chevalier, 2012). It takes them quite long to find the new sorting rule. They have difficulty letting go of a sorting rule once they have discovered it. Children of about age 12 perform much better on the Wisconsin Card Sorting Task: they need less time to find a sorting rule and find it easier to let go of a rule. Thus, 12-year-olds are better able to flexibly switch compared to 7-year-olds. Research also shows that children of about age 15 perform as well on the Wisconsin Card Sorting Task as young do adults of about age 21. Thus, the ability to flexibly switch among multiple different rules develops until mid-adolescence.

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In rudimentary form, cognitive flexibility manifests itself in children as young as about 2 ½ to 3 years old (Brooks, Hanauer, Padowska, & Rosman, 2003; Perner & Lang, 2002). Four-year-olds begin to show an understanding that one can sort cards with a blue car and a red flower following two different sorting rules: color or shape (Zelazo, 2006). In a computer test modified for children age 5 to 8 years (Luciana & Nelson, 1998), after a number of correct sorts, the child automatically proceeds to the next difficulty level; when the task becomes too difficult, it self-terminates. Five-year-olds are able to find a sorting rule and adjust their behavior accordingly. Six-year-olds are also able to apply a new sorting rule to the same pictures that they already responded to with a different sorting rule in previous levels. Children age 7 to 8 years are even more proficient: They are better able to learn and apply rules and to more quickly and accurately adjust their behavior to new circumstances.

**Task switching.** Research with tests such as the sorting tasks discussed above is associated with a number of drawbacks. These tasks not only require cognitive flexibility but also other abilities such as counting, concept formation, working memory, and the ability to inhibit a previously correct response. Thus, these tasks do not comprise pure measures of cognitive flexibility. In an attempt to circumvent such problems, during the past years, new—more process-pure—tasks have been developed to measure cognitive flexibility. These so-called “task-switching” tests are computer based and aimed at children of about 6 years and older (see Cragg & Chevalier, 2012).

The idea behind this task-switching paradigm is simple. As in card-sorting tasks, the child has to learn two rules: Respond either to the color or to the shape of the figures. However, which rule should be applied is not to be inferred from feedback, but is indicated by a cue that appears on the screen before the color/shape figure on each trial. Once the child has learned both rules separately, the child is required to switch between those two rules. A series of color trials is followed by a series of shape trials, which is again followed by a series of color trials, and so on. The sequence of trials consists of trials where the task is repeated (task-repetition trials) and trials on which the task changes (task-switch trials). The ability to flexibly switch between tasks can be examined by comparing reaction times and accuracy on task-repetition trials and task-switch trials.

Research with adults typically shows that responses on task-switch trials are slower and less accurate compared to task-repetition trials (Monsell, 2003). This difference is referred to as “switch costs” (or “local switch costs”) and provides an index of the ability to flexibly switch from one rule to another rule. Research with the task-switching paradigm in children is fairly recent (Davidson et al., 2006; Huizinga et al., 2006). The outcomes show that switch costs of 7-year-olds are larger compared to switch costs of 11-year-olds, which are larger than switch costs of 15-year-olds. Switch costs of 15-year-olds do

not differ from switch costs of young-adults. Thus, based on the outcomes of research with the task switching paradigm, cognitive flexibility appears to develop until mid-adolescence.

### Problems with Flexibility

Adjusting behavior to changing circumstances is not easy. This is particularly true when a change occurs unexpectedly, such as when a plan for a picnic in the park needs to be canceled because of unanticipated rain. Children respond differently to (unexpected) changes. Some children tend to get angry, while others adjust smoothly to the new situation. Some children resist change or need more time to adjust, while others are excited by the change and readily engage in exploration of new circumstances.

**Individual Differences.** The way in which a child manages the need to switch depends on the nature of the change itself, and how the child values the change. For instance, relatively minor and neutral changes (e.g., “we are out of pasta, so today we’ll have pizza for dinner”) will usually have less impact than relatively major changes (e.g., changing schools) or, in the eyes of the child, sensitive changes (e.g., “today you should wear your green sweater because your favorite blue Thomas-the-Train shirt is in the laundry”). As noted above, as they grow older, children become more proficient at adjusting to new circumstances. In addition, as the brain develops, the capacity to process new information improves (Crone & Ridderinkhof, 2011), children become progressively more competent at grasping and overseeing a new situation, and hence accommodate more easily.

Some children experience severe difficulties in adjusting to new situations, and big or small changes are equally adverse to them. Any change is distressing for them. These children prefer to keep things the way they are and stick to their routines. Their ability to respond flexibly usually stays worse than their peers even when they become older. Such children can be perceived by others as rigid, strict, or stubborn.

**Typical Problems.** Tables 1 and 2 illustrate behavior that is typically seen in children and adolescents experiencing problems with flexibility. Note that every typically developing child shows inflexible behavior every now and then. It is the frequency of the behavior that is important. The greater the degree and frequency of inflexible behavior, the more it interferes with daily activities. When a child is stressed or under pressure (e.g., during an exam period, or when there is a quarrel) a normally more flexible child might be inflexible because under stress or pressure all executive functions, including flexibility, are impaired (e.g., Arnsten, Mazure, & Sinha, 2012). In children experiencing problems, most incidences of changing circumstances (either small or more substantial changes) result in uneasy, insecure feelings. The following suggestions demonstrate how children experiencing problems with flexibility can be supported. These suggestions apply to daily life at school.

## Remedial Action

The suggestions below are intended to help students who experience problems with flexibility to function and deal with those issues more smoothly in the classroom. (These suggestions derive from an analysis based on Dutch classroom situations, which are not unlike those in the United States, as presented in Smidts & Huizinga (2011a)). The goal of these suggestions is to ensure that the student obtains insight into tasks or routines, including daily and weekly tasks, ranging from routines in learning school-related skills to the planning and completion of assignments.

**Keeping to daily and weekly routines.** Children experiencing problems with flexibility function best in an environment that is predictable, constant, and consistent. Therefore, following routines is of great importance for these children. In general, routines that are tailored specifically to an individual child are easier to manage at home than at school. Nevertheless, several methods exist for teachers or coaches to help a child function more optimally in a school environment. The following suggestions are intended to render the classroom environment as predictable as possible for students that have trouble adjusting to new circumstances.

- Use a calendar, and display it at visible locations in the classroom, for instance next to the door. Stickers or pictograms can be used for children who cannot yet read fluently.
- Prepare students for today's activities. Pick a quiet moment in the morning to visit with a child at his or her desk and explain what's on today's program.
- Announce a change of activities in advance (e.g., "We'll start with arithmetic in ten minutes.") A while later, repeat the announcement (e.g., "Don't forget, five minutes left before arithmetic.>").
- Try and arrange materials systematically within the classroom and use easily visible labels.
- Make clear appointments with a student. Sometimes it helps (also for class-mates) to print the appointments and display them visibly in the classroom.
- Avoid too many changes at once. For instance, when an intern will be visiting next Monday, and next Thursday's class will be shorter than usual, don't announce these messages both at the same time. Spreading out these messages makes them easier to digest.

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**TABLE 1. Behaviors Indicative of Problems with Cognitive Flexibility in Children**

Problem Behavior	Example
Needs relatively more time to get used to unknown situations.	Attending school for the first time or change of schools, a birthday party, going to the dentist for the first time.
Has difficulty with new people.	Behaves detached or clingy in the presence of unknown visitors, a new teacher, a different baby-sitter, the doctor.
Gets upset when something in the environment changes.	New furniture at home, or a change of location of the furniture, when stuff normally stored in one specific spot (shoes, toys, books) is moved.
Has difficulty stopping ongoing behavior to change and do something different.	Gets confused when it is announced that it is time to go home or when the classroom needs to get cleaned up to start a new activity.
Gets frustrated when others disobey regulations or behave unexpectedly.	Gets angry when the neighbor does not take off his shoes when he enters the house or when a cousin only wants to paint pink flowers when it had been 'agreed' they would both make a drawing of a farm.
Has difficulty getting used to a change in daily routine.	Gets upset when picked up from school by foot instead by car or when groceries still need to be picked up after school, contrary to the daily routine.

**TABLE 2. Behavior Indicative of Problems with Cognitive Flexibility in Adolescents**

Problem Behavior	Example
Has difficulty coming up with alternative solutions for a problem.	Gets stuck when needs to come up with a way to get to school after finding out that buses are on strike.
Gets upset in new situations or a new environment.	Gets angry about a new teacher or change of room.
Resists change of plans.	Panics when a plan that was made earlier unexpectedly changes: "We first have to pick up your new glasses before we visit grandma and grandpa."
Resists change of routine.	Becomes irritated when dinner is ready later than usual.
Has difficulty accepting disappointment or a reprimand.	Stays frustrated for a long time when something does not work out, for example, a difficult homework assignment.

**Providing instructions and helping with assignments.** The way in which a child receives instructions to a large extent determines if she or he will understand the goal and the type of assignment. For a student having problems with switching, it helps to indicate in advance which steps are important for completing the assignment (without giving away too much information). The essence lies in reducing the complexity of the task and providing the student with an analysis of what she or he needs to do. The goal of the following suggestions is to provide instructions as clearly as possible to a child experiencing problems with adjusting to new circumstances.

- Try to be as specific as possible about the assignment: What is the goal, what exactly is expected from the child?
- Provide ample examples of comparable assignments.
- Provide insight into general strategies for solutions, such as approaches that have previously been applied successfully. (“Remember, how we solved ... last week? The current assignment is similar. Like last week, we will do ... again. But we’ll do it slightly differently this time, so that ...”).
- Try to make the assignment as clear as possible by breaking it down into small chunks of information. Eventually, make a checklist of the independent pieces.
- Make templates for repeating or similar assignments.

The goal of the following suggestions is to support a student when working on the assignment.

- Provide extra time for new assignments.
- Provide as much positive feedback as possible (“Go on, you are doing well, keep up the good work”) while avoiding negative feedback (“You completed four different tasks already, well done! Try and do one more” rather than, “There are six tasks that you still haven’t finished, so try a little harder”).
- Help a student remember the individual steps of the assignment and their sequence (“When you finish this, then you can proceed with ...”).
- Analyze together with the student what went well and where there’s room for improvement. Try to get him or her back on track with step-by-step instructions.

**Build on school-related skills.** Many school-related activities call for flexibility in one form or other, such as changing perspective. For example, when working on a writing assignment, one may need to find different words that share the same meaning. When getting stuck during arithmetic, one needs to discover and try out alternative solutions. Both cases require flexible adjustment. The suggestions below are aimed at helping children with difficulties adjusting to new circumstances with school-related activities.

- Practice writing from the student’s perspective (“Describe how you rode a bicycle in front of your home. What did you do? What happened?”)
- Practice writing from someone else’s perspective (“How would your neighbor describe your bike ride?”)
- Be clear about the topics that will be covered during an exam or quiz.
- Give children practice with the different kinds of tests before they are given the actual test.
  - What does a question aiming at knowledge look like? How will the topic of the question be introduced? What will you ask of the student exactly?
  - What does a question aiming at insight look like? How is the topic introduced? What will you be asking of the student?
  - What does a question aiming at practical application look like? How is the topic introduced? What will you ask of the student?

### Summary

Social and goal-directed behavior in classroom situations requires a child to think and behave in a flexible manner. New situations may call upon a change in thoughts or behavior. When the current situation changes, a child is required to adjust to the new situation. This often involves adjusting, or regulating, emotions. Young children are less able to adapt to a new situation, as this skill is not fully developed until mid-adolescence. The more flexible someone is, the less time and energy it takes to get used to a new situation. Problems with flexibility become observable when a child needs more time to adjust to a new situation relative to other children, or when changes cause feelings of discomfort within a child. Predictability and routine are essential for children experiencing problems with flexible adjustment. The results of empirical research on the development of children’s flexibility will foster practitioners’ tools to provide tailor-made interventions for children with difficulties adjusting to new situations.

### References

- Arnsten, A., Mazure, C. M., & Sinha, R. (2012). This is your brain in meltdown. *Scientific American*, 306(4), 48–53.
- Brooks, P. J., Hanauer, J. B., Padowska, B., & Rosman, H. (2003). The role of selective attention in preschoolers’ rule use in a novel dimensional card sort. *Cognitive Development*, 18(2), 195–215.
- Chelune, G. J., & Baer, R. A. (1986). Developmental norms for the Wisconsin Card Sorting Test. *Journal of Clinical and Experimental Neuropsychology*, 8(3), 219–228.
- Cragg, L., & Chevalier, N. (2012). The processes underlying flexibility in childhood. *Quarterly Journal of Experimental Psychology*, 65(2).
- Crone, E. A., Bunge, S. A., van der Molen, M. W., & Ridderinkhof, K. R. (2006). Switching between tasks and responses: a developmental study. *Developmental Science*, 9(3), 278–287.
- Crone, E. A., & Ridderinkhof, K. R. (2011). The developing brain: From theory to neuroimaging and back. *Developmental Cognitive Neuroscience*, 1(2), 101–109.

- Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, 44(11), 2037–2078.
- Diamond, A. (2006). The early development of executive functions. In E. Bialystok, & F. I. M. Craik (Eds.), *Lifespan cognition: Mechanisms of change* (pp. 70–95). New York, NY: Oxford University Press.
- Grant, D. A., & Berg, E. A. (1948). A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card sorting problem. *Journal of Experimental Psychology*, 34, 404–411.
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348–362.
- Heaton, R. K., Chelune, G. J., Talley, J. L., Kay, G. G., & Curtis, G. (1993). *Wisconsin Card Sorting Test Manual, revised and expanded*. Odessa, FL: Psychological Assessment Resources.
- Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44(11), 2017–2036.
- Huizinga, M., & van der Molen, M. W. (2011). Task switching and shifting between stopping and going: Developmental change in between-trial control adjustments. *Journal of Experimental Child Psychology*, 108(3), 484–503.
- Luciana, M., & Nelson, C. A. (1998). The functional emergence of prefrontally-guided working memory systems in four- to eight-year-old children. *Neuropsychologia*, 36(3), 273–293.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100.
- Monsell, S. (2003). Task switching. *Trends in Cognitive Sciences*, 7(3), 134–140.
- Perner, J., & Lang, B. (2002). What causes 3-year-olds’ difficulty on the dimensional change card sorting task? *Infant and Child Development*, 11(2), 93–105.
- Smidts, D. P., & Huizinga, M. (2011). *Gedrag in uitvoering*. Amsterdam: Nieuwezijds.
- Zelazo, P. D. (2006). The Dimensional Change Card Sort (DCCS): A method of assessing executive function in children. *Nature Protocols*, 1(1), 297–301.

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