



How the tuberous sclerosis brain pays attention : A fact sheet on the spectrum of attentional problems in TSC

What is attention?

In 1890, William James, a well known psychologist, made the interesting statement that 'everybody knows what attention is'. In a way we all do understand what attention is because we use 'attention' words all the time: we 'pay attention' to what someone says; our attention is 'grabbed' by something interesting on the television or by a loud noise; we 'concentrate' on work or 'switch' our attention to something else. This is referred to as the 'folk psychology' of attention.

The problem is that when brain researchers talk about attention, they refer to very specific functions of the brain. The difference between the folk psychology of attention and neuropsychological meanings of attention can lead to problems when researchers and parents talk to each other.

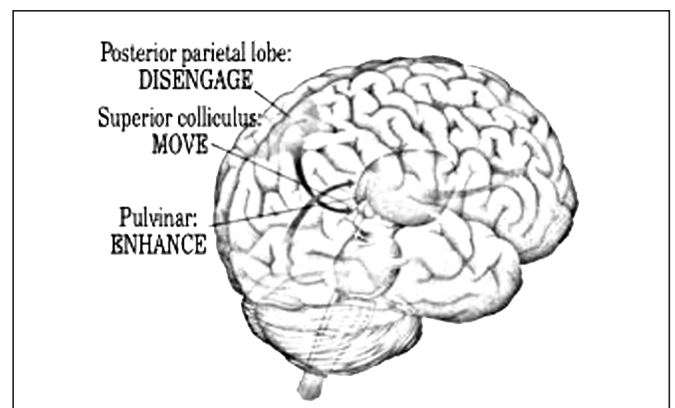
This fact sheet will explain the meaning of some of the terms used in attention research and will tell you what sort of tests one can do to look for problems with attention. It will start by explaining the different types of attention and where in the brain it happens. It will then look at the sort of attention problems that we see in children and adults who have Tuberous Sclerosis and how that can lead to difficulty in learning and behaviour.

Is there only one sort of attention?

For a long time, researchers thought that attention was just one thing, but we now know that there are different components of attention. These functions are organised in the brain into 'attention networks' and at least three such networks have so far been identified.

1. The Orienting network

This is the function of the brain that 'grabs' our attention when we notice something out of the corner of our eye. Imagine that you notice a sudden movement. It may be a curtain blowing, or an animal moving or a person coming into the room. Automatically, our brains force us to *disengage* from what we're doing, to *move* our attention to the new stimulus and to *enhance* the focus on whatever it was that attracted our attention. Brain imaging studies have shown that it is a part of the parietal brain lobe that disengages our attention, a part right in the middle of the brain called the superior colliculus that moves the attention and a small bit of the thalamus that enhances our focus to find out whether it was the cat, the curtain or a surprise visitor.



2. The Executive attention network

As soon as we have shifted our attention to something new, the executive attention network is needed to focus our minds on a particular thing and prevent us from getting distracted by other things. A small part on the inner surface of the

frontal lobes called the anterior cingulate, helps us to do that. The anterior cingulate ensures that we can detect the things we're looking for and helps to select the right way to respond. It also helps to 'hold in mind' what we are doing. For instance, to find your favourite breakfast cereal on the shelves in the supermarket, the anterior cingulate will focus your attention, help you to keep in mind what you are looking for and prevent your mind from getting distracted by all the other tantalizing things on the shelves!

3. The Vigilance (Sustained attention) network

Sometimes we have to concentrate and stay alert for a long time, a bit like someone keeping watch. We don't have to do anything in particular and it might get a bit boring to be alert without doing anything interesting. But, we have to be ready to respond when someone arrives, or when there is a noise. The vigilance network in the brain is responsible to sustain our attention over a long period of time. Research has shown that it is the right parietal and right frontal areas of the brain that does that.

Do the networks ever have to work together?

Even though the attention networks are separate from one another and each can be damaged without causing trouble to the other networks, they often have to work together. A good example is when we have to do two things at the same time. Let's say you are trying to watch television while someone else is talking to you. We all know that it can be very difficult. But, it is less difficult to drive while someone is talking to us. The reason is that after a lot of practice, we can do some things automatically and therefore don't have to concentrate on it all the time. In everyday life the networks of the brain often have to work together to make sure we can look and listen and think and talk all at the same time.

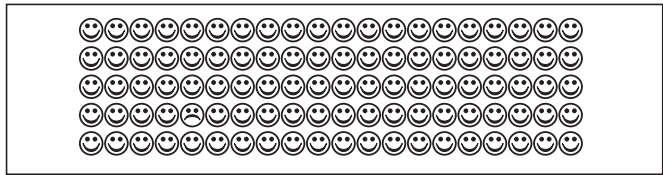
What are the components or building blocks of the attention networks?

There are many different building blocks of attention. Let us look at some of them:

1. Selective Attention

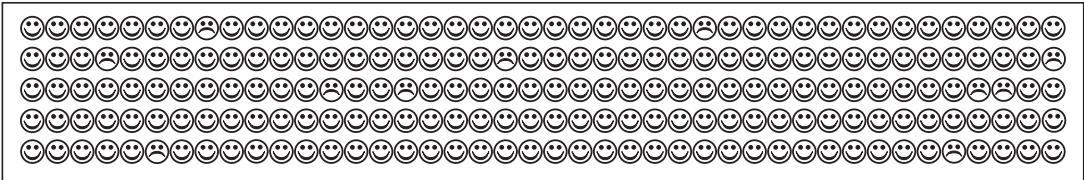
Task: See how quickly you can find the sad face among the smiley faces in the box below.

Selective or focused attention is the ability to filter information in order to detect relevant information and reject irrelevant or distracting information. A good everyday example is in visual search tasks such as finding your favourite brand of breakfast cereal on the shelves in the supermarket or finding the sad face in the game above. Our ability to have selective attention develops rapidly during the first few years of life and reaches adult levels around the age of 7.



2. Sustained Attention

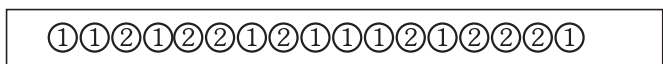
Task: Look through all the faces in the box below and say 'yes' every time you see a sad face.



Sustained attention is the capacity to maintain active attention to a task, a goal or one's own behaviour in spite of the fact that it is not a very interesting task. Putting hundreds of letters in envelopes and putting stamps on all of them, or checking through the rows of faces above, are examples of such tasks. Most of the time we can do such jobs without having to think about it. Occasionally we have a 'slip of attention' and we forget to put on a stamp or to put the letter in the envelope. Having sustained attention problems is what most of us mean when we find it difficult to 'concentrate' for a long time. Even though most children are able to concentrate for a long time by the age of 12, sustained attention continues to improve into adulthood.

3 Attentional Control/switching

Task: Go through the list of numbers in the box below. When you see a ① say 'one' and when you see a ② say 'two'.



Task: Go through the list of numbers again. This time, when you see a ① say ‘two’ and when you see a ② say ‘one’.

The term attentional control or attentional switching refers to tasks where we have to switch our response or reverse our response. The tasks above are good examples. The first task is not too difficult and most people can do it quite quickly and accurately. But when you saw the ① and had to say ‘two’ and vice versa, the task became quite difficult! These sort of tasks get difficult because we have to inhibit the automatic response and switch or reverse our responses. This ability to switch/control is a measure of our ‘mental flexibility’. The ability to switch/control can be seen in young children, but we gradually get better and better at doing this until we’re into our 20’s.

4 Response inhibition

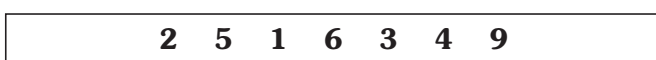
Task: Look at the row of faces in the box below. Every time you see a smiley face say ‘yes’. When you see a sad face, don’t say anything.



Response inhibition refers to preventing yourself from reacting or responding to internal or external influences that may interfere with the task we’re performing. In the task above, you had to stop yourself from saying ‘yes’ when you saw a sad face. Imagine you are in the public library and suddenly think of something funny. You can’t burst out laughing, because people will get annoyed. Sometimes we may get angry at someone and feel like shouting at them, but we stop ourselves from doing so because we know that it will be the wrong thing to do. These are examples of response inhibition in an everyday situation. The influences we have could be thoughts, wishes, memories, sensations or motor impulses. The important thing is that we have to inhibit responding. Our ability to inhibit responses develops gradually throughout childhood and into adulthood.

5. Working Memory

Task: Look at the numbers below for 5 seconds. Then close your eyes and see if you can remember the list.



Working memory is also known as short-term memory in neuropsychological terms. It is the ability to hold a small bit of information ‘in mind’.

Examples are remembering a telephone number while you look for your addressbook to write it down or ‘seeing in your minds eye’ a road map that you have just looked at. We all need to have a good working memory in order to perform everyday tasks. Research has shown that even though the basic components of working memory are present around the age of 8, more complex and difficult tasks that involve working memory go on developing until we are adults.

What happens to the components of attention in TSC?

Not a lot of research has been performed on the components of attention in TSC, but a study at the University of Cambridge recently asked this question. We identified all the children with TSC who lived in a chosen part of England with normal or near-normal intelligence. All the children were then tested with tasks from the Test of Everyday Attention for Children (TEA-Ch). The results showed that 90% of all the children, across all levels of ability, had problems with some aspects of attention. Many children had difficulties with sustained attention, response inhibition and attentional switching. Many children with TSC were quite good at doing the visual search selective attention tasks. The research study suggested that, because TSC affects individuals from early in embryological development, most of the attentional domains in the brain are at high risk of being affected, even in the brightest children with TSC and in those who have never had epilepsy.

There have not been any studies of attentional skills in adults with TSC, but early evidence from research in Cambridge suggest that many adults with the disorder may have similar difficulties in attention.

How can these neuropsychological attention difficulties affect our lives?

Many TSC children with attention problems will present with the sort of behaviours that we associate with ADHD/Hyperkinetic disorder. They may be overactive, restless, fidgety or impulsive. They may also be aggressive or difficult to manage in groups or at school. Children who have these sort of behaviours should be assessed for a diagnosis of ADHD/hyperkinetic disorder and be helped to prevent further problems with peer relationships, school difficulties and at home.

A separate fact sheet is available specifically about ADHD/Hyperkinetic disorder (Fact Sheet 33). However, in addition, the Cambridge study showed that some children with TSC who don't have ADHD-like behavioural problems, may also have deficits in the attentional networks of their brains. Because attention is so important for everything we do in our lives, poor attention can lead to many other problems such as memory problems, language difficulties or struggling with school and other work. These problems can make anyone feel unhappy or uncertain about themselves and in turn, make our friends and family feel worried.

How can we find out if we have attentional difficulties?

Neuropsychologists and child neuropsychiatrists can perform tests to see whether you have trouble with the components of attention. They can give you game-like tests of your attention and concentration which will allow them to see how well you do in comparison to others of your age and ability.

What can we do if neuropsychological deficits are found?

It can be very useful to identify which components of attention are relative strengths and which are relative weaknesses. That way we can use our strengths to cope with difficulties. If children have good visual attention skills, instructions and teaching can be geared at a more visual approach. If a child finds it difficult to do two things at the same time, it can help to make teachers aware of that and, for instance, try to do only one thing at a time. Clinicians and researchers are just beginning to think of interventions or treatment

programs specifically aimed at improving our attentional skills. These sort of approaches may become very valuable for children and adults with Tuberous Sclerosis. When attentional problems exist with the behavioural problems of ADHD/hyperkinetic disorder, medication such as Ritalin, is often considered. One needs to be careful with such medications in TSC, because of its interactions with other drugs and epilepsy. But, it is possible that stimulant drugs can improve attentional skills and ADHD/hyperkinetic-related behaviours very much.

We are still in the early stages of understanding how all the attention domains in the brain work and what we can do to improve these skills. Hopefully research in the coming years will help us to improve our understanding of these difficulties.

Where can I read more about attention and the brain?

Many books and articles have been written about attention. Two books that are particularly interesting, even if we don't know very much about the brain are:

Cognitive Neuroscience The Biology of the Mind edited by Gazzaniga, Ivry and Mangun (1998), and

Images of Mind written by Posner and Raichle (1998)

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