Greebles recognition experiments comparing people with and without prosopagnosia and is face processing actually special?

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Introduction

The Greebles are a set of computer-generated novel objects rendered by the program Alias Sketch on an Apple Macintosh. They can be grouped into two "genders" depending on their parts orientation on the vertical axis and five different families, which are defined by their central parts.

Greebles, even though used in research for less than fifteen years, already find application in many interesting areas of modern science - Greebles expertise compared to other expertise, aspects of working memory and neuroimaging but the ones I consider rather interesting is using Greebles on people with prosopagnosia and to determine whether face processing is a rather "special" ability . I think those areas are quite related because if face processing is actually situated in a different area of the brain then the logical conclusion from this is that actually people who have prosopagnosia will not have any problems with object recognition which is not always true.

Prosopagnosia (also known as face blindness) is cognitive impairment in which the ability to recognize faces is severely damaged, but the that of object recognition is relatively intact. It is caused by damaging the right temporal lobe. Apart from the most severe cases the impaired have no problems in telling whether the thing in front of them is an object of a face. Also the level of prosopagnosia completely varies – some patients are said not to be able to distinguish between one face, from two points of view, while others have no difficulty in determining it. This raises the question whether actually the visual processing system is one modular system with several specialised units or rather several, completely independent systems.

The authors are trying to find whether actually visually impaired people will have any problems with Greeble recognition after an expert training and if actually as mentioned above the visual system is one big specialised unit or not.

Methods

In the Duchaine et al. (2004) experiment a specific individual called Edward is presented – he is 53 years old, married, has a PhD in Physics and has face prosopagnosia from years. He recalls that even as a child he had serious difficulties in recognizing faces of familiar people. It was crucial that the tested person had normal object recognition as it would really affect the results with Greebles. The other six experiment participants were age-matched without any visual impairments.

At first the group of people was presented to a set of famous faces. Edward recognized three out of 25, while the control subjects averaged about 21.6. Which makes the person with prosopagnosia's performance on the test about seven times worse than the one of people without it. Also his responses took about six times longer. On the second test, which is also called the Cambridge memory test, the subject were presented six target faces and then tested with novel views of the target faces and also two non-target ones. At the beginning of this experiment they were shown a set of 18 items in which they knew which target faces are going to be presented to them and after that for the remaining 54 they control subjects could be shown any of the target faces. On the first 18 items Edward was correct on 13, while all the others nine age-matched subjects were correct about all of them. On the second set the subject with prosopagnosia managed to be correct on 26, while the others averaged 43.9 with results in the interval 36 to 53.

The group for the second set of tests consisted of 6 people, all of them had either Master's of PhD, two of them were men, 4 women, the mean age was 48. The Greeble training in the Duchaine expert learning scheme is actually quite similar to the one in the Gauthier and Tarr (1997). At the first session the control subjects were presented five Greebles and with every next session the number of Greebles increased by five. At the the end of the fourth session the subjects have already been introduced to all the Greebles which means that in the four last sessions there were no new objects introduced. There were three tests – naming, individual verification and family verification. Compared to the other test subjects, Edward performed really well, especially in the family verification test, where after the 4^{th} session he maintained an excellent score of being 100% correct on every test (as seen in figure 1). Initially, his response times were actually a little bit slower in the beginning, but after the third or the fourth session he gets precisely in the median range (as seen in figure 2).

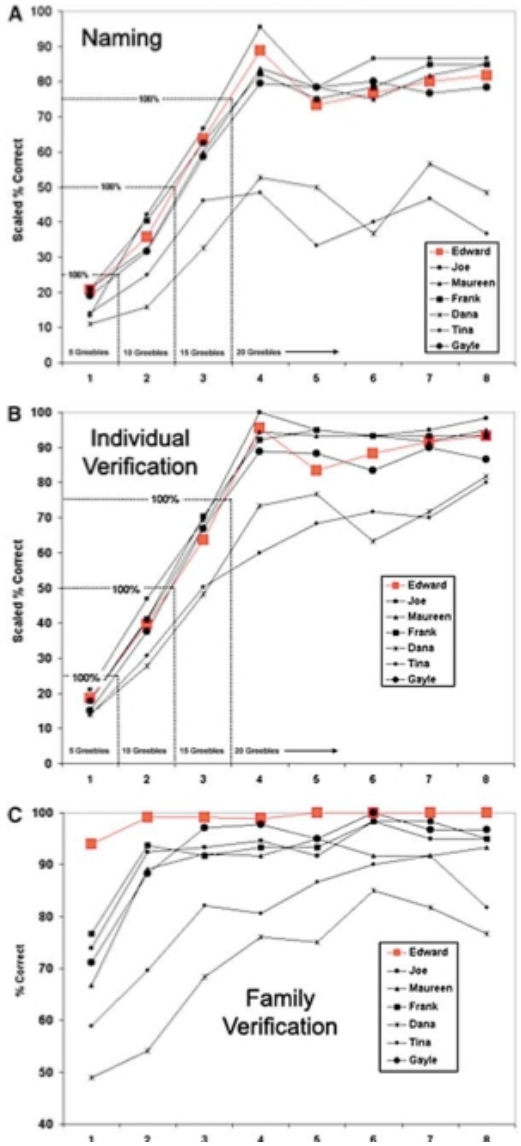

fig 1. Edward's results compared to the other control subjects.

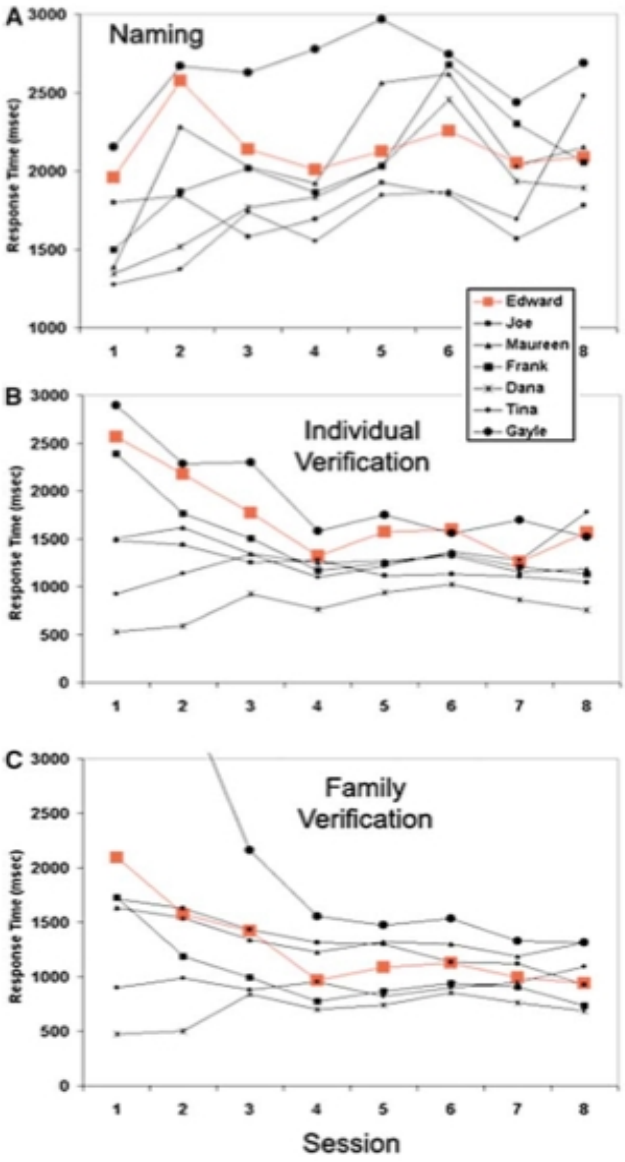

Fig. 2 Edward's response time compared to other people.

Both images are taken from the "Normal Greeble Learning in a Severe Case of Developmental Prosopagnosia" (Case Study) by Duchaine et al. (2004). I included them as I think they illustrate really well the behaviour of the subject with prosopagnosia in Greebles expert learning.

It turns out that after all the collected data we have two interpretations of the experiment. The first is that the Greeble expert training mechanisms are actually different from the object recognition and non-expert one. However, the second possibility that the authors (Duchaine et al. 2004) favour, is that if the Greeble training does not produce any expertise then both Edward and the control subjects use the same mechanisms for object recognition to identify the Greebles.

Even though it has been claimed that Greeble expertise training leads to perceptual and neural results similar to those in face recognition. It is actually shown while observing the fusiform gyrus

(McKone and Kawisher, 2004) that Greeble identification leads to left-lateralized markers rather than the right-lateralized markers, we can observe in the process of discriminating between different faces.

In the second experiment McCarthy et al. (1997) used functional magnetic resonance imaging to determine what exactly is difference in neuron activation caused by showing objects and faces. McCarthy et al. group of participants included no people with any kind of agnosia, because if there were people with any kind of visual impairment the results would not be correct.

The experiment was the following – a scrambled object montage with some faces between, which was supposed to evoke the general object and face recognition area an and faces between an object montage that was not supposed to activate the face recognition area. The purpose of this was to see if when when the face is shown there will actually be a isolated active area in the brain (face processing one), which will not fire whilst being shown the objects.

The results of the experiment confirmed the hypothesis – when shown the face among the scrambled object montage bilateral region of the fusiform gyrus were activated, but when presented among the object montage a focal area in the right fusiform region. Which gave us the suggestion that there actually is specialised area that is responsible for face recognition.

Those results have been proved to some extent by the patient C.K. , who had severe object agnosia, but had unimpaired face recognition. This is to show that even though that the hypothesis that there is actually a separate mechanism for identifying faces and objects. However, those results were controverted by another patient L.H. (Farah et al., 1995) who suffered from a selective prosopagnosia. L.H. could not distinguish between upright faces, but was quite successful with recognizing inverted faces.

The results of the aforementioned studies allow us to think about several interpretations. There are certain evidences that face recognition is highly specialised are in the cortex that is responsible for it, but it is not certain yet whether it is a part of one domain for object perception. And this uncertainty can be proven by the attempts to discriminate between different complex artificial stimuli like the Greebles (Gauthier and Tarr, 1997).

Recognizing and interpreting the visual information given us by the faces in incredibly important for primates, such as. Therefore it is very logical to propose that there is a highly-specialized system

that is responsible just for the face recognition. However, it is as nearly as possible that there is only one module, which is part of a bigger object recognition system, which extracts the face-specific information and then passes for processing after already been marked as face. For now it is nearly impossible to determine the existence of such specialised system by just looking at the brain activity when presented faces. Rather than this we should stimulate the brain with all kind of classes of objects and see exactly what is happening – does every class of object activate just one small area, system by itself, or it ignites a tiny module which then passes the information to the bigger object recognition system.

Conclusion

The brain undoubtedly is the most complex organ in our body. Even though we have reached a certainly good level of scientific progress we still cannot say what exactly is happening in it or what kind of mechanisms govern the whole it.

Using Greebles on the person with severe prosopagnosia gave us really interesting results. If we look closely at the charts with Edward's performance compared to other people we can say that he is performing very well and even in some areas he excels the other people without prosopagnosia – for instance the family verification – where he got about 100% after three or four attempts. Also after the middle stage of the training it took him about the average time to identify the Greebles. This data shows us that probably being completely unable to recognize faces does not mean that you will be completely unable to recognize objects. Therefore there should be at least modularity in the visual processing system, rather than having one area of the brain responsible for recognition in general.

On the other side, the question whether face and object recognition are situated in different areas of the brain remains open. We have some results that show us some data about what actually happens when a face is presented to a person, but it is not clear enough whether there is actually something more. The data from McCarthy et al. (1997) shows that there are several areas which are activated when face recognition is evoked in the two different situations. However the present data is not enough – we just present the control subjects faces and other stimuli rather than presenting different classes of stimuli and observing what is going to happen – will there be one general part of the brain activated or for every class there will be a specialised module?

From the two previous articles we can say that even at first glimpse are really different the two

research areas are actually connected. By studying complex stimuli like the Greebles and trying to expert train people with some forms of prosopagnosia we can determine whether their brain is activated when they are shown faces, or it is fully inactive. By studying brain-damaged people we can actually explore the brain in a more complete way because they have areas which are not functioning at all while others are , but the cognition process is not entirely activated which means that it actually becomes something we do not completely realise, but do.

Therefore from all this facts we can deduct that that:

1. Prosopagnosia itself does not affect person's ability to recognize objects.
2. Even though that there are evidences that there is an area in the fusiform region which activates when presented faces, the data is still not enough. And because of this we don't really know whether face recognition should be considered really special or not.

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