How to come, see and go for it

Last December, Ardi Roelofs, staff member at the Max Planck Institute for Psycholinguistics, research fellow at the FC Donders Centre for Cognitive Neuroimaging and senior researcher at the Nijmegen Institute for Cognition and Information (NICI) was awarded a VICI-grant from NWO, the Netherlands Organisation for Scientific Research. A VICI-grant is awarded only to scientists with both experience and innovative ideas. The money involved, about 1 million euro, pays for five people to work on the project. In the next couple of years they will try to find out everything there is to know about the rules we use to resist temptation.

The VICI-project isn't so much about temptation as about goal-directedness, Ardi Roelofs admits. 'What I want to know is, given a goal and the motivation to reach it, what mechanism allows for goal-directed responding, even when you have to resist some kind of temptation or distraction?'

Rules and associations

'The accepted view for over more than 2000 years – this is in fact how Aristotle thought about it – is that we have all kinds of associations between stimuli and responses in our mind. At the heart of resisting temptation is the idea that you have a very strong association or inclination to do something but still you are able to refrain from doing that. How do you do that? There must be something more than associations at work, apparently. Around 1900, an increasing number of philosophers and psychologists wondered about this problem. One of the solutions to it was proposed by a group of psychologists at Würzburg. They demonstrated the importance of the task, in determining a response. Associations would still be vital, but depending on the task, you can push the strongest associations to the back of your mind and let your behaviour be governed by weaker, but more appropriate associations.'

This sounds quite plausible – and indeed this still is the dominant theory in the literature, says Roelofs. But this may not be for long, he hopes. 'In the VICI-project, I will try to prove another theory. Although the association theory works extremely well for simple behaviour, it breaks down at complex behaviour like playing chess or proving logic theorems. For this kind of complex behaviour, where a lot of thinking is involved, people are supposed to select their responses using a lot of 'if... then...'-rules. The idea of working with such a rule system has been extremely important in artificial intelligence, the branch of computer science that is involved with designing 'thinking' computers, like chess computers, and robots. And in that field, this theory is undisputed, for instance if you want a computer to play chess, you will use a rule system and not an associative system. 'Now - a few years ago I started to work on a rule system for simple behaviour, for word production. Like saying "apple" to a picture of an apple. Or saying "fruit" to the picture of an apple, depending on the task, exactly the type of area where associative theories worked very well. And it appeared that the model that I developed worked just as well. So there might be no need to assume that you have two different systems for simple and complex goal-directed behaviour. It might just be the case that in simple behaviour, goal-directedness is also governed by a rule system.'

Four projects

To find proof for this theory, the VICI-project is divided in four subprojects. In one of these subprojects, Ardi Roelofs will make use of a very well-known psychological task: the Stroop task. In this task, test subjects get to see words like 'red' or 'green' in a certain congruent or incongruent colour; for instance: the word 'green' printed in red colour or in

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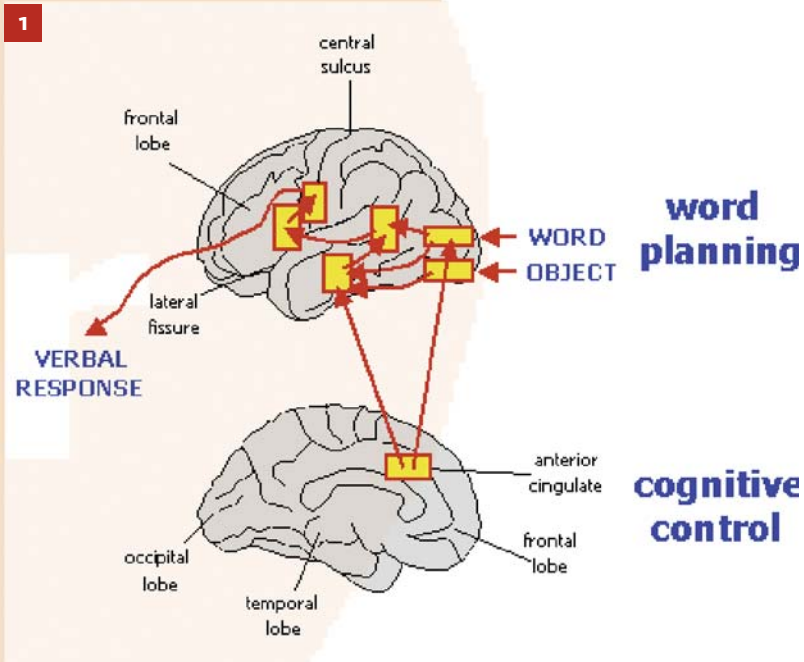
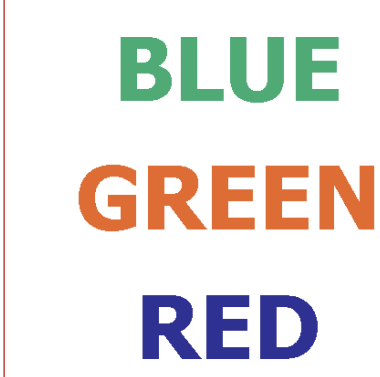


1 Word planning and executive control in the picture-word task. Lateral view (top panel) and medial view (bottom panel) of the left hemisphere of the human brain. The word planning system achieves picture naming. The executive system centered on the anterior cingulate achieves that the picture is named rather than the word read.



green. 'You ask people to name the colour in which the word is printed, and when colour and word don't match, their reactions are slower. Apparently you cannot resist the temptation of reading the incongruent word, even though the task is just to name the colour. You read the word and it gets into your system. This task was developed by Stroop in 1935 and it is one of the standard tests for selective attention.

'In this part of the VICI-project, we will look at the eye movements of test subjects. These are interesting because, on the one hand, you gaze at something you are tempted by, but you can also use your eyes to avoid the distraction, by looking away. So the eyes are an instrument of selective attention. We are going to measure how long people look at these Stroop-stimuli, which of course we will vary and manipulate in all kinds of ways.

'Another project is on bilingualism. If you speak in a foreign language, how do you resist the temptation of your mother tongue? When I set myself the task to speak in English, how am I able to ignore the strong impulse to speak in Dutch?

'The third project concerns the brain: what areas in the brain help us to do one thing and refrain from another? There is one area in the brain, the Anterior Cingulate Cortex or ACC, that is particularly active in this regard and it is also active in performing tasks like the Stroop task. There is a lot of discussion on what this area is actually doing. A prominent view is that the ACC signals the need for control, that it would function as a sort of alarm bell. Another view, and this is also what I believe, is that the area implements the control itself. I think that the ACC is not just the alarm bell, it's the fire brigade as well. When you look at people with severe impairments in this area you'll find that they are extremely passive. There is a lack of any voluntary behaviour. And that fits very well with the idea that the ACC is an executive area, that is does more than signal the need for control. I think that with certain varieties of the Stroop task, we might be able to find more support for this theory.

'And then there is the fourth and final project, which will involve computational modeling. The model we use is a model for word production, developed here at the Max Planck Institute over the past fifteen years. Originally this model only described how we produce words, how we describe pictures. The Stroop task involves word production: you have to name the ink colour. We are extending this very detailed psycholinguistic theory of word production to include selective attention, such as that occurring in the Stroop task. It looks like this model helps us enormously to account for many details of Stroop phenomena that other people have described. The message here is that having a theory of the details of the action itself will help you ultimately in understanding how the action is controlled.'

Theoretical breakthrough

Will it be a breakthrough if the VICI-group is able to prove that people use a rule system to select their responses, even with simple tasks and in simple behaviour? Ardi thinks it will. 'If we can account for simple and complex behaviour with one theory instead of the two-headed, hybrid theory people are using now, we will be making theoretical progress in understanding how the mind works. It's all very theoretical and academic, I know, but still it does make sense to do this, in particular because the Stroop task is very often used in applied psychology. If our insight in this task and the performance on this task grows, that could be useful in practical settings. Maybe there are better tests to be developed for selective attention, maybe we can get a better understanding of what is actually happening with people who have attention disorders.' •