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The P3 component and the empathizing-systemizing theory: a putative relationship between an ERP component and cognitive style

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Abstract

Males and females are found to perform differently in a number of areas, and studies of gender differences in behaviour and cognition are popular areas of research. The empathizing-systemizing theory (E-S theory) claims that males and females differ in their cognitive styles. Females are often found to be more empathizing, while males are often found to be more systemizing. Based on previous research in the areas of cognition and neuroimaging there seems to be common brain areas responsible for empathizing, systemizing and the generating of the P3 component. The main focus of this study is to investigate whether there are correlations between the latency and the amplitude of the P3 component, and the degree of empathizing and systemizing. To investigate gender differences, the empathy quotient (EQ) and the systemizing quotient-revised (SQ-R) were used. The P3 was found using the visual continuous performance test (vCPT) in a qEEG paradigm. A correlation analysis revealed gender differences. For males it was found a relationship between higher EQ score and longer P3 latency. For females a relationship was found between higher SQ-R score and longer P3 latency. Further analysis revealed that the P3 latency could explain nearly 50 % of the variance in the questionnaire-scores. The results indicate that gender differences in preference for cognitive styles may be physiological based, in that males use their cognitive resources more efficient when systemizing, and females more efficient when empathizing. This study lends further support to the notion that males and females seems to at least in part use different strategies when empathizing and systemizing, in that it is more cognitively demanding for a male to be empathizing, and for a female to be systemizing.

Content

Introduction

Males and females are found to perform differently in a number of areas, and studies of gender differences in behaviour and cognition are popular areas of research. It has been found that one gender performs better than the other in many cognitive tasks, and a preference for different cognitive strategies have also been established between males and females (e.g., Jordan, Wüstenberg, Heinze, Peters, & Jänke, 2002; Kucian, Loenneker, Dietrich, Martin, & von Aster, 2005). Gender-based differences in social cognition, particularly empathic behaviour and competence have been widely reported (e.g., Baron-Cohen, 2003; Flaherty & Richman, 1989; Hall, 1978) where females often are found to be superior to males. Neurofunctional gender differences are also found in some brain areas responsible for emotion and cognition (e.g., Azim, Mobbs, Jo, Menon, & Reiss., 2005; George, Ketter, Parekh, Herscovitch, & Post, 1996; Hofer et al., 2006; Piefke, Weiss, Markowitsch, & Fink, 2005). This supports the notion that males and females may use, at least in part, different strategies for cognitive and emotional processing, which in turn may contribute to gender differences observed in empathy (Schulte-Rüther, Markowitsch, Shah, Fink, & Piefke, 2008). Conversely, it has been found differences in areas where males are found to perform better, such as spatial performance (e.g., Astur, Ortiz, & Sutherland, 1998; Contreras, Colom, Shih, Alava, Santacreu, 2001; Geary, 1995; Moffat, Hampson, & Hatzipantelis, 1998), mental rotation of objects (Crucian & Berenbaum, 1998; Roberts & Bell, 2000) and mathematical reasoning (e.g., Benbow & Stanley, 1983).

Kucian, Loenneker, Dietrich, Martin & von Aster (2005) used fMRI to examine whether different brain activation and performance pattern could be observed between genders during simple number tasks, mental rotation, and exact calculation and approximation, which are tasks that demand the use of more complex solving strategies. They found that males tend to use visuospatial strategies, whereas females preferred strategies involving verbal and spatial working memory. Corresponding psychological theory differentiates between functional and predicative thinking (Mölle, Schwank, Marshall, Klöhn, & Born, 2000). Functional thinking emphasises the preference for thinking in terms of causes / effects and modes of action, whereas predicative thinking does not care so much on dynamics, as on static structure and the embedded complex relationship. While females prefer predicative thinking, males tend to use more functional thinking algorithms (Nöel, Fias, & Brysbaert, 1997). Kucian et al., (2005) concluded that the observed gender differences in tasks that demand the use of more complex problem-solving strategies indicate that women

use partly different cognitive networks compared to men. These strategies involve spatial and verbal working memory and speech mechanisms while solving mental rotation and number related problems. In contrast, tasks that do not demand the use of special problem-solving strategies, such as basic comparison of numerical magnitude evoke no gender differences in brain activation pattern.

Neubauer, Grabner, Fink & Neuper (2005) investigated intelligence and neural efficiency using event-related desynchronization (ERD) in the EEG during the performance of a verbal and a visuospatial task. They found that verbal intelligence in females correlated with brain activation during performance of a verbal task. Visuospatial ability in males was found to be correlated with brain activation during the performance of a visuospatial task. Neubauer et al., (2005) believe that these findings can be seen as support for a physiological correlate of sex differences in different areas of cognitive abilities. They believe that this can be a reflection of sex differences in brain structure which could facilitate spatial processing in males and verbal processing in females.

It is increasingly popular to investigate gender differences like these, and it has been noticed for some time that males often enter into engineering and physical sciences, while females more often study humanitarian sciences. Gender differences and education has recently been investigated by Billington, Baron-Cohen, & Wheelwright (2007), Wheelwright, et al., (2006), and Zeyer (2010) using the concept of different cognitive styles. They all found that science students scored higher on systemizing, and humanities students scored higher on empathizing. This concept of cognitive style has been developed by Baron-Cohen and his colleagues (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Baron-Cohen & Wheelwright, 2004). This cognition concept proposes the interplay of two psychological dimensions: empathizing (E) and systemizing (S). The theory is therefore called the empathizing – systemizing theory (E-S theory) and proposes that gender differences can be described by the relationship between the degree of empathizing (E) and systemizing (S) abilities. Every person is considered to inhabit both empathizing and systemizing skills, but on different levels. Some are predominantly systemizers (S > E), whilst others have a dominant empathizing cognitive style (E > S). There are also persons who have a balanced cognitive style (E = S). Women are on average found to have a stronger tendency to empathize, and men a stronger tendency to systemize (Baron-Cohen, Joliffe, Mortimore, & Robertson, 1997; Baron-Cohen, 2002; Baron-Cohen, Knickmeyer, & Belmonte, 2005). But there will always be individual differences, and persons who are atypical for their gender (Billington et al., 2007).

Much of the research in these areas are based upon self-report measures, however such an approach tells us little about the underlying neural substrates responsible for the reported gender differences. Novel methods used to investigate these underlying neural mechanisms are the neuroimaging techniques fMRI and EEG in combination with self-report measures.

The empathizing – systemizing theory

Empathizing is by Baron-Cohen (2002) defined as both the drive and the ability to identify another person's mental state and to respond with appropriate emotions. According to Chakrabarti & Baron-Cohen (2006) empathizing is not just about calculation of what someone else thinks and feels (or what is sometimes called mindreading). It is also about establishing an appropriate emotional reaction inside you, an emotion that is triggered by the other person's emotion. Empathizing is done in order to better understand other persons, to predict their behaviour, and to connect or resonate with them emotionally. Thus empathizing is a powerful way of understanding and predicting the social world (Baron-Cohen et al.,2003).

Empathizing has both a cognitive and affective component (Baron-Cohen & Wheelwright, 2004). Cognitive empathy is involved in the explicit understanding of another's feeling and subjective experience to understand their perspective. This means that you are able to some extent to set aside your own current perspective, attributing a mental state to the other person, and then inferring the likely content of their mental state. The cognitive element thus allows you to predict the other person's mental state or behaviour (Chakrabarti & Baron-Cohen, 2006). The affective component of empathizing involves an emotional response that arises as a result of the comprehension of another individual's emotional state (Eisenberg, 2002, as cited in Billington et al., 2007). This may be the most basic component of empathy. A similar component has in other accounts been called 'emotional contagion', defined as the tendency to automatically mimic and synchronize facial expressions, vocalizations, postures and movements with those of another person, and consequently, to converge on an emotional level (Hatfield, Cacioppo, & Rapson, 1992, as cited in Chakrabarti & Baron-Cohen, 2006).

Systemizing is by Baron- Cohen and colleagues (2003) defined as the drive to analyse or construct systems. A system is defined as something that takes input, which can then be operated on in different ways, to deliver different outputs in a rule-governed way. Another way we can try to systemize is when we are confronted by various outputs, and try to infer backwards from the output as to what the operation was that produced this particular output (Baron-Cohen et al., 2003). Systemizing is thus held to be a powerful way of understanding and predicting the law-governed inanimate universe, and allows you to predict the behaviour

of a system, and therefore to control it. Systems are found in a broad range of domains: technical (e.g., tools); natural (e.g., ecosystems); abstract (e.g., mathematics); social (e.g., the managerial structure of a company), and spatial (e.g., mental rotation). To possess a systemizing cognitive style, one needs the ability to identify local details and their interaction and to abstract from Gestalt perceptional distractors, also known as "field independent" cognitive style (Witkin, Lewis, Hetzman, Machover, & Bretnall Meisser, 1962, as cited in Zeyer, 2010).

To measure the degree to which a person empathizes and systemizes, the Empathy Quotient (EQ) and Systemizing Quotient- Revised (SQ-R) were developed (Baron-Cohen et al., 2003; Wheelwright et al., 2006). The two questionnaires exist in different versions, but each of these calculates an empathizing quotient and a systemizing quotient, providing a measure of the individual's capacity to utilize the two cognitive styles.

Research in support for the E-S theory

In support for the claim of the E-S theory, females have been found to be superior in social tasks, such as some aspects of language (Hyde & Linn, 1988); tests of social judgement (Hall, 1978); picking up subtle social nuances (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999a; Hall, 1978), and measures of cooperation (Ounsted & Taylor, 1972, as cited in Wakabayashi et al., 2007).

Males have been found to score higher on performance tasks which tap systemizing ability such as predicting physical systems (Lawson, Baron-Cohen, & Wheelwright, 2004); constructing 3-D models and predicting what 2-D plans of 3-D shapes would look like (Kimura, 1999, as cited in Billington, Baron-Cohen, & Bor, 2008); geospatial navigation (Galea & Kimura, 1993), and as mentioned above, spatial performance (e.g., Astur et al., 1998; Contreras et al., 2001; Moffat et al., 1998), mental rotation (Crucian & Berenbaum, 1998; Roberts & Bell, 2000), and some branches of mathematics (Benbow & Stanley, 1983). This is not to say that females cannot achieve high systemizing scores, but that on average there is a bias towards a higher degree of systemizing in males (Billington et al., 2008). It has also been found that systemizing skills in childhood is positively correlated with levels of foetal testosterone (FT) measured during amniocentesis (Auyeung et al., 2006). This may be part of the explanation of the observed gender differences in systemizing, since FT it believed to have organizing effects on brain development and is produced in greater quantities in males (Baron-Cohen et al., 2005).

This previous research supports the notion that females on average are superior in tasks that require a high degree of empathizing, and that males are superior on tasks that require a high degree of systemizing.

It is unclear if empathizing and systemizing reflect independent mechanisms, or a single underlying mechanism, such that these being mutually exclusive phenomena. Baron-Cohen et al., (2003) suspect that two independent mechanisms are involved, because they have seen few individuals who are superior at both of the cognitive styles. There seems to be a trend for some trade-off between these two domains, suggesting that if two independent mechanisms are involved, there may be a special relationship between them. The nature of this relationship needs to be understood both at the level of cognition and neuroscience (Baron-Cohen et al., 2003). It is possible that empathizing and systemizing might be specific abilities that have developed in response to qualitatively different kinds of phenomena. When appropriate we systemize, apply rules, and think in terms of event regularities. In other situations, we empathize, demonstrate greater flexibility and think in terms of contingencies (Lawson et al., 2004).

Electroencephalogram

Electroencephalography (EEG) is an imaging technique that maps the electrical activity on the scalp generated by brain structures. EEG measures changes in electrical potentials caused by a large number of synchronous electrical dipoles formed during neural excitations (Teplan, 2002). EEG patterns have been shown to be modified by a vide range of variables, including biochemical, metabolic, circulatory, hormonal, neuroelectric, and behavioural factors (Bronzino, 1995, as cited in Teplan, 2002). EEG-recording is a non-invasive procedure that can be applied repeatedly to patients, healty adults, and children with virtually no risk or limitations. It is therefore being widely used to study the brain organization of cognitive processes such as perception, memory, attention, language, and emotion (Teplan, 2002). The greatest advantage of EEG is temporal resolution. Complex patterns of neural activity that occurs within fractions of a second after a stimulus has been presented can be recorded. EEG provide less spatial resolution compared to MRI and PET. So to enhance estimation of the task relevant brain areas, EEG is often combined with MRI scans

Quantitative electroencephalography (qEEG)

Quantitative EEG (qEEG) applies multichannel measurements that can better determine spatial structures and localize areas with brain activity or abnormality. In qEEG and other

functional neuroimaging techniques it is assumed that the perceptual and cognitive operations exhibit a distinct and reliable profile of brain activity (Gevins, 1984). The results are often used for topographic brain mapping represented with colour maps in 2D or 3D to enhance visualization (Teplan, 2002).

Event-related potentials

Event-related potentials (ERPs) are time-locked responses to external or internal stimuli that can be extracted from the EEG. Because of their good temporal resolution which is in the order of milliseconds, they can accurately measure when processing activities takes place in the human brain (Picton et al., 2000), and are thought to reflect the neurophysiological correlates of cognitive processes (Brázdil et al., 2005).

ERP consists of characteristic components that span in time, ranging from early components beginning at 50 ms to components as late as 600 ms – 1000 ms. Each component is labelled with a "P" (for positive) or "N" (for negative) scalp potentials, and either latency (measured in milliseconds) from stimulus onset (e.g., N200) or the order in which the component is observed (e.g., N2).). According to Banaschewski & Brandeis, (2007) and Picton & Hillyard (1988, cited in Jeste & Nelson, 2009) early components (generally the first 100 – 200 ms) reflect basic sensory processing of stimuli, while later components (generally those after 200 ms) reflect the perceptual and cognitive processing of stimuli. The exact timing of early versus late components depends largely on the instructions given and the modality being studied (Jeste & Nelson, 2009). These components reflect various sensory, cognitive (e.g., stimulus evaluation), and motor processes that are classified on the basis of their scalp distribution and response to experimental variables (Friedman, Cycowicz, & Gaeta, 2001). Components are measured by assessing their amplitude and latency. Amplitude (measured in μV) is defined as the difference between the mean pre-stimulus baseline voltage and the largest peak of the ERP waveform within a defined time-window. Latency is defined as the time from stimulus onset to the point of maximum positive or negative amplitude within a defined time-window (Polich, 2007).

Neuropsychological research of cognitive functioning in various (patient) populations have demonstrated that ERP components could serve as informative markers of neurodevelopmental status in general as well as reflect development of more specific abilities (Courchesne, 1978).

The P3 component

The P3 is among the most intensely researched ERP components. The component was first identified by Sutton, Tueting, Zubin & John (1965, as cited in Key, Dove, & Maguire, 2005), in a cuing paradigm as a pronounced positivity over parietal areas that occurred in response to an unexpected stimulus type, occurring approximately 300 ms after stimulus onset. This effect was present both for auditory (clicks) and visual (light flashes) stimuli. It is now assumed that the P3 is modality non-specific, meaning that it can be evoked from visual, somatosensory and auditory tasks (Bomba & Pang, 2004). The P3 component is found to be implicated in a large number of cognitive and affective processes and is traditionally associated with allocation of mental resources (Polich, 2007; Polich & Kok, 1995). It has also been linked to inhibitory mechanism (Kirmizi- Alsan et al., 2006) and memory processes (Polich, 2007). The latency is assumed to reflect the duration of stimulus evaluation[1] (Donchin & Coles, 1988, as cited in Key et al., 2005), and associated with cognitive efficiency (Polich & Criado, 2006). Shorter latencies are in some studies found to be related to superior cognitive performance (Pelosi et al., 1992). In contrast the P3 amplitude is believed to be more closely related to the intensity of processing (Kok, 1990; Polich & Kok, 1995), and is assumed to be proportional to the amount of attentional resources allocated to processing a given stimuli (Johnson, 1988, as cited in Gray, Ambady, Lowenthal, & Deldin, 2004).

The P3 (with subcomponents P3a, P3b) is a component elicited when one has to discriminate an infrequent stimulus from frequent standards. It reflects the cortical processing of the probability of occurrence of a task-relevant event. (Jeste & Nelson, 2009), and is found to be maximal at central and parietal regions (Polich, 2007).

Using a visual continuous performance test (vCPT) the P3b can be seen. The vCPT, like other continuous performance tests (CPTs) is designed to measure complex attentional functions, such as response inhibition and sustained attention (Kirmizi-Alsan et al., 2006). Sustained attention is by Ward (2004, as cited in Kirmizi-Alsan et al., 2006) defined as the ability to maintain an efficient level of responding on a demanding task over a period of time. The P3b is thought to reflect controlled information processing, in the sense that it is typically elicited by task-relevant stimuli to which the participant is actively paying attention (Jonkman, Lansbergen, & Stauder, 2003; Friedman et al., 2001), as for example in a CPT-task.

[1] The concept of stimulus evaluation refers to all processes in the information-processing stream that occur prior to selection and preparation of motor responses (Kok, 2001).

Common biological basis for the P3 and empathizing and systemizing

Several important brain regions have been identified for the brain basis of empathizing, specifically the orbito-frontal and medial-frontal cortex, superior temporal sulcus, and the amygdala (Baron-Cohen et al., 1999b; Baron-Cohen et al., 2000; Frith & Frith, 1999). The amygdala has been shown to be active during the processing of emotional states, and lesions to this area cause impairment of emotion recognition (Adolphs, 2002; Shaw et al., 2005). The orbitofrontal cortex is essential for the regulation of emotions, and damage in this region is associated with a wide range of social emotional deficits, including impaired social judgement and disinhibited behaviour (Decety & Jackson, 2004).

Some of the brain regions identified for the brain basis of empathizing is also seen as possible neural generators for the P3. It is over two decades since the first publication of the first studies on neural generators for the P3, but there is still controversy in the area. Previous ERP studies have demonstrated multiple contributors to the P3 component in different cortical and subcortical structures (Baudena, Halgren, Heit, & Clarke, 1995; Brázdil, Rektor, Dufek, Jurák, & Kuba,1999; Halgren et al., 1995a, 1995b; Halgren, Marinkovic, & Chauvel, 1998; McCarthy, Wood, Williamson, & Spencer, 1989; Rektor et al., 2003; Yingling & Hosobuchi, 1984), but an extensive list of them has yet to be determined.

One source of the P3 is believed to be in the mesiotemporal structures, which include hippocampus, amygdala, and parahippocampal gyrus (McCarthy et al., 1989), and these are the same brain regions found to be involved in emotional processing. The orbitofrontal and medial frontal cortices has also been revealed at generators for the P3 (Baudena et al.,1995; Brázdil et al.,1999; Halgren et al.,1995a, 1998) and these areas are also seen in the brain basis for empathizing.

A more spatially extensive generator of P3 has been located within the anterior cingulate cortex (ACC) in intracerebral ERP studies (Brázdil et al.,2005). The ACC is found to be implicated in mood disorders, and in processing the emotional significance of stimuli (Cardinal, Parkinson, Hall, & Everitt, 2002).

Prefrontal and parietal cortices have been implicated in the performance of spatial and mathematical tasks (Cohen, Dehaene, Cochon, Lehericy, & Naccache, 2000; Dehaene, Piazza, Pinel & Cohen, 2003; Dehaene, Spelke, Pinel, Stanescu, & Tsivkin, 1999; Gruber, Indefrey, Steinmetz, & Kleinschmidt, 2001; Menon, Rivera, White, Glover & Reiss, 2000), and regions located in the parietal lobes is also seen as generators for the P3 (Bledowski et al., 2004; Ebmeier et al., 1995; Kirino, Belger, Goldman- Rakic, & McCarthy, 2000). Spatial and

mathematical tasks are believed to tap into systemizing, and also associated with increased activation in parietal cortex (Billington et al., 2008).

Previous neuroimaging research on empathizing and systemizing

It is still unclear what the exact nature of the underlying neurocognitive mechanisms are drive empathizing and systemizing. Previous neuroimaging studies of empathizing and empathy have often investigated empathy-related ERPs or mu-rhythm (e.g., Han, Fan & Mao, 2008; Cheng, Tzeng, Decety, Imada & Hsieh, 2006; Schulte-Rüther et al., 2008). Neuroimaging studies of systemizing have not been as extensively investigated yet. But there have been studies investigating tasks that are believed to tap into systemizing abilities (e.g., Weiss et al., 2003; Bell, Willson, Wilman, Dave & Silverstone, 2006; Kucian et al., 2005). The only neuroimaging study found by the author investigating the cognitive style of systemizing was done by Billington et al (2008). They used fMRI to investigate individual differences in a Navon-task in combination with SQ-R. Their results indicate that systemizing was associated with increased activation in brain regions associated with enhancing and maintaining attention. They believe that this heightened attentional set, coupled with local orienting and the ability to focus on details, leads to improved pattern and rule perception seen in those with a systemizing cognitive style.

While investigating empathy researchers have often tried to understand it as a process where an observer perceives other's emotional states and then generates a similar mental state internally. Much of the research in this area has looked at gender differences in empathy for pain. Han et al., (2008) compared empathy-related ERPs between males and females, and found differences in both early and late components of empathic processes between the two genders.

The mu-rhythm and the human mirror neuron system (hMNS) have been found to correlate with empathy. According to Silas, Levy, Nielsen, Slade, & Holmes, (2010) the mu-rhythm is seen as a reliable indicator of the hMNS, which has been implicated in empathy and other higher order social cognition. It is been suggested that the hMNS provide the basic sensory-motor mechanism that automatically align our behaviour with other persons, and therefore facilitates social communication (Rizzolatti & Arbib, 1998). Cheng et al., (2006) found gender differences in the hMNS and this appeared in accordance with the previous notion that women on average are stronger empathizers, while men being better systemizers in the general population (Baron-Cohen et al.,1997; Baron-Cohen, 2002; Baron-Cohen et al., 2005).

Correlations between hMNS and individual differences have also been found by Schulte-Rüther et al., (2008). They suggest that better female empathic abilities are related to an enhanced reliance on the hMNS while assessing the emotional states of other people. Males seem to rely on a more cognitive strategy, especially when describing their own subjective emotional response to the other people's expression of emotion.

The present study

Previous research investigating gender differences in cognitive styles have used different self-report measures and neuroimaging techniques, although not always in combination. The majority of self-report studies have found that females are better at empathizing, whilst males are better at systemizing. Neuroimaging studies have often investigated either empathizing or systemizing, not both in the same study. The majority of EEG studies investigating empathizing have looked at either empathy-related ERPs or mu-rhythm and the hMNS. The author found only one neuroimaging study investigating the cognitive style of systemizing. Based on previous research in the areas of cognition and neuroimaging there seems to be common areas responsible for empathizing, systemizing and for generating the P3 component. On the basis of the commonalities of these brain areas, it would make sense to investigate the possibility of correlations between cognitive styles and aspects of the P3 component. The E-S theory claims that biological differences in the brain can explain the gender differences found for empathizing and systemizing.

The main focus of this study will be to investigate whether there are correlations between the latency and the amplitude of the P3 component and the degree of empathizing and systemizing.

If correlations are found, the nature of these will be further investigated. As previous self-report studies on empathizing and systemizing have found gender differences, it will be expected to find the same in this study.

Method

Participants

40 healthy clinical psychology students (13 males and 27 females, aged 20-28 years: M = 22.72 years, S.D. = 1.66) recruited at NTNU, Trondheim. All participation was voluntary. The qEEG-recordings and questionnaires were performed as part of a lab-course in biological psychology. To avoid a state of dependence between students and the teacher responsible for the course, the students were asked to participate in this project after the end of the semester. Through signing an informed consent (see appendix A), they allowed the use of their EEG-recordings and results from the Empathy Quotient (EQ; see appendix B) and the Systemizing Quotient-Revised (SQ-R; see appendix C) after the semester had ended. The project was approved by the local ethics committee.

Four females were excluded from the study due to missing data in the questionnaires, and one female was excluded due to difficulties during analyzing the data.
The finale study included 35 students (N=35, aged 21-28 years, M = 22.86, S.D. =1.70), divided into thirteen males (aged 21-24: M= 23.00, S.D. = 1.29), and twenty-two females (aged 21-28 years: M = 22.77, S.D. =1.93)

Apparatus

EEG was recorded from 19 scalp site using a Tin-electrode cap (ElectroCap, United States), Mitsar amplifier (Mitsar EEG-201, St.Petersburg, Russia) and the WinEEG 2.82 software package (Mitsar, St.Petersburg, Russia).
The electrodes were arranged according to the International 10-20 system (Fp1, Fp2, F7, F3, Fz, F4, F8, T3, C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1 and O2) against linked earlobes reference electrodes (Figure 1).

The ground electrode was placed 1.5 cm anterior to the frontal midline electrode (Fz). Electro Gel, and NuPrep gel (50 :50) (ElectroCap, United States) was used to achieve contact between the electrodes and the scalp, and Ten 20 EEG paste (D-O. Weaver and CO, USA) were used to attain contact between the earlobes and the reference electrodes.
Impedance was kept below 10 Ω. Sampling rate was 250 Hz, and band-pass filter ranged from 0.53 – 50 Hz. Notchfilter was set to 45-55 in order to reduce electrical inference.
Data was stored on external hard-disk for offline analysis.

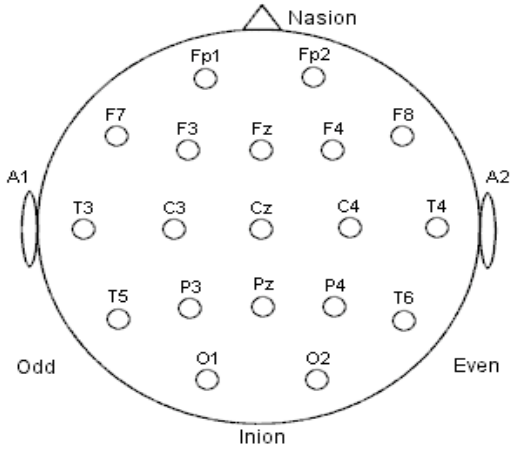

Figure 1:. *The arrangement of electrodes over the scalp and earlobes according to the international 10-20 system.*

Stimuli

Stimuli were generated by the psychological software tool *PsyTask* (Mitsar, St.Petersburg, Russia). The stimuli used is known as visual continuous performance test (vCPT)

In this version of the vCPT there are three categories of stimuli:

1) 20 different images of animals –referred to as A,

2) 20 different images of plants –referred to as P, and

3) 20 different images of humans presented together with an artificial novel sound – HS.

The vCPT involves four conditions: animal-animal (a-a), animal-plant (a-p), plant-plant (p-p) and plant-human (p-h). The plant-human condition also presents a 60 dB novel sound with the human-picture (Figure 2). The a-a condition is called the Go-condition, and the a-p is the NoGo-condition. Response (button press) should be provided only for the second animal in the animal- animal condition.

The trials were grouped into four sessions with hundred trials each. In each session a unique set of five A stimuli, five P and five HS stimuli was selected. Each session consisted of a pseudo-random presentation of 100 pairs of stimuli with equal probability for each category and each stimulus.

The duration of stimuli was equal to 100ms. Trials consisted of presentation of a pair of stimuli with inter-stimulus intervals of 1100ms. The interval between trials was equal to 3100ms and the response interval was from 100 – 1000ms.

A break was given every 5 min to prevent drowsiness.

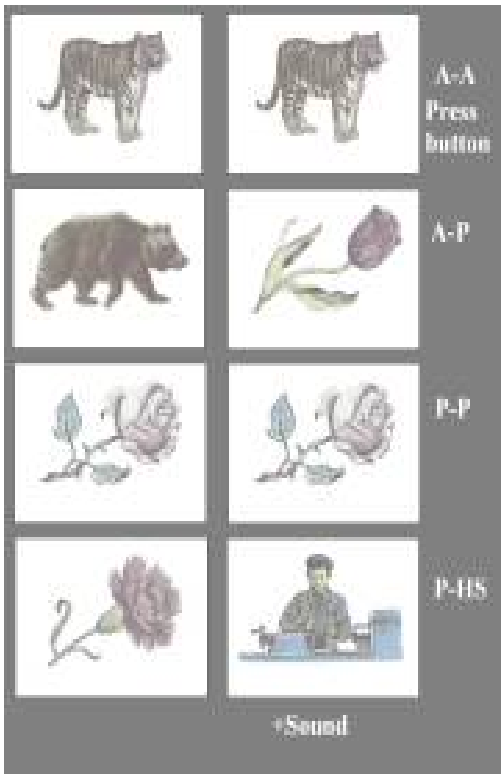

Figure 2. *Illustration of the different stimulus in the vCPT task*

Procedure

During the vCPT test, the subject sat in a comfortable chair with armrests (figure 3). Pictures were presented in the centre of a computer monitor placed 100 cm from the subjects' eyes. Before each session, the test was explained to the subject in detail, and between 5- 10 training tasks were performed. Accuracy and speed were encouraged.

Information was given about artefacts, and the subject was instructed to relax their face muscles, and not to move unnecessary during the recording, in order to reduce artefacts. The experimental room was divided from the control room with a one-way mirror.

All participants were recorded during three condition – Eyes open (EO – 3minutes), eyes closed (EC – 3minutes) and the vCPT (20 minutes).

In the vCPT subjects were instructed to press a button with the index finger of their dominant hand as fast as possible every time the a-a (Go-condition) appeared on the screen, and to hold or ignore pressing on the other trials (NoGo-condition)

Instructions about and recordings of the EO and EC were given prior to the vCPT. Before recording of the vCPT, instructions were given, and if necessary repeated again just before recording.

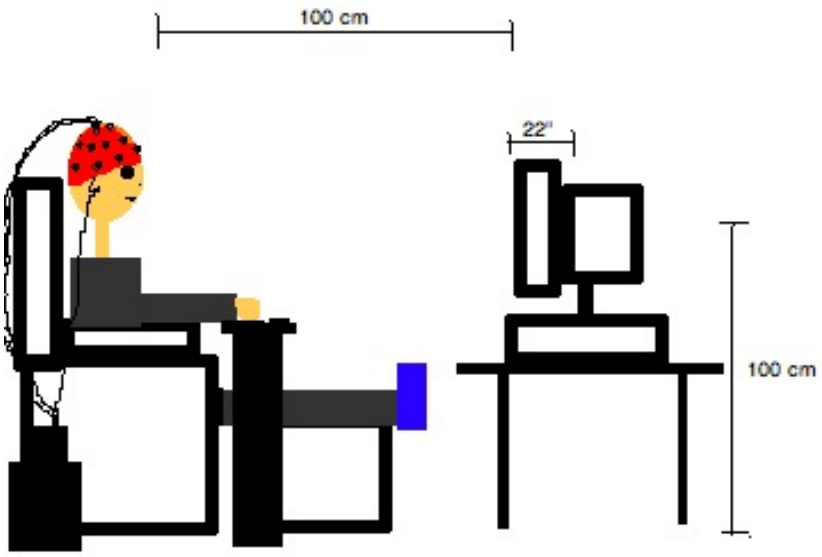

Figure 3. *Illustration of the experimental setting.(with permission from Wiik,,2009).*

Artefact correction

Eye movements- and muscle artefacts were removed using spatial filtering and independent component analysis (ICA)[2]. Artefacts with amplitudes above 50 µV ranging from 1-12 Hz, and above 20 µV in the range of 0.35 – 50 Hz were removed automatically by the WinEEG. All data were also visually inspected, and further artefacts were removed if necessary.

Questinnaires: the empathy quotient and the systemizing quotient-revised

The EQ (Baron-Cohen et al., 2003) and SQ-R (Wheelwright et al., 2006) have a forced-choice format, and are self-administered. The questionnaires used in this study were the Norwegian versions (translated by Teigen, 2008). Participants are asked to indicate whether they 'strongly agree', 'slightly agree', 'slightly disagree' or 'strongly disagree' with a statement. Approximately half the items on each questionnaire are worded so that a high scorer will agree with the item, to avoid response bias.

[2] ICA is a computational method that separates a set of mixes potentials measured at the scalp into a coressponding set of statistically independent source signals (Stone, 2004, as cited in Mueller, Candrian, Kropotov, Ponomarev, & Bachera.,2010).

Procedure for filling out the EQ and SQ-R

The EQ and SQ-R were filled out after each participant had performed the qEEG-recording. Half of the participants filled out the EQ first, and then the SQ-R, and the other half did it in the reverse order to avoid response bias. The questionnaires were filled out either alone, or in small groups (< 4). Instructions were given to fill out the questionnaires in accordance with their everyday life, and not to think too long about the items in question.

The empathy quotient (EQ)

The Norwegian version of the EQ consists of 40 items, (statements) with 2 points available for a 'strongly' response and 1 point for an appropriate 'slightly' response. The minimum score is 0 and the maximum is 80. The questionnaire asks questions like 'Friendships and relationships are just too difficult, so I tend not to bother with them', 'I am good at predicting how someone will feel' and 'I can usually appreciate the other person's viewpoint, even if I don't agree with it'.

Scoring the EQ

On the following 21 items, 'strongly agree' responses score two points, and 'slightly agree' responses score one point: 1, 3,11,13,14,15,21,22,23,24,26,27,28,29,34,35,36,37,38,39, and 40. On the following 19 items, 'strongly disagree' responses score two points, and 'slightly disagree' responses scores one point: 2,4,5,6,7,8,9,10,12,16,17,18,19,20,25,30,31,32 and 33. (see appendix D)

The systemizing quotient- revised (SQ-R)

The Norwegian version of the SQ-R has 75 items. Participants can score 0, 1 or 2 on each item of the SQ-R, with half the items on the SQ-R being reverse scored in order to avoid response bias. Thus the minimum score is 0 and the maximum is 150.

The SQ-R asks questions such as "I like music shops because they are clearly organised" and "When I learn a language I become intrigued by the grammatical rules".

The SQ-R is a recently revised version of the SQ, with improved psychometric properties and sex-neutral items (Wheelwright et al., 2006).

Scoring the SQ-R

On the following 39 items, a 'strongly agree' response scores 2 points, and 'slightly agree' responses score 1 point: 1, 2, 4, 5, 7, 9, 11, 12, 13, 14, 16, 18, 19, 20, 21, 23, 25, 27, 29, 30, 32, 36, 38, 41, 42, 43, 46, 50, 53, 55, 60, 61, 62, 66, 68, 69, 72, 74, 75

On the following 36 items, 'strongly disagree' responses score 2 points, and 'slightly disagree' responses score 1 point: 3, 6, 8, 10, 15, 17, 22, 24, 26, 28, 31, 33, 34, 35, 37, 39, 40, 44, 45, 47, 48, 49, 51, 52, 54, 56, 57, 58, 59, 63, 64, 65, 67, 70, 71, 73. (see appendix E).

Behavioural data

Group means (M) and standard deviations (SD) were obtained for reaction-time (RT), and a independent-samples T-test were performed using SPSS version 17.0 to investigate gender differences.

ERP analysis

The P3 was defined as the third positive peak after stimulus onset. Both the amplitude and latency were measured manually by visual inspection. Most of the cited Go / NoGo studies have reported a parietal maximum for Go-trials and a central maximum for NoGo-trials (Jodo & Inove, 1990; Karlin, Martz, & Mordkoff, 1969; Kok, 1986; Pfefferbaum, Ford, Weller, & Kopell,1985; Pfefferbaum & Ford, 1988; Simson, Vaughan Jr, & Ritter,1977). The P3 Go was measured at the highest point at the electrode Pz, or in some cases in the Cz if that looked like a better fit. The P3 NoGo was measured at the highest point in the electrode Cz. When in doubt, the S-Loreta was used for further investigation. Groups means (M) and standard deviations (S.D.) for P3 Go amplitude and latency, P3 NoGo amplitude and latency from the vCPT task were obtained for males and females.

Statistical analysis

All statistical analysis was done using SPSS version 17.0. Preliminary analysis using Kolmogorov-Smirnov and Levene's test were performed for all data to ensure no violation of the assumption of normality and equality of variances. Further analysis of the data investigated gender differences using correlation analysis, as well as correlations between the self-report measures and ERP measures.

RESULTS

Preliminary analysis indicated that the data did not violate the assumptions of normality and homogeneity of variances. This allowed for independent-samples *t*-tests, and Pearson product-moment correlations to be used for further statistical investigations of the data. Because the preliminary tests indicated normality, and it is a relatively small sample, outliers were not removed from the data.

Questionnaires

Empathy quotient

Mean scores (M) and standard deviations (SD) were calculated for all participant (N=35) on the empathy questionnaire (EQ). The same calculations were also done for males and females separately.

Results of the calculations are presented in Table 1. Mean score for all participants on the EQ is 53.23 (SD = 9.59), and an independent samples *t*-test revealed that females scored significantly higher than males t (33) = 5.12, p = .00.

Systemizing quotient-revised

Mean scores for all participants (N = 35) on the systemizing quotient-revised (SQ-R) is 47.26 (SD = 19.38). Males scored higher than females, but the independent- samples *t*-test revealed that this was not a significant difference. Results are presented in Table 1.

Table 1: Mean score and standard deviation for scores on the self-report measures for the entire sample, and males and females separately.

	All		Males		Females	
	M	SD	M	SD	M	SD
EQ	53.23	9.56	45.08	8.87	58.05	6.11
SQ-R	47.26	19.38	54.23	22.28	43.14	16.64

A Pearson product-moment correlations between the score on the EQ and SQ-R revealed no significant relationships (Table 2).

Table 2: Correlations between EQ and SQ-R for all participants, and separately for males and females

	All (N = 35)	Males (N = 13)	Females (N = 22)
EQ * SQ-R	- .154	.257	- .188

Behavioural measures

The average reaction time (RT) on the vCPT for all participants were 299.43 ms (S.D. = 33.82). The RTs were examined for males (M= 276.38, S.D. = 21.73), compared with females (M = 313.05, S.D. = 32.55), and an independent samples *t*-test revealed that males had significantly shorter RTs, t (33) = 3.60, p = .001.

Event-related potentials

After visual inspection of the ERPs, the average for all participants were calculated. (See Table 3). Independent-samples *t*-test revealed no significant differences between males and females for either of the measures (latency and amplitude). Grand average ERPs of the Go / NoGo condition measures for all participants, and for males and females separately, are seen in Figure 4.

Table 3: Mean score and standard deviation on the Go / NoGo – amplitude and latency for the entire samples, and males and females separately.

	All		Males		Females	
	M	SD	M	SD	M	SD
P3 Go amplitude	9.29	2.66	9.10	1.90	9.41	3.07
P3 Go latency	326.74	23.06	324.92	24.23	327.82	22.84
P3 NoGo amplitude	12.49	3.68	12.17	2.96	12.68	4.09
P3 NoGo latency	339.77	17.40	340.00	14.05	339.64	19.44

Grand average ERPs of the P3 Go and NoGo conditions

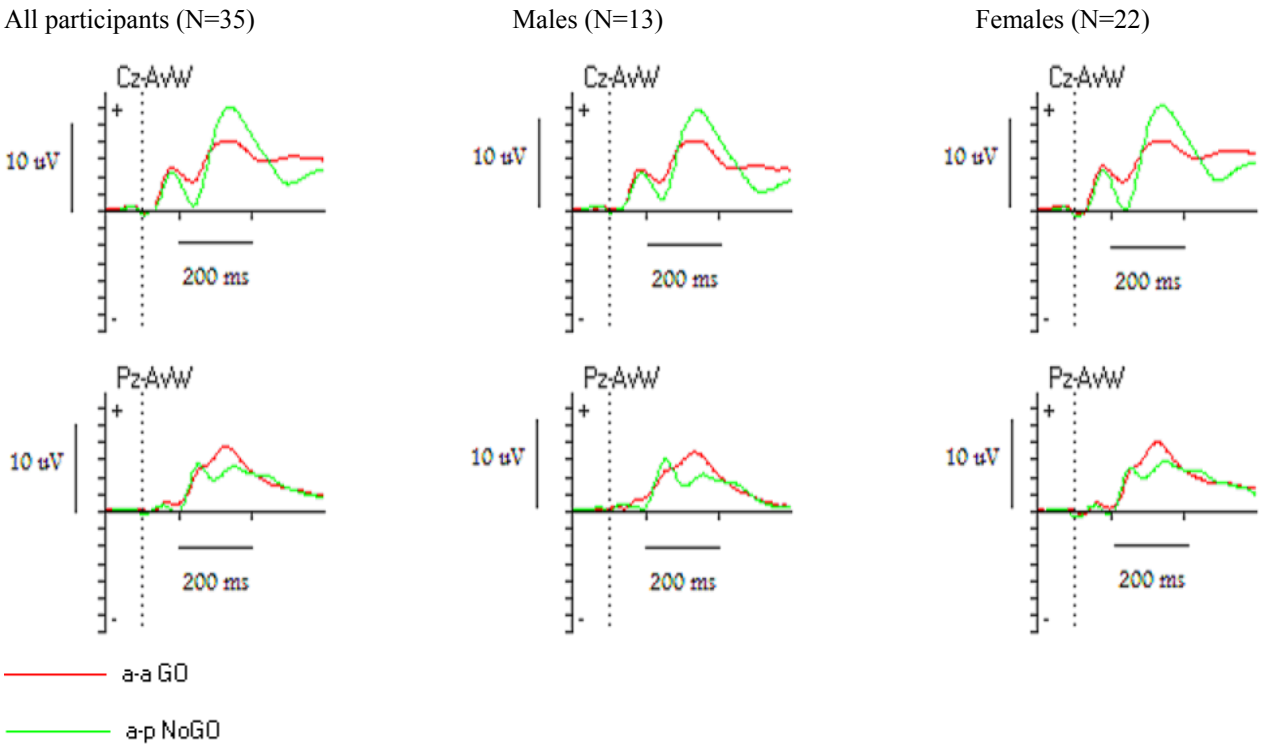

Figure 4) Grand average ERPs of all participants, and separate for males and females. The Pz showing Go-condition (red line), and Cz showing NoGo-condition (green line). The Go-condition has maximal amplitude in Pz, and NoGo has maximal amplitude in Cz.

Correlations between questionnaires, ERPs and RTs

Pearson's product-moment correlations were computed for questionnaires, ERP measures, (P3 Go amplitude and latency, P3 NoGo amplitude and latency), and RTs. This was investigated for all participants (see Table 4), and separately for males (see Table 5), and females (see Table 6). Determining the strength of relationships was done following Cohen's (1988, as cited in Pallant, 2005) guidelines:

r = .10 to .29 small; r = .30 to .49 medium; r = .50 to 1.0 large

All participants

The correlations analysis for all participants did not reveal any significant relationships between self-report scores, ERPs, or RTs.

Table 4: Correlations between self-report measures, ERPs and RTs for all participants (N = 35)

	RT	P3 Go amplitude	P3 Go latency	P3 NoGo amplitude	P3 NoGo latency
EQ	.299	.174	.235	.178	.048
SQ-R	-.203	.108	.331	.145	.138

Males

The correlation analysis for males (N=13) revealed one positive correlation.

This correlation is seen between the EQ and P3 Go latency [$r = .713$, $p < .01$]. This result indicates that there is a strong relationship between the two variables, with longer P3 latency associated with higher score on the EQ. A coefficient of determination was calculated (as described by Pallant, 2005), and the result indicates that there is 50.8 % shared variance. (For correlation and trend, see figure 5).

Table 5: Correlations between self-report measures, ERPs and RTs for males (N =13)

	RT	P3 Go amplitude	P3 Go latency	P3 NoGo amplitude	P3 NoGo latency
EQ	.005	.365	.713**	.391	.489
SQ-R	- .008	- .055	- .040	.361	- .399

** Correlation is significant at the 0.01 level (2-tailed)

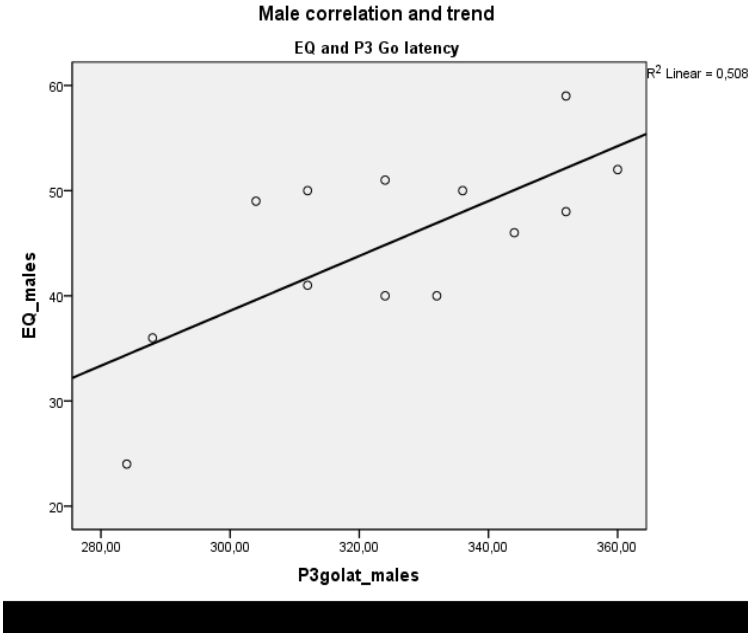

Figure 5) Scatterplot of the correlation found for males between the P3 Go latency (X-axis) and the score on the EQ (Y-axis).

Females

The correlation analysis revealed two positive correlations. The first relationship is between the SQ-R and P3 Go latency, [$r = .695$, $p < .01$], and is a strong relationship.

The second positive correlation is between SQ-R and P3 NoGo latency [$r = .449$, $p < .05$], and is seen as a medium strength relationship.

A coefficient of determination was calculated for both correlations (as described by Pallant, 2005), and the results indicates that there is 48. 3% shared variance between the P3 Go latency and SQ-R, and 20.1 % shared variance between the P3 NoGo latency and SQ-R. (For correlations and trends, see figure 6a, 6b).

Table 6: Correlations between self-report measures and ERP measures for females (N =22)

	RT	P3 Go amplitude	P3 Go latency	P3 NoGo amplitude	P3 NoGo latency
EQ	- .145	.113	- .131	.067	- .170
SQ-R	- .101	.229	.695**	.078	.449*

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

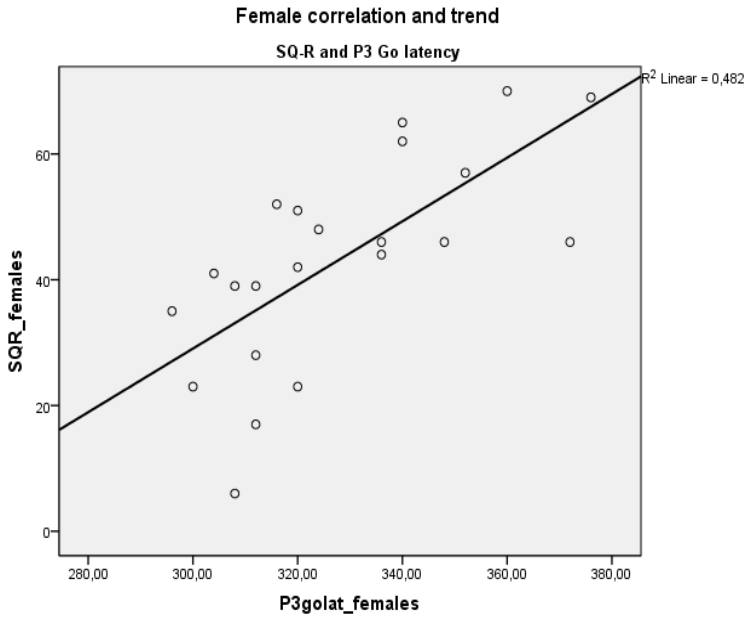

Figure 6a): Scatterplot of the correlation found for females between the P3 Go latency (X-axis) and the score on the SQ-R (Y-axis).

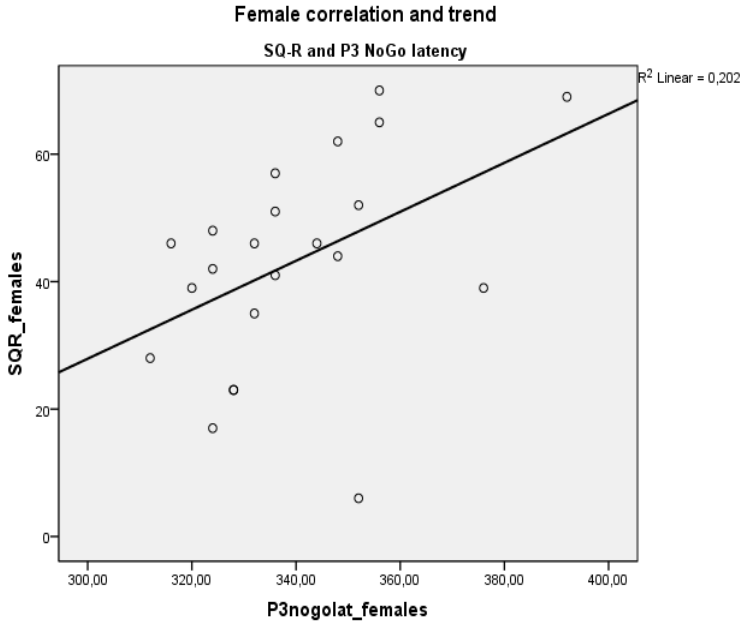

Figure 6b): Scatterplot of the correlation found for females between the P3 NoGo latency (X-axis) and the score on the SQ-R (Y-axis).

Discussion

The aim of this study was to investigate the possibility of relationships between aspects of the P3 component and the cognitive styles of empathizing and systemizing. To test this possibility a clinical psychology student population was examined. The results indicate that there is a relationship between the P3 latency and the degree of empathizing and systemizing. The correlations were found to be gender-specific. For males it was found that the P3 latency correlated with degree of empathizing, as measured by the EQ. Analysis revealed that the P3 latency could explain half of the observed variance of the score on the EQ. For females it was found that the P3 latency was correlated with degree of systemizing, as measured by the SQ-R. Analysis revealed that the P3 latency could explain nearly half of the observed variance of the score on the SQ-R.

Questionnaires

The majority of previous studies investigating the E-S dimension have found that females score higher on the EQ, and males score higher on the SQ-R (e.g., Billington et al., 2007; Wheelwright et al., 2006). It was therefore expected to find the same tendency in the present study. The participants' score on the self-report questionnaires displayed the expected gender differences or trends in those directions. Females were found to be superior on the EQ, and males were found to score higher on the SQ-R, although differences were not significant. The results for the SQ-R probably reflects sample size, since previously found gender differences using the EQ and SQ-R have been based on much larger samples, which included more male participants.

The mean score for males and females on both questionnaires were compared to the mean scores found in the previous study by Wheelwright et al (2006). It was found that the male scores were close to the mean score of humanities students[3] on both the EQ and SQ-R. The females score on the EQ was higher than the mean score for any of the student-populations reported by Wheelwright et al (2006), but the SQ-R was close to the mean score reported for humanities students. The higher mean score on the EQ indicates that female clinical psychology students may be more empathizing than other the student-populations investigated by Wheelwright et al (2006)[4].

[3] Humanities studies included: classics, languages, drama, education, law, architecture, philosophy, oriental studies, English, linguistics, theology, history, history and philosophy of science, history of art and music.
[4] They compared EQ and SQ-R scores between physical science, biological science, social science and humanities.

It has previously been suggested that it is a possibility for a relationship between empathizing and systemizing (Baron-Cohen et al., 2003) as previously mentioned. A correlation analysis did not reveal any significant relationship between the degree of empathizing and degree of systemizing for this population.

Event-related potentials

There were not revealed any significant gender differences for the P3s, neither for latency nor amplitude. Gender differences have previously been investigated by Kucian et al (2005). They used fMRI to study gender differences during simple tasks, and complex tasks, and found no gender differences for simple tasks. The vCPT used in this study is regarded as a simple task, and this may be a possible explanation for why there were not found gender differences. The results can also be a reflection of an unequal number of male and female participants.

Correlations

The analysis revealed that there are relationships between the P3 component and the cognitive styles of empathizing and systemizing for both genders. For the male participants there were found a correlation between the P3 Go latency and degree of empathizing. For females there were found that degree of systemizing was correlated with both the P3 Go latency and the P3 NoGo latency. Based on the correlations found, it might be that P3 latency may be a physiological reflection of different cognitive styles. Males that tend to score higher on the EQ, display higher P3 latencies while empathizing. Female that tend to score higher on the SQ-R display higher P3 latencies while systemizing. The relationships found between the P3 latency and systemizing for females is unexpected, as there was not found a significant difference between the males and females on the SQ-R, or on the ERPs, only a trend towards males being more systemizing.

The calculation of the coefficient of determination indicates that quite a large amount of the variance of the questionnaire-scores could be explained by the P3 latency. For both genders it was found to be about 50%. These findings give support to the notion that the degree to which an individual display empathizing and systemizing tendencies has biological explanations. This will be further addressed in the general discussion.

Shorter P3 latencies have in some studies been found to be related to superior cognitive performance (Pelosi et al., 1992). Results from the present study indicate that males have an inferior cognitive performance while empathizing compared to females, and females have an inferior cognitive performance while systemizing. This can be interpreted as

systemizing being a more 'intuitive' cognitive style for males, and empathizing a more 'intuitive' cognitive style for females. This will be further elaborated in the general discussion.

General discussion

The results revealed in the present study indicates that the P3 component can be linked to gender differences in cognition, as seen by the gender differences in correlations between the latency and cognitive styles. The P3 component has previously been found to be implicated in a large number of cognitive and affective processes (Polich, 2007; Polich & Kok, 1995), and supports the results found in the present study.

The correlations found between the P3 latency and cognitive styles indicate that the P3 component could be linked to development of a gender-specific ability. According to Courchesne (1978) ERP components, such as the P3, can serve as informative markers of neurodevelopmental status in general, and also reflect development of more specific abilities. Indications of a physiological correlate for gender differences in cognitive abilities has also been found by Neubauer et al., (2005). They found that verbal intelligence in females was correlated with brain activation during performance of a verbal task, and visuospatial ability in males correlating with brain activation during performance of a visuospatial task. Gender differences while utilizing different cognitive strategies have also been found by Kucian et al (2005). They found that females tend to prefer strategies involving verbal and spatial working memory, and males tend to use more visuospatial strategies.

In line with the E-S theory it has been found that females often prefer predicative thinking, and males tend to use more functional thinking algorithms (Noel et al., 1997). For some tasks, such as mathematics and predicting patterns, functional thinking may be regarded as the most efficient, and the average male is often found to better at this. When males are found to be superior in a task, this can be reflected in shorter latencies compared to tasks where males are found to be inferior, such as empathizing. Understanding how other people feel, or why they feel as they do, requires empathizing. To empathize males have to use a cognitive strategy which they may not find as natural and intuitive as systemizing, and they therefore have to spend more cognitive resources, as measured by the increased P3 latency. For females it would be opposite. An empathizing style or predicating thinking would be efficient when assessing how others feel, but it would not be as efficient when applied to mathematics or predicting patterns. Hence females have to spend more cognitive resources,

and the latencies would be longer, because they have to use a non-optimal cognitive style than their more natural and intuitive one.

Gender differences have also been established in the human mirror neuron systems (hMNS). Cheng and colleagues (2006) found that gender differences in the hMNS appeared in accordance with females being stronger empathizer, and men being stronger systemizers. There has also been found correlations between the hMNS and individual differences in empathy. Schulte- Rüther et al., (2008) suggested that the better female empathic abilities are related to an enhanced reliance on the hMNS while assessing the emotional states of other people. They believe that males rely on a more cognitive strategy when assessing emotional states of other people than females do. Schulte-Rüther et al's (2008) suggestion supports the results from this present study. The results indicate that males seem to rely on a more cognitive strategy when empathizing, as seen by longer P3 latencies following higher score on the EQ. For females there was not found that the P3 latency is longer when the EQ score is higher. These results seen together with the previous findings by Cheng et al., (2006) and Schulte-Rüther et al., (2008) can be interpreted as physiological evidence for the E-S theory.

The expected female superiority in empathizing was found, but it was not found that males scored significantly higher on systemizing, even though there was a trend for males scoring higher. Despite the lack of a significant differences between males and females in systemizing, significant positive correlations was revealed between the P3 latency and score on the SQ-R for females. This could be an indication of females using a more cognitive strategy when systemizing, as seen by longer P3 latencies when SQ-R score is higher. Individual differences between high and low systemizers has previously been investigated using fMRI (Billington et al., 2008). They found that systemizing was associated with increased activation in brain regions related to enhancing and maintaining attention in individuals with high on SQ-R scores. They believe it might be that this heightened attentional set, coupled with local orienting and the ability to focus on details, leads to improved pattern and rule perception seen in those with a systemizing cognitive style. Although Billington et al's (2008) study investigated individual differences in systemizing, it is possible to speculate that the same is valid for the gender differences found in the present study.

The results revealed in the present study are supported by findings in previous neuroimaging studies. Males and females have previously been found to use different cognitive strategies when empathizing and systemizing (e.g., Schulte- Rüther et al., 2008; Cheng et al., 2006), and correlations between the P3 latency and cognitive styles found here

are supported by these previous findings. The E-S theory claims that males are more systemizing than females. It can therefore be speculated that males are more systemizing, because it is more intuitive to them, and thus empathizing requires more cognitive processing. The opposite can be speculated is valid for females. Empathizing can be more intuitive to them, and thus systemizing requires more cognitive processing. As revealed for both gender, the inferior cognitive style demands more cognitive processing, as reflected in the correlations between the P3 latency and inferior cognitive style.

Baron-Cohen et al (2003) suspected that there are two independent mechanisms involved in empathizing and systemizing, because they have found very few people who score high on both cognitive styles. Based on the results from this present study, it is difficult to say if there are only one or two independent mechanisms involved. Analysis did not reveal any significant relationship between them. Lawson et al., (2004) have suggested that empathizing and systemizing might be specific abilities that have developed in response to qualitatively different kinds of phenomena. When appropriate we systemize, apply rules, and think in terms of event regularities. In other situations we empathize, demonstrate greater flexibility, and think in terms of contingencies. This present study indicates that males use more cognitive resources when empathizing, and females use more cognitive resources when systemizing, but this is not to say that we do not empathize and systemize when appropriate. The results only indicate that males are inferior at empathizing and females are inferior at systemizing.

Conclusion

The present study revealed that there are relationships between the P3 latency and the cognitive style of empathizing and systemizing. The correlations found were gender-specific, and for the inferior cognitive style of the gender. For males it was found that the P3 latency was correlated with degree of empathizing, and that the latency could explain half of the variance of the empathizing-score. For females it was found that the P3 latency was correlated with degree of systemizing, and that the latency could explain nearly half of the variance of the systemizing score. Based on the results from the present study, it is plausible that gender differences in cognitive styles is dependent or is in a special relationship with the P3 latency. Empathizing can be seen as more natural and intuitive to females and systemizing more natural and intuitive to males, in that females have a more efficient cognitive processing for empathizing, and males have a more efficient cognitive processing for systemizing. The

results indicate that more cognitive processing is necessary to be better at the inferior cognitive style, as measured by longer latencies.

This study lends further support to the notion that males and females seems to at least in part use different strategies when empathizing and systemizing, in that it is more cognitively demanding for a male to be empathizing, and for a female to be systemizing.

Limitations of this study

The population investigated in the present study was clinical psychology students. This is a population that may not be representative for the general population. In light of their chose of study, it can be expected that they are above average in empathizing compared to the general population. The analysis did reveal that the females scored higher on the EQ than found in previous studies. The expectancy for higher degree of empathizing in the population investigated is also reflected in the unequal number of males and females in the present study. There were almost twice as many female students participating, and this is expected since females are found to be more empathizing, and thus more females apply to this study. Ideally it should be an equal number of females and males when investigating gender differences.

The present study was done as a part of a student- exercise with limited time, and thus limited access to participants. The number of participants was therefore smaller than in previous studies investigating gender differences using the EQ and SQ-R. Previous studies have often included more than 100 participants, but these are studies only investigating gender differences using questionnaires. When compared to previous neuroimaging studies, there are more participants in the present study than in most such studies.

The present study was part of a student-exercise, and it therefore a possibility for uncertainties in the measurements. The use of self-reports can also be a source of uncertainty. Demand characteristics are a common treat against internal validity. The population investigated could be biased to be seen as more empathizing than they really are, being that they are clinical psychology-students. They should also have more knowledge about the use of questionnaires than other populations, which also can be a treat against the internal validity of the study. The EQ used in the present study has been found to be valid and reliable (for more information, see Lawrence, Shaw, Baker & David, 2004). The validity and reliability of the SQ-R has not been investigated to the knowledge of the author, and this can thus be a source of uncertainty.

The population investigated was found to be different from other populations investigated in previous studies, in that they are found to be more empathizing. This

difference may treaten the external validity, and therefore the results from the present study should not be regarded as valid for other populations.

Propositions for further study

Empathizing and systemizing has been seen in relation to choice of study. Studies have revealed that humanities students are more empathizing than science students, and that science students are more systemizing than humanities students. The present study investigated clinical psychology students, which were found to be more empathizing than humanities students. It would therefore be interesting to replicate this study with other student-populations, as for example science student, and other normal populations.
For the future it would be of interest to investigate different patient populations. The main question being whether there is a consistent correlation and then linearity to the phenomenon. For example investigations of affective disorder vs pathological systemizer (Aspergers syndrome). The desired goal will in the end be to be able to use aspects of ERPs components (peak latency and amplitude) to supplement clinical assessments.

Lawrence et al., (2004) divided the EQ into different subscales. These subscales measure 'cognitive empathy', 'emotional reactivity' and 'social skills'. For the future it could be interesting to see if there are population-differences in the score on the different subscales, and how the relationship is between these three subscales and the P3 component. Lawrence et al., (2004) also believes that these different subscales may have clinical applications.

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APPENDIX A

Informed consent

Informasjon og forespørsel om deltakelse i studiet:

"Studie av dynamikken i strategivalg hos en høyt utdannet normalpopulasjon"

Bakgrunn og hensikt med studien
Dette er en forespørsel om å delta i et forskningsprosjekt for å undersøke sammenhengen mellom elementer fra målinger med kvantitativ elektroencefalografi (qEEG) og resultater fra spørreskjema som kartlegger strategivalg.

Hva studien innebærer for deg
Hvis du sier ja til å delta i studien, innebærer det at du frigjør data fra labøvelsen som du deltok i på kurset psypro4020. Dvs, det er kun ditt resultat fra spørreskjema og data fra qEEG-opptaket som vi ber om tilgang til. Ditt navn vil ikke knyttes til disse data eller benyttes i noen annen sammenheng.

Det er ingen risiko forbundet med disse undersøkelsene.

Slik ivaretas ditt datamateriale og personopplysninger
Forskningsdata lagres elektronisk ved laben, og kun personer med relevant tilgang til studien har tilgang til de. Det vil bli benyttet en omkodingsliste, det vil si at ditt navn vil bli erstattet med et nummer. På denne måten vil ikke ditt navn kunne knyttes til datamaterialet. Kun masterstudent vil ha tilgang til omkodingslisten. Vedkommende som behandler data er underlagt taushetsplikt og er kjent med forvaltningsloven § 13 sammenholdt med § 13a, 13b, 13c og 13f. Alle opplysninger vil bli behandlet konfidensielt og i henhold til Helsinki-deklarasjonen.

Dine rettigheter
Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert evt feil i de opplysningene vi har registrert. Hvis du senere trekker deg fra studien, kan du kreve materialet destruert. Du kan også kreve å få slettet opplysninger vi har registrert. Ved henvendelse til prosjektansvarlig kan du få nærmere opplysninger om dette. Du kan ikke få slettet opplysninger eller destruert materiale dersom de er anonymisert, er viderebehandlet eller dersom opplysningene allerede er inngått i vitenskapelig arbeid.

Du bestemmer selv
Det er frivillig å delta i studien. Dersom du velger å ikke delta, er det ikke nødvendig å oppgi grunn. Du kan til enhver tid trekke seg fra studiet. Om du skulle bestemme seg for å ikke delta, får dette ingen konsekvenser for deg nå eller i fremtiden.

På grunn av arbeid med å etablere en qEEG-database er det av interesse å ta vare på EEG-data etter opptak. Dine data er anonymisert og kan ikke knyttes til deg på noen måte. Dersom du likevel ønsker å reservere deg fra at dine qEEG-data lagres etter prosjektslutt har du mulighet til dette når du fyller ut samtykkeskjema.

Prosjektansvarlig / mer informasjon

Prosjektleder: Professor Karl Jacobsen, Psykologisk Institutt, NTNU.

Labansvarlig: Førsteamanuens Stig Hollup, Psykologisk Institutt, NTNU

Hvis du har spørsmål om studien eller trenger informasjon, kan du ta kontakt med Stig Hollup: stig.hollup@svt.ntnu.no eller tlf 97044042

Samtykkeskjema for studien

”Studie av dynamikken i strategivalg hos en høyt utdannet normalpopulasjon”

Deltakelsen i studien er basert på ditt frivillige, informerte samtykke. Dersom du ønsker informasjon utover det som fremkommer i informasjonsskrivet, har du fullstendig anledning til å be om det. Dersom du etter å ha fått den informasjon du synes er nødvendig, sier ja til å delta i prosjektet, bes du signere samtykkeerklæringen. Du kan når som helst, og uten begrunnelse be om at alle data innhentet fra deg, slettes.

Jeg, _____ (navn med blokkbokstaver), bekrefter at jeg har mottatt skriftlig informasjon om studien, har fått anledning til å innhente den informasjon jeg har hatt behov for, og er villig til å delta i prosjektet.

Jeg samtykker i at data fra mitt qEEG-opptak og utfylte spørreskjema kan tas vare på etter prosjektslutt: ja ☐ nei ☐

Sted / Dato Signatur prosjektdeltaker:

APPENDIX B

CAMBRIDGE ATFERDSSKALA

Nedenfor finner du en liste av påstander. Les hver påstand nøye og vurder i hvilken grad du er enig eller uenig. Sett en ring rundt svaret du velger. Det finnes ingen riktige eller gale svar, heller ingen lurespørsmål.

Eksempler:

E1. Jeg ville bli svært ute av meg hvis jeg ikke kunne høre på musikk hver dag. — Helt enig | (Litt enig) | Litt uenig | Helt uenig

E2. Jeg liker bedre å snakke med vennene mine på telefon enn å skrive brev til dem. — Helt enig | Litt enig | Litt uenig | (Helt uenig)

E3. Jeg har ingen trang til å reise til andre deler av verden. — (Helt enig) | Litt enig | Litt uenig | Helt uenig

E4. Jeg liker bedre å lese enn å danse. — Helt enig | Litt enig | (Litt uenig) | Helt uenig

Svar på hvert av spørsmålene nedenfor:

1. Jeg forstår raskt signaler om at noen ønsker å delta i en samtale. — Helt enig | Litt enig | Litt uenig | Helt uenig
2. Jeg synes det er vanskelig å forklare for andre noe jeg selv forstår, hvis de ikke får det med seg første gang jeg forklarer. — Helt enig | Litt enig | Litt uenig | Helt uenig
3. Jeg liker å vise andre mennesker omsorg. — Helt enig | Litt enig | Litt uenig | Helt uenig
4. Jeg synes det er vanskelig å vite hvordan jeg skal opptre i sosiale situasjoner. — Helt enig | Litt enig | Litt uenig | Helt uenig
5. Folk sier ofte til meg at jeg står for hardt på mitt i diskusjoner. — Helt enig | Litt enig | Litt uenig | Helt uenig
6. Det plager meg ikke noe særlig om jeg kommer for sent til en avtale med en venn. — Helt enig | Litt enig | Litt uenig | Helt uenig
7. Vennskap og relasjoner er så vanskelige at jeg pleier å unngå å bry meg med slikt. — Helt enig | Litt enig | Litt uenig | Helt uenig
8. Jeg synes ofte det er vanskelig å vurdere om noe er uhøflig eller høflig. — Helt enig | Litt enig | Litt uenig | Helt uenig
9. Når jeg snakker med noen, pleier jeg å fokusere mer på mine egne tanker enn på hva den jeg snakker med kanskje måtte tenke. — Helt enig | Litt enig | Litt uenig | Helt uenig

10. Da jeg var barn, likte jeg å kutte opp mark for å se hva som skjedde.	Helt enig	Litt enig	Litt uenig	Helt uenig
11. Jeg forstår raskt om noen sier en ting, men mener noe annet.	Helt enig	Litt enig	Litt uenig	Helt uenig
12. Det er vanskelig for meg å forstå hvorfor mennesker blir så ute av seg over visse ting.	Helt enig	Litt enig	Litt uenig	Helt uenig
13. Det er lett for meg å sette meg inn i en annens sted.	Helt enig	Litt enig	Litt uenig	Helt uenig
14. Jeg er god til å forutsi hva andre kommer til å føle.	Helt enig	Litt enig	Litt uenig	Helt uenig
15. Jeg oppdager raskt om noen i en gruppe føler seg utilpass eller ubekvem.	Helt enig	Litt enig	Litt uenig	Helt uenig
16. Hvis jeg sier noe som noen blir fornærmet over, mener jeg det er deres problem, ikke mitt.	Helt enig	Litt enig	Litt uenig	Helt uenig
17. Hvis noen spurte meg om jeg likte frisyren deres, ville jeg svart ærlig, selv om jeg ikke likte den.	Helt enig	Litt enig	Litt uenig	Helt uenig
18. Det er ikke alltid jeg forstår hvorfor folk blir fornærmet av en enkel bemerkning.	Helt enig	Litt enig	Litt uenig	Helt uenig
19. Jeg blir egentlig ikke noe særlig følelsesmessig berørt av å se andre gråte.	Helt enig	Litt enig	Litt uenig	Helt uenig
20. Jeg er svært direkte, noe enkelte mennesker tolker som at jeg er uhøflig, selv om jeg ikke mener å være det.	Helt enig	Litt enig	Litt uenig	Helt uenig
21. Jeg pleier ikke å synes at sosiale situasjoner er forvirrende.	Helt enig	Litt enig	Litt uenig	Helt uenig
22. Andre forteller meg at jeg er god til å forstå hvordan de tenker og føler.	Helt enig	Litt enig	Litt uenig	Helt uenig
23. Når jeg snakker med noen, snakker jeg heller om deres opplevelser og erfaringer enn om mine egne.	Helt enig	Litt enig	Litt uenig	Helt uenig
24. Det gjør meg vondt å se dyr lide.	Helt enig	Litt enig	Litt uenig	Helt uenig
25. Jeg klarer å ta beslutninger uten å la meg påvirke av andre menneskers følelser.	Helt enig	Litt enig	Litt uenig	Helt uenig
26. Jeg ser lett om en annen er interessert eller kjeder seg når jeg forteller om noe.	Helt enig	Litt enig	Litt uenig	Helt uenig

27. Jeg blir fortvilet når jeg i nyhetssendingene på TV ser mennesker som lider.	Helt enig	Litt enig	Litt uenig	Helt uenig
28. Venner betror seg ofte til meg om sine problemer og gir uttrykk for at jeg er forståelsesfull.	Helt enig	Litt enig	Litt uenig	Helt uenig
29. Jeg kan kjenne på meg om jeg trenger meg på, selv om den andre ikke forteller meg det.	Helt enig	Litt enig	Litt uenig	Helt uenig
30. Noen ganger får jeg høre av andre at jeg går for langt med ertingen min.	Helt enig	Litt enig	Litt uenig	Helt uenig
31. Andre sier ofte at jeg er lite sensitiv, men jeg forstår ikke alltid hvorfor.	Helt enig	Litt enig	Litt uenig	Helt uenig
32. Hvis det kommer en fremmed inn i en gruppe mennesker, mener jeg det er opp til den fremmede å gjøre en innsats for å bli en del av gruppen.	Helt enig	Litt enig	Litt uenig	Helt uenig
33. Jeg blir vanligvis ikke følelsesmessig berørt av å se en film.	Helt enig	Litt enig	Litt uenig	Helt uenig
34. Jeg kan raskt og intuitivt innstille meg i forhold til hvordan en annen har det.	Helt enig	Litt enig	Litt uenig	Helt uenig
35. Det er lett for meg å snappe opp hva en annen kan ha lyst til å snakke om.	Helt enig	Litt enig	Litt uenig	Helt uenig
36. Jeg merker det om noen skjuler sine egentlige følelser.	Helt enig	Litt enig	Litt uenig	Helt uenig
37. Jeg tenker ikke bevisst over hvilke regler som gjelder i sosiale situasjoner.	Helt enig	Litt enig	Litt uenig	Helt uenig
38. Jeg er flink til å forutsi hva andre kommer til å gjøre.	Helt enig	Litt enig	Litt uenig	Helt uenig
39. Jeg pleier å bli følelsesmessig engasjert når en venn har problemer.	Helt enig	Litt enig	Litt uenig	Helt uenig
40. Jeg kan vanligvis forstå andres synspunkter, selv om jeg ikke er enig i dem.	Helt enig	Litt enig	Litt uenig	Helt uenig

APPENDIX C

CAMBRIDGE ATFERDSSKALA (revidert)

Nedenfor finner du en liste av påstander. Les hver påstand nøye og vurder i hvilken grad du er enig eller uenig. Sett en ring rundt svaret du velger. Det finnes ingen riktige eller gale svar, heller ingen lurespørsmål.

1. Jeg synes det er svært enkelt å lese togtabeller, selv når jeg må kombinere tabeller for ulike strekninger.	Helt enig	Litt enig	Litt uenig	Helt uenig
2. Jeg liker platebutikker og/eller bokhandler, fordi de er ryddige og velorganiserte	Helt enig	Litt enig	Litt uenig	Helt uenig
3. Jeg ville ikke like å ha ansvaret for å organisere tilstelninger som for eksempel basarer, fester eller konferanser.	Helt enig	Litt enig	Litt uenig	Helt uenig
4. Når jeg leser noe, legger jeg alltid merke til om grammatikken er korrekt.	Helt enig	Litt enig	Litt uenig	Helt uenig
5. Jeg plasserer ofte mennesker i ulike kategorier (i mitt stille sinn).	Helt enig	Litt enig	Litt uenig	Helt uenig
6. Jeg synes det er vanskelig å lese og forstå kart.	Helt enig	Litt enig	Litt uenig	Helt uenig
7. Når jeg betrakter et fjell, tenker jeg på hvordan det ble formet i sin tid.	Helt enig	Litt enig	Litt uenig	Helt uenig
8. Jeg er ikke interessert i å ha detaljkunnskap om vekslingskurser, rentenivå og aksjekurser.	Helt enig	Litt enig	Litt uenig	Helt uenig
9. Hvis jeg skulle kjøpe bil, ville jeg skaffe meg nøyaktig informasjon om motorens ytelse.	Helt enig	Litt enig	Litt uenig	Helt uenig
10. Jeg synes det er vanskelig å lære å bruke videokameraer.	Helt enig	Litt enig	Litt uenig	Helt uenig
11. Når det er noe jeg liker, synes jeg det er gøy å samle mange ulike eksemplarer, slik at jeg kan se hvordan de er forskjellige fra hverandre.	Helt enig	Litt enig	Litt uenig	Helt uenig
12. Når jeg lærer språk, lar jeg meg fascinere av grammatikken.	Helt enig	Litt enig	Litt uenig	Helt uenig
13. Jeg liker å vite hvordan komiteer og utvalg er sammensatt, både hva komitémedlemmene står for og hvilken funksjon de har.	Helt enig	Litt enig	Litt uenig	Helt uenig

14. Hvis jeg hadde noe jeg samlet på (for eksempel CDer, mynter eller frimerker), ville samlingen min være svært godt organisert.	Helt enig	Litt enig	Litt uenig	Helt uenig
15. Jeg synes det er vanskelig å forstå bruksanvisninger som skal vise hvordan man setter sammen ting.	Helt enig	Litt enig	Litt uenig	Helt uenig
16. Når jeg betrakter en bygning, bli jeg nysgjerrig på hvordan den er konstruert.	Helt enig	Litt enig	Litt uenig	Helt uenig
17. Jeg har ingen interesse av å forstå hvordan trådløs kommunikasjon (for eksempel mobiltelefoner) fungerer.	Helt enig	Litt enig	Litt uenig	Helt uenig
18. Når jeg reiser med tog, tenker jeg ofte på hvordan nettverket av avganger og ankomster koordineres.	Helt enig	Litt enig	Litt uenig	Helt uenig
19. Jeg liker å bla gjennom produktkataloger for å studere detaljer om det enkelte produkt og hvordan det er, sammenliknet med andre produkter.	Helt enig	Litt enig	Litt uenig	Helt uenig
20. Når jeg går tom for noe i hjemmet, skriver jeg det alltid ned på handlelisten.	Helt enig	Litt enig	Litt uenig	Helt uenig
21. Jeg vet ganske nøyaktig hvor mye penger som har gått inn og ut av kontoen min denne måneden.	Helt enig	Litt enig	Litt uenig	Helt uenig
22. Da jeg var liten, var jeg ikke spesielt glad i å samle på ting som for eksempel klistremerker, fotballkort eller andre ting som det var vanlig å samle på.	Helt enig	Litt enig	Litt uenig	Helt uenig
23. Jeg er interessert i slektstreet mitt og i å forstå hvor de ulike personene hører hjemme i slektstreet.	Helt enig	Litt enig	Litt uenig	Helt uenig
24. Når jeg leser om historiske hendelser, bryr jeg meg lite om eksakte datoer.	Helt enig	Litt enig	Litt uenig	Helt uenig
25. Jeg synes det er lett å forstå hvordan oddsen fungerer i tipping.	Helt enig	Litt enig	Litt uenig	Helt uenig
26. Jeg liker ikke spill som krever høy grad av strategisk tenkning (for eksempel sjakk, Risk, Othello, bridge)	Helt enig	Litt enig	Litt uenig	Helt uenig
27. Når jeg lærer om en ny kategori, liker jeg å skaffe meg detaljkunnskap om forskjellene mellom medlemmene i kategorien.	Helt enig	Litt enig	Litt uenig	Helt uenig

28. Jeg synes ikke det er noe stort problem om de menneskene jeg lever sammen med, forstyrrer rutinene mine.	Helt enig	Litt enig	Litt uenig	Helt uenig
29. Når jeg ser et dyr, liker jeg å vite nøyaktig hvilken art det tilhører.	Helt enig	Litt enig	Litt uenig	Helt uenig
30. Jeg kan huske store mengder informasjon om emner som interesserer meg, for eksempel ulike lands flagg eller flyselskapslogoer.	Helt enig	Litt enig	Litt uenig	Helt uenig
31. Hjemme hos meg selv arkiverer jeg ikke systematisk alle viktige dokumenter som garantier eller forsikringsdokumenter.	Helt enig	Litt enig	Litt uenig	Helt uenig
32. Jeg er fascinert av hvordan maskiner virker.	Helt enig	Litt enig	Litt uenig	Helt uenig
33. Når jeg ser på et møbel, tenker jeg ikke på detaljer som handler om hvordan det ble konstruert.	Helt enig	Litt enig	Litt uenig	Helt uenig
34. Jeg vet veldig lite om de ulike stadiene en lov skal gjennom før den blir vedtatt i Norge.	Helt enig	Litt enig	Litt uenig	Helt uenig
35. Jeg pleier ikke se på TV-programmer om forskning eller lese artikler som handler om forskning og naturvitenskap.	Helt enig	Litt enig	Litt uenig	Helt uenig
36. Hvis noen stopper meg på hjemstedet mitt og spør meg om veien til ett eller annet lokalt sted, synes jeg det er lett å forklare dem det.	Helt enig	Litt enig	Litt uenig	Helt uenig
37. Når jeg ser på et maleri, tenker jeg vanligvis ikke på hvilke teknikker kunstneren brukte.	Helt enig	Litt enig	Litt uenig	Helt uenig
38. Jeg liker best sosiale aktiviteter som er strukturert rundt en aktivitet, for eksempel rundt en hobby.	Helt enig	Litt enig	Litt uenig	Helt uenig
39. Jeg sjekker ikke alltid kontoutskriftene mot bankterminal- og minibankkvitteringer.	Helt enig	Litt enig	Litt uenig	Helt uenig
40. Jeg har liten interesse av å kjenne til hvordan regjeringen og departementene er organisert.	Helt enig	Litt enig	Litt uenig	Helt uenig
41. Jeg er interessert i å kjenne veien en elv tar fra dens utspring til den renner ut i havet.	Helt enig	Litt enig	Litt uenig	Helt uenig
42. Jeg har en stor samling av noe, for eksempel bøker, CD-er, DVD-er etc.	Helt enig	Litt enig	Litt uenig	Helt uenig

43. Hvis det hadde vært noe galt med det elektriske anlegget i hjemmet mitt, ville jeg vært i stand til å reparere det selv.	Helt enig	Litt enig	Litt uenig	Helt uenig
44. Klesskapet mitt er ikke så velorganisert at samme type klær ligger samlet.	Helt enig	Litt enig	Litt uenig	Helt uenig
.				
45. Jeg leser sjelden artikler og nettsider som handler om ny teknologi.	Helt enig	Litt enig	Litt uenig	Helt uenig
46. Det er lett for meg å se for meg hvordan de største veiene i mitt fylke er knyttet sammen.	Helt enig	Litt enig	Litt uenig	Helt uenig
47. Når det er valg, er jeg ikke interessert i resultatene for de enkelte valgkretsene.	Helt enig	Litt enig	Litt uenig	Helt uenig
48. Jeg er ikke spesielt glad i å lære om fakta og tall i historien.	Helt enig	Litt enig	Litt uenig	Helt uenig
49. Jeg pleier ikke ha i hodet når personer har fødselsdag.	Helt enig	Litt enig	Litt uenig	Helt uenig
50. Når jeg går tur, er jeg interessert i å se på hvordan trær er forskjellige fra hverandre.	Helt enig	Litt enig	Litt uenig	Helt uenig
51. Jeg synes det er vanskelig å forstå informasjon fra bankene om ulike investerings- og spareformer.	Helt enig	Litt enig	Litt uenig	Helt uenig
52. Hvis jeg skulle kjøpe nytt kamera, ville jeg ikke sette meg grundig inn i kvaliteten på objektivet.	Helt enig	Litt enig	Litt uenig	Helt uenig
53. Hvis jeg skulle kjøpe meg ny PC, ville jeg skaffe meg nøyaktig informasjon om prosessorhastighet og harddiskkapasitet.	Helt enig	Litt enig	Litt uenig	Helt uenig
54. Jeg leser ikke juridiske dokumenter særlig grundig.	Helt enig	Litt enig	Litt uenig	Helt uenig
55. Når jeg kommer til kassen i supermarkedet, pakker jeg ulike kategorier varer i ulike poser.	Helt enig	Litt enig	Litt uenig	Helt uenig
56. Jeg følger ikke noe spesielt system når jeg gjør rent hjemme.	Helt enig	Litt enig	Litt uenig	Helt uenig
57. Jeg liker ikke inngående politiske diskusjoner.	Helt enig	Litt enig	Litt uenig	Helt uenig
58. Jeg er ikke særlig pirkete når jeg pusser opp hjemme.	Helt enig	Litt enig	Litt uenig	Helt uenig
59. Jeg liker ikke å planlegge ting fra start til slutt.	Helt enig	Litt enig	Litt uenig	Helt uenig

60. Hvis jeg skulle kjøpe nytt musikkanlegg, ville jeg vite alt om de tekniske finessene. Helt enig Litt enig Litt uenig Helt uenig

61. Jeg har en tendens til å spare på ting som andre ville ha kastet, i tilfelle de kan komme til nytte senere. Helt enig Litt enig Litt uenig Helt uenig

62. Jeg unngår situasjoner jeg ikke kan kontrollere. Helt enig Litt enig Litt uenig Helt uenig

63. Jeg bryr meg ikke om å kjenne navnet på plantene jeg ser rundt meg. Helt enig Litt enig Litt uenig Helt uenig

64. Når jeg lytter til værmeldingen, er jeg lite interessert i de ulike værmønstrene. Helt enig Litt enig Litt uenig Helt uenig

65. Det plager meg ikke om ting i huset ikke ligger på sin faste plass. Helt enig Litt enig Litt uenig Helt uenig

66. Når det gjelder matematikk, er jeg fascinert av reglene og systemene. Helt enig Litt enig Litt uenig Helt uenig

67. Jeg synes det er vanskelig å finne fram i en ny by. Helt enig Litt enig Litt uenig Helt uenig

68. Jeg kunne lett ramse opp mine ti favorittbøker, både titler og deres forfattere. Helt enig Litt enig Litt uenig Helt uenig

69. Når jeg leser avisen, trekkes oppmerksomheten mot det som finnes av tabeller, for eksempel over fotballresultater og aksjekurser. Helt enig Litt enig Litt uenig Helt uenig

70. Når jeg sitter på et fly, tenker jeg ikke på aerodynamikken. Helt enig Litt enig Litt uenig Helt uenig

71. Jeg fører ikke nøyaktig husholdningsregnskap. Helt enig Litt enig Litt uenig Helt uenig

72. Når jeg har mye jeg skal handle, liker jeg å planlegge hvilke butikker jeg skal gå innom og i hvilken rekkefølge. Helt enig Litt enig Litt uenig Helt uenig

73. Når jeg lager mat, tenker jeg ikke på hvordan ulike metoder og hver enkelt ingrediens bidrar til det ferdige produktet. Helt enig Litt enig Litt uenig Helt uenig

74. Når jeg hører på musikk, legger jeg alltid merke til hvordan musikken er bygd opp. Helt enig Litt enig Litt uenig Helt uenig

75. Jeg kunne lett lage en liste over mine ti favorittsanger, med titler og navn på artisten(e). Helt enig Litt enig Litt uenig Helt uenig

APPENDIX D

The Cambridge Behaviour Scale: Scoring Key

For full details, please see:

S. Baron-Cohen and S. Wheelwright, (2004)

The Empathy Quotient (EQ). An investigation of adults with Asperger Syndrome or High Functioning Autism, and normal sex differences

Journal of Autism and Developmental Disorders 34:163-175

Please note that this version for the questionnaire has 40 items as the 20 filler items discussed in the paper have been removed.

Responses that score 1 or 2 points are marked. Other responses score 0. For total score, sum all items.

		strongly agree	slightly agree	slightly disagree	strongly disagree
1.	I can easily tell if someone else wants to enter a conversation.	2	1		
2.	I find it difficult to explain to others things that I understand easily, when they don’t understand it first time.			1	2
3.	I really enjoy caring for other people.	2	1		
4.	I find it hard to know what to do in a social situation.			1	2
5.	People often tell me that I went too far in driving my point home in a discussion.			1	2
6.	It doesn’t bother me too much if I am late meeting a friend.			1	2
7.	Friendships and relationships are just too difficult, so I tend not to bother with them.			1	2
8.	I often find it difficult to judge if something is rude or polite.			1	2
9.	In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.			1	2
10.	When I was a child, I enjoyed cutting up worms to see what would happen.			1	2
11.	I can pick up quickly if someone says one thing but means another.	2	1		
12.	It is hard for me to see why some things upset people so much.			1	2
13.	I find it easy to put myself in somebody else’s shoes.	2	1		
14.	I am good at predicting how someone will feel.	2	1		

		strongly agree	slightly agree	slightly disagree	strongly disagree
15.	I am quick to spot when someone in a group is feeling awkward or uncomfortable.	2	1		
16.	If I say something that someone else is offended by, I think that that's their problem, not mine.			1	2
17.	If anyone asked me if I like their haricut, I would reply truthfully, even if I didn't like it.			1	2
18.	I can't always see why someone should have felt offended by a remark.			1	2
19.	Seeing people cry doesn't really upset me.			1	2
20.	I am very blunt, which some people take to be rudeness, even though this is unintentional.			1	2
21.	I don't tend to find social situations confusing	2	1		
22.	Other people tell me I am good at understanding how they are feeling and what they are thinking.	2	1		
23.	When I talk to people, I tend to talk about their experiences rather than my own.	2	1		
24.	It upsets me to see animals in pain.	2	1		
25.	I am able to make decisions without being influenced by people's feelings.			1	2
26.	I can easily tell if someone else is interested or bored with what I am saying.	2	1		
27.	I get upset if I see people suffering on news programmes.	2	1		
28.	Friends usually talk to me about their problems as they say I am very understanding.	2	1		
29.	I can sense if I am intruding, even if the other person doesn't tell me.	2	1		
30.	People sometimes tell me that I have gone too far with teasing.			1	2
31.	Other people often say that I am insensitive, though I don't always see why.			1	2
32.	If I see a stranger in a group, I think that it is up to them to make an effort to join in.			1	2
33.	I usually stay emotionally detached when watching a film.			1	2
34.	I can tune into how someone else feels rapidly and intuitively.	2	1		

35.	I can easily work out what another person might want to talk about.	2	1		
		strongly agree	**slightly agree**	**slightly disagree**	**strongly disagree**
36.	I can tell if someone is masking their true emotion.	2	1		
37.	I don’t consciously work out the rules of social situations.	2	1		
38.	I am good at predicting what someone will do.	2	1		
39.	I tend to get emotionally involved with a friend’s problems.	2	1		
40.	I can usually appreciate the other person’s viewpoint, even if I don’t agree with it.	2	1		

APPENDIX E

Revised Cambridge Personality Questionnaire: Scoring Key

For full details, please see:

S. Wheelwright, S. Baron-Cohen, N. Goldenfeld, J. Delaney, D. Fine, R. Smith, L. Weil and A. Wakabayashi, (2006)
Predicting Autism Spectrum Quotient (AQ) from the Systemizing Quotient-Revised (SQ-R) and Empathy Quotient (EQ)
Brain Research 1079:47-56

Responses that score 1 or 2 points are marked. Other responses score 0. For total score, sum all items.

		strongly agree	slightly agree	slightly disagree	strongly disagree
1.	I find it very easy to use train timetables, even if this involves several connections.	2	1		
2.	I like music or book shops because they are clearly organised.	2	1		
3.	I would not enjoy organising events e.g. fundraising evenings, fetes, conferences.			1	2
4.	When I read something, I always notice whether it is grammatically correct.	2	1		
5.	I find myself categorising people into types (in my own mind).	2	1		
6.	I find it difficult to read and understand maps.			1	2
7.	When I look at a mountain, I think about how precisely it was formed.	2	1		
8.	I am not interested in the details of exchange rates, interest rates, stocks and shares.			1	2
9.	If I were buying a car, I would want to obtain specific information about its engine capacity.	2	1		
10.	I find it difficult to learn how to programme video recorders.			1	2
11.	When I like something I like to collect a lot of different examples of that type of object, so I can see how they differ from each other.	2	1		
12.	When I learn a language, I become intrigued by its grammatical rules.	2	1		
13.	I like to know how committees are structured in terms of who the different committee members represent or what their functions are.	2	1		
14.	If I had a collection (e.g. CDs, coins, stamps), it would be highly organised.	2	1		

		strongly agree	slightly agree	slightly disagree	strongly disagree
15.	I find it difficult to understand instruction manuals for putting appliances together.			1	2
16.	When I look at a building, I am curious about the precise way it was constructed.	2	1		
17.	I am not interested in understanding how wireless communication works (e.g. mobile phones).			1	2
18.	When travelling by train, I often wonder exactly how the rail networks are coordinated.	2	1		
19.	I enjoy looking through catalogues of products to see the details of each product and how it compares to others.	2	1		
20.	Whenever I run out of something at home, I always add it to a shopping list.	2	1		
21.	I know, with reasonable accuracy, how much money has come in and gone out of my bank account this month.	2	1		
22.	When I was young I did not enjoy collecting sets of things e.g. stickers, football cards etc.			1	2
23.	I am interested in my family tree and in understanding how everyone is related to each other in the family.	2	1		
24.	When I learn about historical events, I do not focus on exact dates.			1	2
25.	I find it easy to grasp exactly how odds work in betting.	2	1		
26.	I do not enjoy games that involve a high degree of strategy (e.g. chess, Risk, Games Workshop).			1	2
27.	When I learn about a new category I like to go into detail to understand the small differences between different members of that category.	2	1		
28.	I do not find it distressing if people who live with me upset my routines.			1	2
29.	When I look at an animal, I like to know the precise species it belongs to.	2	1		
30.	I can remember large amounts of information about a topic that interests me e.g. flags of the world, airline logos.	2	1		
31.	At home, I do not carefully file all important documents e.g. guarantees, insurance policies			1	2
32.	I am fascinated by how machines work.	2	1		
33.	When I look at a piece of furniture, I do not notice the details of how it was constructed.			1	2

		strongly agree	slightly agree	slightly disagree	strongly disagree
34.	I know very little about the different stages of the legislation process in my country.			1	2
35.	I do not tend to watch science documentaries on television or read articles about science and nature.			1	2
36.	If someone stops to ask me the way, I'd be able to give directions to any part of my home town.	2	1		
37.	When I look at a painting, I do not usually think about the technique involved in making it.			1	2
38.	I prefer social interactions that are structured around a clear activity, e.g. a hobby.	2	1		
39.	I do not always check off receipts etc. against my bank statement.			1	2
40.	I am not interested in how the government is organised into different ministries and departments.			1	2
41.	I am interested in knowing the path a river takes from its source to the sea.	2	1		
42.	I have a large collection e.g. of books, CDs, videos etc.	2	1		
43.	If there was a problem with the electrical wiring in my home, I'd be able to fix it myself.	2	1		
44.	My clothes are not carefully organised into different types in my wardrobe.			1	2
45.	I rarely read articles or webpages about new technology.			1	2
46.	I can easily visualise how the motorways in my region link up.	2	1		
47.	When an election is being held, I am not interested in the results for each constituency.			1	2
48.	I do not particularly enjoy learning about facts and figures in history.			1	2
49.	I do not tend to remember people's birthdays (in terms of which day and month this falls).			1	2
50.	When I am walking in the country, I am curious about how the various kinds of trees differ.	2	1		
51.	I find it difficult to understand information the bank sends me on different investment and saving systems.			1	2
52.	If I were buying a camera, I would not look carefully into the quality of the lens.			1	2

		strongly agree	slightly agree	slightly disagree	strongly disagree
53.	If I were buying a computer, I would want to know exact details about its hard drive capacity and processor speed.	2	1		
54.	I do not read legal documents very carefully.			1	2
55.	When I get to the checkout at a supermarket I pack different categories of goods into separate bags.	2	1		
56.	I do not follow any particular system when I'm cleaning at home.			1	2
57.	I do not enjoy in-depth political discussions.			1	2
58.	I am not very meticulous when I carry out D.I.Y or home improvements.			1	2
59.	I would not enjoy planning a business from scratch to completion.			1	2
60.	If I were buying a stereo, I would want to know about its precise technical features.	2	1		
61.	I tend to keep things that other people might throw away, in case they might be useful for something in the future.	2	1		
62.	I avoid situations which I can not control.	2	1		
63.	I do not care to know the names of the plants I see.			1	2
64.	When I hear the weather forecast, I am not very interested in the meteorological patterns.			1	2
65.	It does not bother me if things in the house are not in their proper place.			1	2
66.	In maths, I am intrigued by the rules and patterns governing numbers.	2	1		
67.	I find it difficult to learn my way around a new city.			1	2
68.	I could list my favourite 10 books, recalling titles and authors' names from memory.	2	1		
69.	When I read the newspaper, I am drawn to tables of information, such as football league scores or stock market indices.	2	1		
70.	When I'm in a plane, I do not think about the aerodynamics.			1	2
71.	I do not keep careful records of my household bills.			1	2
72.	When I have a lot of shopping to do, I like to plan which shops I am going to visit and in what order.	2	1		

		strongly agree	slightly agree	slightly disagree	strongly disagree
73.	When I cook, I do not think about exactly how different methods and ingredients contribute to the final product.			1	2
74.	When I listen to a piece of music, I always notice the way it's structured.	2	1		
75.	I could generate a list of my favourite 10 songs from memory, including the title and the artist's name who performed each song.	2	1		