DIPLOMARBEIT

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“Attribution und
sozial-kognitive Neurowissenschaften:
Effekte differenzieller Ursachenwahrnehmung auf die
Fehlerverarbeitung“

Verfasserin

Sylvia Terbeck

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1) EINLEITUNG

Seit den 80er Jahren, vor allem durch die methodische Weiterentwicklung von bildgebenden Verfahren, hat sich mit „Social Cognitive Neuroscience“ ein neuer Forschungsbereich entwickelt. In diesem Forschungsbereich geht es um die integrative Verbindung von kognitiven und sozialpsychologischen Theorien mit den Neurowissenschaften (Easton & Emery, 2005). Derzeit ist der Bereich der „Social Cognitive Neuroscience“ sehr populär. Dadurch ist ein enormer Anstieg von Publikationen zu diesem Thema zu konstatieren (Easton & Emery, 2005). Auch Zeitschriften – z. B. „Social Cognititve and Affective Neuroscience“ und „Social Neuroscience“ - sind für dieses neue Forschungsfeld aufgelegt worden.

Durch die Etablierung der „Social Cognitive Neuroscience“ entsteht aber auch eine Reihe methodischer Probleme. So verweisen Easton & Emery (2005) darauf, dass sogar sehr einfach erscheinende Prozesse (wie z. B. visuelle Wahrnehmung) auf neuronaler Ebene von einem komplexen Netzwerk mit über 50 kortikalen Arealen und Billionen von Neuronen gesteuert werden. Wie würde das nun aussehen, wenn man die neuronalen Grundlagen von sozialen Konzepten untersuchen würde?

Die Untersuchung interpersoneller Interaktionen und menschlicher sozialer Prozesse ist äußerst kompliziert. Selbst moderne Methoden bildgebender Verfahren und Primatenstudien können hierbei nur teilweise Einblicke geben.

Bisher sind die Methoden der sozial-kognitiven Neurowissenschaften zumeist begrenzt auf die Verwendung von visuellen sozialen Reizen oder die Beantwortung von Fragebögen, die während einer fMRI- oder EEG-Messung präsentiert werden. Die ökologische Validität solcher Methoden ist stark reduziert, da das *tatsächliche Erlebnis der natürlichen Situation* in diesen artifiziellen Situationen nicht gegeben ist. In Zukunft könnte durch die Weiterentwicklung von portablen EEG-Systemen (portable MRI-Scanner wird es nicht geben!) oder von mit dem Internet verbundenen Kameras das experimentelle Design von sozial-neurowissenschaftlichen Studien verbessert werden.

Die Problematik der ökologischen Validität soll in dieser Diplomarbeit auch als zentraler Aspekt angesprochen werden. Im ersten Manuskript wird von einem experimentellen Design berichtet, welches eine natürliche Situation simuliert. Es wird dadurch versucht, dem realen Erleben des sozial-kognitiven Konzeptes während der Registrierung von Hirnaktivitäten näher zu kommen.

Ein anderer methodischer Aspekt, der in der folgenden Arbeit behandelt werden soll, befasst sich mit einem Problem, welches Adolphs (2003) in seinem einflussreichen Review über die zehn zentralen Fragen sozial-kognitiver Neurowissenschaften schildert. Bei sozialen Phänomenen gibt es sehr viele verschiedenen Faktoren (Mediatorvariablen), die ausgeschlossen oder kontrolliert werden müssen (Adolphs, 2003). Nach Adolphs (2003) ist es sehr schwierig, alle diese Faktoren zu berücksichtigen. Dies kann dazu führen, dass viele Studien nicht signifikante Ergebnisse aufweisen. Das im Folgenden geschilderte experimentelle Design soll auch eine Möglichkeit liefern, ein soziales Konzept so zu erfassen, dass viele medierende Variablen kontrolliert oder ausgeschlossen werden können.

Neben den methodischen Aspekten werden in den folgenden Artikeln auch die Effekte von Attribution auf ereigniskorrelierte Potenziale betrachtet.

Attribution, definiert als die wahrgenommene Ursache von Ereignissen (Stroebe et al, 2003), ist seit den 60er Jahren ein zentrales Konzept in der Sozialpsychologie. Schon 1958 postulierte Heider, dass Menschen – ähnlich einem Wissenschaftler – geneigt sind, Ereignissen Ursachen zuzuschreiben, um Unsicherheit zu reduzieren. Heider (1958) unterschied hierbei zwischen externer und interner Attribution; also einer Ursache inner- oder außerhalb der Person. Bezogen auf den Leistungskontext und basierend auf Methoden der multidimensionalen Skalierung (Passer et al, 1978), entwickelte Weiner (1985) eine Klassifikation, welche einer 2x2x2 orthogonalen Taxonomie mit bipolarem Kontinuum pro Dimension entspricht. Weiner (1985) nannte hier die drei Dimensionen: Lokation, Stabilität und Kontrollierbarkeit. Lokation (intern/extern) beschreibt den „Ort“ der Ursache, während sich Stabilität (stabil/variabel) auf die zeitliche Struktur der Ursache bezieht. Kontrollierbarkeit (kontrollierbar/unkontrollierbar) weist auf den Grad des willentlichen Einflusses der Ursache hin.

Attribution hat bisher in den sozial-kognitiven Neurowissenschaften noch wenig Beachtung gefunden. In der folgenden Studie werden ereigniskorrelierte Potenziale betrachtet, die im Zusammenhang mit Entscheidungsfindung und der Überwachung von Aktivitäten stehen. Es geht also im weiteren Sinne auch um Funktionen, welche dem anterioren cingulären Kortex (ACC) zuzuschreiben sind (Bush et al, 2000).

Der ACC, welcher anatomisch im medialen Teil des Frontallappens anzusiedeln ist, ist auch Teil des limbischen Systems. Generell ist der ventromediale präfrontale Kortex von seiner funktionellen Anatomie her eine wesentliche Struktur für „höhere" soziale Funktionen (klassisch hierzu: der Fall „Phineas Gage") und auch für die Integration von Emotion und Kognition (Damasio, 1994). In ihrem populären Review berichtete Brothers (1990) auf Basis von Studien der Neurowissenschaften, Neurophysiologie, Neuropathologie und Primatenstudien über neuronale Strukturen, welche für soziale Interaktionen und Konzepte relevant sind. Unter dem Begriff „social brain" nannte Brothers hier den anterioren temporalen Kortex, den Temporalpol, Kerne der Amygdala und den orbitofrontalen Kortex. Zahlreiche Studien beschäftigen sich in diesem Zusammenhang mit der spezifischeren Bestimmung präfrontaler Aktivierungen und sozialer Konzepte. Abbildung 1 gibt einen Überblick über die funktionelle Anatomie sozialer Funktionen des präfrontalen Kortex.

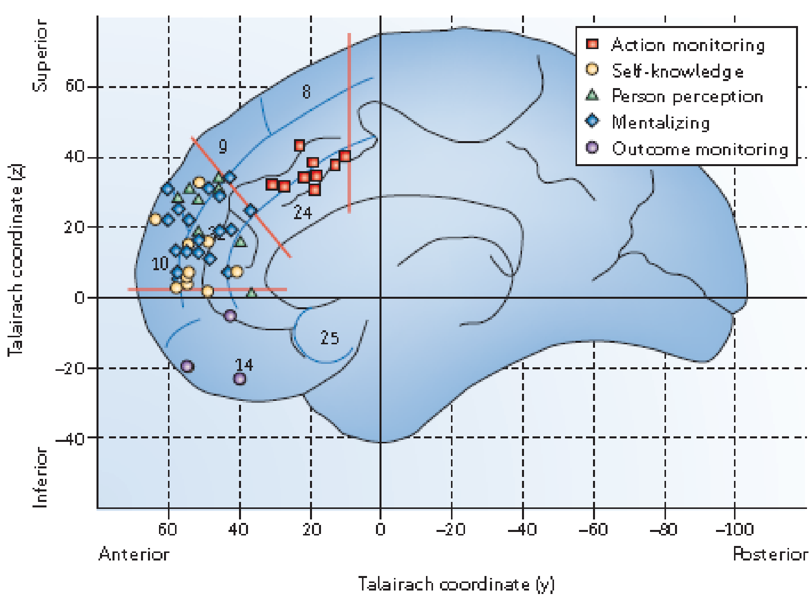

Abbildung 1: Funktionale Anatomie sozialer Funktionen des medialen präfrontalen Kortex (aus: Amodio & Frith, 2006).

Für die Studie dieser Arbeit wurde die EEG-Methode (bzw. die Auswertung von ereigniskorrelierten Potenzialen) verwendet. Es wird daher hier auch kurz auf die generellen Grundlagen einer EEG-Messung eingegangen.

Die Methodik zur Untersuchung von Hirnaktivitäten hat ihre Anfänge erst in diesem Jahrhundert. Dass im Nervensystem Informationen elektrisch weitergeleitet werden, also Stromfelder entstehen, wurde erstmals durch die berühmten Froschschenkelexperimente von Luigi Galvani (1737-1789) bekannt (Birbaumer & Schmidt, 2006).

Bei der EEG-Methode geht es um die Registrierung der elektrischen Hirnaktivität. Der Vorteil einer EEG-Messung - im Vergleich zu bildgebenden Verfahren - liegt in einer höheren zeitlichen Auflösung. Trotz Weiterentwicklung durch Programme, welche aufgrund bio-physikalischer Modelle die Quellen der Hirnaktivität bei EEG-Messungen berechnen können, unterliegt die räumliche Auflösung des EEGs der von bildgebenden Verfahren. Um den spezifischen Zusammenhang von Verhalten (in dieser Studie: Begehen eines Fehlers) und den korrelierenden Hirnaktivitäten zu ermitteln, wurden die EEG-Daten nach ereigniskorrelierten Potenzialen (EKP) ausgewertet.
Im Gegensatz dazu würden bei einer Frequenzanalyse unabhängig vom onset eines Ereignisses Amplitude und Zeit verrechnet. Durch den zeitlichen Bezug zu dem spezifischen Ereignis können bei der EKP-Analyse Komponenten (Amplituden charakteristischer Stärke und zeitlicher Bezogenheit zum Ereignis) durch die Mittlung der zeitbezogenen EEG-Registrierung aus zufälligem Rauschen extrahiert werden.

Allgemein werden beim EEG Feldaktivitäten von Zellensembles in kortikalen (hier vor allem Pyramidenzellen) aber auch in subkortikalen Arealen registriert. Birbaumer und Schmidt (2006) beschreiben, dass ein EEG-Signal aus exzitatorischen postsynaptischen Potenzialen (EPSP) an apikalen Dendriten der 1. und 2. kortikalen Schicht entsteht. Gemeint sind hier die Pyramidenzellen des Kortex, welche in einer charakteristischen Weise angeordnet sind. Die Dendriten dieser Zellen liegen in den schädelnäheren Kortexschichten, während die Zellkörper in relativ tieferen Schichten angesiedelt sind. Bei der Entstehung von EPSPs an den apikalen Dendriten durch exitatorische Fasern aus u. a. unspezifischen thalamischen Kernen kommt es durch die räumliche Ausrichtung der Pyramidenzellen zu einer Dipolstruktur.

Das EPSP löst im Extrazellulärraum um die Dendriten ein negatives Feldpotenzial (Senke) aus, während der Extrazellulärraum der Zellkörper positive Feldladung zeigt (Quelle). Registriert werden mit den Schädelelektroden also elektrische Spannungsschwankungen, welcher durch Feldpotenziale umgekehrter Polarität (Dipolstruktur) in der Großhirnrinde entstehen bzw. aus subkortikalen Schichten weitergeleitet werden. Diese Signale müssen verstärkt werden, da Schädelknochen und Kopfhaut eine dämpfende Wirkung ausüben. Bei der Analyse wird dann durch Mittelung das Signal vom Rauschen getrennt und es werden irrelevante Frequenzen wie auch Artefakte eliminiert.

Überblick über die folgenden Artikel

Die Arbeit wird sich mit zwei Aspekten der sozial-kognitiven Neurowissenschaften beschäftigen:

(1) Experimentelles Design von neurowissenschaftlichen Studien zum Thema Attribution.

(2) Auswirkung von Attribution auf ereigniskorrelierte Potenziale.

Der erste Artikel behandelt - neben einer ausführlichen Darstellung klassischer sozialpsychologischer Studien zum Thema Leistungsattribution und Erkenntnissen der Neurowissenschaften zum Attributionsthema - auch methodische Aspekte neurowissenschaftlicher Forschung. Insbesondere sollen auch die Besonderheiten von experimentellen Arrangements bei der neurowissenschaftlichen Untersuchung von höheren sozialen Prozessen betrachtet werden. Es wurde von mir ein neues experimentelles Paradigma entwickelt und evaluiert, welches eine optimale Vorgehensweise bietet, um Attributionsprozesse neurowissenschaftlich erfassen zu können.

Mittels der neu entwickelten Methode werden im zweiten Artikel die Auswirkungen von Attribution auf ereigniskorrelierte Potenziale untersucht. Es wird deutlich werden, wie Erkenntnisse aus der klassischen Sozialpsychologie auf Phänomen auf neuronaler Ebene übertragen werden können. Drei frühe ereigniskorrelierte Komponenten (error related negativity (ERN), feedback error related negativity (fERN), P300) werden in der Studie betrachtet. Die ERN und eine frontomediale Negativierung nach Feedback onset (fERN) sind im Zusammenhang mit der Fehler- und der Feedbackverarbeitung in zahlreichen elektrophysiologischen Studien beobachtet worden (Hajcak et al, 2005; Larson et al, 2006; Luu et al, 2003; Masaki et al, 2006; Pailing & Segalowitz, 2003; Ulsberger et al, 2006). Studien zeigten, dass die Komponenten durch den individuellen Wert und die Wichtigkeit des Fehlers für die Personen beeinflussbar sind (Boksem, 2006; Hajack et al, 2005; Luu & Tucker, 2000; Pailing & Segalowith, 2003;). Es ist zu vermuten, dass Lerneffekte (eine spätere Verhaltens-modifikation durch Fehlerdetektion) nur dann stattfinden, wenn der Fehler für die Personen relevant ist. Ist eine Person zum Beispiel nicht motiviert oder zeigt eine klinische Störung bzw. eine Extremausprägung einer Persönlichkeitseigenschaft, die dazu führen, dass sie Fehler als weniger wichtig annimmt, dann zeigt sich eine reduzierte Amplitude der ERN (Hajcak et al, 2005; Larson et al, 2006; Luu et al, 2003; Masaki et al, 2006; Pailing & Segalowitz, 2003; Ulsberger et al, 2006).

Für die fERN gilt allerdings dabei die Besonderheit, dass sich der motivational-emotionale Einfluss wahrscheinlich nicht in der Amplitude (Hajcak et al, 2005) - *sondern in der Auslösung* - dieser Komponente zeigt. Luu & Tucker (2000) haben herausgefunden, dass eine fERN nach Feedback entstanden ist, wenn das Feedback keinen informativen, aber einen emotionalen Wert hat.

Daraus abgeleitet habe ich mich in meiner Diplomarbeit mit dem Einfluss von Attribution auf die ERN und die fERN befasst. Basierend auf Erkenntnissen der Sozialpsychologie - dass externe Attributionen die Verantwortung und damit auch den Wert des Fehlers reduzieren - wurde die Hypothese untersucht, ob unterschiedlich wahrgenommene Ursachen des Fehlers (intern vs. extern) einen Effekt auf die ERN und fERN haben. Demzufolge wurde für die ERN bei interner Attribution eine höhere Amplitude erwartet als bei externe Attribution. Eine fERN wurde nur für die interne Bedingung erwartet, da nur hier das Feedback einen emotionalen Wert hat.

Wie erwartet zeigte sich in den gemittelten EEG-Daten nur für die interne Bedingung eine fERN Komponente, was die Annahme von Luu & Tucker (2000) bestätigt, dass eine fERN auch durch einen emotionalen Wert des Fehlers entstehen kann. Für die ERN ließen sich keine Unterschiede in den Attributionsbedingungen feststellen. In der externen Bedingung war zusätzlich die P300 reduziert, was ebenfalls darauf hindeutet, dass für die extern attribuierenden Versuchspersonen der Fehler und das Feedback weniger „Wert“ hatten.

Diese Studie stellt damit die erste Arbeit dar, die sich mit den Auswirkungen von Attribution auf ereigniskorrelierte Potenziale beschäftigt. Sie soll dazu anregen, das Attributionskonzept ebenfalls auf neuronaler Ebene zu betrachten, da Attribution ein wesentliches Phänomen ist, welches sich auf Verhalten, Emotion und Kognition - aber auch auf primäre Prozesse wie Wahrnehmung - auswirken kann.

Statt einer klassischen Schilderung der Arbeit werden in dieser Diplomarbeit zwei von mir erstellte Artikel präsentiert, welche beide zur Publikation an Fachzeitschriften gesendet worden sind. Die erste Arbeit ist bereits im „Journal of Neuroscience Methods“ 173 (1), 13-19 veröffentlicht.

Anmerkung zu dieser Arbeit:
Die entsprechenden Literaturangaben und Hinweise auf zusätzliche Materialien im Anhang befinden sich jeweils am Ende eines Kapitels.

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2) Manuscript A:

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Attribution and Social Cognitive Neuroscience:
A new approach for the "online -assessment" of causality ascriptions and their emotional consequences.

Sylvia Terbeck [1]*
Paul Chesterman[2]
Florian Ph. S Fischmeister[1]
Ulrich Leodolter[1]
Herbert Bauer[1]

[1] Department of Clinical, Biological and Differential Psychology, University of Vienna, Liebiggasse 5, A-1010 Vienna, Austria

[2] School of Psychology, University of Wales Bangor, Adeilad Brigantia, Gwynedd LL57 2AS, UK

*Corresponding author:
Sylvia Terbeck, Department of Clinical, Biological and Differential Psychology, University of Vienna, Liebiggasse 5, A-1010 Vienna, Austria; Phone: +43-1-4277-47803; Fax: +43-1-4277-47939; E-Mail: sylviaterbeck@web.de

Abstract

Attribution Theory plays a central role in understanding cognitive processes that have emotional consequences; however, there has been very limited attention to its neural basis. After reviewing classical studies in social psychology in which attribution has been experimentally manipulated we developed a new approach that allows the investigation of state attributions and emotional consequences using neuroscience methodologies. Participants responded to the Erikson Flanker Task, but, in order to maintain the participant's beliefs about the nature of the task and to produce a significant number of error responses, an adaptive algorithm tuned the available time to respond such that, dependent on the subject's actual performance, the negative feedback rate was held at chance level. In order to initiate variation in attribution participants were informed that one and the same task was either easy or difficult. As a result of these two different instructions the two groups differed significantly in error attribution only on the locus of causality dimension. Additionally, attributions were found to be stable over a large number of trials, while accuracy and reaction time remained the same. Thus, the new paradigm is particularly suitable for cognitive neuroscience research that evaluates brain behavior relationships of higher order processes in 'simulated achievement settings'.

Keywords: Causality Ascription, Manipulation of Attribution, Social Cognitive Neuroscience, Moral Emotions

1. Introduction

Social Psychology and Neuroscience have developed primarily independently, however, more recently, studies using combined methodologies and theoretical approaches have begun to elucidate the neural basis of social cognition. This has been referred to as Social Cognitive Neuroscience (for comprehensive reviews see Adolphs, 2001 or Amodio and Frith, 2006). There has been, however, very limited investigation of the neural bases of attributions, even though they have been shown to interact with numerous psychological variables including emotion (Mc Farland and Ross, 1983), self-esteem (Borckner and Guare, 1983), expectations (Phares, 1957) and motivation (Rotter, 1954), as well as behavior and learning (Wasserman, 1990). This may in part be due to the lack of a reliable method to experimentally manipulate attribution, which also can fulfill the task demands of cognitive neuroscience studies.

Heider (1958), developing ideas derived from classical philosophy and Gestalt psychology (Foersterling, 2001), formulated the concept of causal attribution, which is defined as the process of arriving at perceived causes of someone's own and other people's behavior (Weiner, 1992). Insights gained from attribution theory have been applied to a variety of research domains such as health psychology (Taylor, 1983) and personality styles (Rotter, 1954) as well as clinical (Foersterling, 1988), educational (Weiner, 1979), and organizational psychology (Folkes, 1990). Since the approach we developed addresses beliefs about someone's own failure and success, we will focus on attributions in the achievement context.

Weiner's analysis of achievement behavior (Weiner et al, 1971), based on the work of Heider (1958), Kelley (1967), and Rotter (1954) remains an influential model (Foersterling, 2001). In European societies four causes are most frequently used to account for success or failure; ability, effort, difficulty and chance (e.g. Elig and Frieze, 1979; Weiner, 1992). Based on previous research using multidimensional scaling and factor analysis Passer et al., 1978 and Weiner (1985) developed a classification of perceived causes of effects according to a 2×2×2 orthogonal taxonomy with a bipolar continuum for each dimension; internal/external causality (the location of causality), stability/instability (the temporal nature of the cause) and controllability/uncontrollability (the degree of volitional control).

Weiner suggested that aptitude attributions are internal, stable, and uncontrollable, whereas attributions to task characteristics are external, stable, and uncontrollable. Futhermore he suggested that temporary effort ascriptions are internal, unstable, and controllable, whilst chance attributions are external, unstable, and uncontrollable.

1.1. Manipulation of Attribution

How stimulus information influences causal thinking, depends on the information (causes) individuals are provided with and the degree to which the possible causes co-vary with the effect (Kelley, 1967; Foersterling, 2001). Based on numerous studies (e.g. Phares, 1957; Weiner and Kulka, 1970; Meyer, 1973) Weiner (1992) concluded that consistency (variance of the effect over circumstances), consensus (variance of the effect between people), perceived task characteristics and task structure were the main determinants of whether success or failure was ascribed to either the individual's ability or the task's difficulty. Weiner and Kulka (1970) examined the effect of consensus information on causality ascriptions. Participants were provided with information about the task outcome of a fictitious person and the social norm (rate of success of a large sample). The results demonstrated that increased consistency between the performance of the fictitious person and other individuals led to more external attributions (such as task characteristics). However, the importance of consensus information remains uncertain (for a discussion see Foersterling, 2001).

Providing different information with the intention to modify ascriptions has been investigated since the early phase of attribution theory. Phares (1957) first changed outcome ascriptions by introducing an ambiguous task, in which success was attributed to either chance or ability. The 'skill' instruction described the task as being difficult but solvable dependent on the participant's ability whereas the 'chance' instruction described the task as being extremely difficult and solvable at pure chance level. Phares's results demonstrated that expectancy of success or failure was closely linked to 'skill' and 'chance' beliefs. A number of studies have shown that changes in expectancy correlate with the stability dimension, independently of the location of causality dimension (e.g. Meyer, 1973). Furthermore, changes in the stability more than the locus of causality dimension influence performance quality (Meyer, 1973).

However, the use of gambling tasks (a classical paradigm for chance dependent tasks) has been described as problematic for inducing causality ascriptions; individuals tend to misconceive gambling tasks as being ability dependent, i.e. attribute them internally rather than externally (e.g. Wortmann, 1975). In order to ensure that experimental manipulation of the locus of causality dimension has the desired effect and to avoid confounding this with the stability/instability dimension, changes in expectancy and performance should be equal for external and internal attributions.

Based on these experimental findings, manipulation of perceived causality has also been used in therapeutic approaches (for an overview see: Foersterling, 1985, Foersterling, 1988). In a therapeutically oriented ’reattribution’ approach Brockner and Guare (1983) investigated whether individuals with low self-esteem can improve task performance when causal ascriptions to task difficulty were introduced. They asked two groups of participants to work on an insolvable concept formation task. Before starting the task subjects in the experimental group were presented with fake information on the performance of ’previous subjects’. For the ‘external group’ the information described the task as relatively difficult, by showing that ’previous participants’ did very poorly, whereas the task was described as relatively easy for the ‘internal group’. Brockner and Guare could demonstrate that the information on social norms combined with that of task characteristics successfully modified the subject’s attributions for task failure. In addition, as predicted, low self-esteem individuals improved their performance in the external manipulation group.

More recently, using the CDS-II (The revised Causal Dimension Scale, Mc Auley et al, 1992) questionnaire for manipulation check, Van Dyck and Homsma (2005) found that, although 93% of their participants recognized ’time pressure’ as an obvious cause of errors, 19% attributed their performance failure to internal causes (e.g. ‘not enough time for me’) rather than to external ones. They assumed that even when people agree with an external cause, they might not necessarily form an external attribution. This highlights the problem of measuring attribution when only a ’concrete’ cause is offered. To avoid this problem, Homsma et al. (2007) gave ’explicit instructions’ in order to manipulate attribution. They told their subjects to think about possible causes for errors and to attribute them to internal, external, stable or unstable causes. Although subjects appeared to make attributions as expected, they might have, by being compliant, been following these instructions but not been truly generating these attributions.

Cognitive Neuroscience and Attribution

More recently, attribution has been investigated with neuroscience approaches (Lieberman et al., 2002; Blackwood et al., 2003; Harris et al., 2005). According to the causality of observed behavior Liebermann et al. (2002) described a possible neural system that would underlie the dual process model of attribution. The authors distinguished between a reflective system and a reflexive system, which they postulated had a different neuro-anatomical basis. In this model automatic initial dispositional attributions are produced by the reflexive system, whereas the reflective system is responsible for propositional thoughts; on the neural level the lateral temporal cortex, including the superior temporal sulcus (STS), parts of the temporal lobes, and the temporal poles (as part of the reflexive system) may be responsible for processing the information involved in dispositional attributions. To further investigate this model Harris et al. (2005), using fMRI and an experimental paradigm based on Kelley's attribution theory, found activity in the STS associated with person attributions (internal attribution of observed behavior). The authors speculated that dispositional ascriptions of other people's behavior might recruit parts of the neuronal circuits associated with "Theory of Mind".

However, whether ascriptions of someone's own behavior activate the same neural circuits is uncertain, since no judgment of observed behavior is required. There appears to be only one brain imaging study that investigated self ascriptions. Seeking to identify the neural systems involved in self serving biases (external attribution of negative events and internal attributions for positive events) and self responsibility, Blackwood et al. (2003) found activity in the left lateral cerebellar hemisphere, bilaterally in the pre-motor cortex, and the right lingual gyrus, when individuals reported internal attributions of experienced positive and negative events (self responsibility). In contrast, external attributions (ascribing effects to other people or outside causes) resulted in activation of the STS. That STS activity was found with external attributions is notable, since it supports the involvement of the STS in ascribing events to other people's dispositions or responsibility. The authors also assumed that the brain activity associated with self responsibility is related to 'simpler internal models of goal-directed action'. In addition, self serving vs. non-self serving biases yielded different brain activation patterns. The authors used ten statements of the IPSAQ (Internal, Personal, and Situational Attributions Questionnaire) to which participants responded to during the fMRI scan. However the authors realized that the methodology resulted in a small number of described external attributions and a limited variety of ascriptions in some subjects resulting in several data sets being discarded.

That very few studies have investigated attribution with neuroscience methodologies may in part be due to the problem of high-level social cognition eliciting brain activation patterns that reflect a number of confounding variables, limiting interpretation of the findings (Kok et al., 2006). Cacioppo et al., (2003) stated that when using subtractive techniques for imaging data, the interpretations of the subtracted images depends on the different task demands between the experimental and the control condition which may not reflect a single psychological variable. In addition, Cacioppo et al. observed that using the subtractive method requires that the information processing is linear and additive which may not hold for complex social phenomena.

1.2. The present study

The aim of the present study was to develop an experimental design that enables both, the manipulation of causal ascriptions of one's own behavior in 'a real-life achievement context', and its concurrent application with cognitive neuroscience methods, e.g. EEG or fMRI. We used a modified, speeded, arrowhead version of the Erikson Flanker Task (Erikson and Erikson, 1974). Since a Flanker task has often been used in electrophysiological research (e.g. Fiehler et al., 2005) task demands for electroencephalogram (EEG) data analysis are given. A large number of erroneous and correct trials, under all conditions, allows for the use of averaging techniques. Although fMRI does not have the same time resolution as electrophysiological responses, a Flanker Task can still be utilized in imaging studies. Ullsperger and Cramon (2001) developed an interleaved design for image acquisition, to improve temporal resolution with a flanker task. We hypothesized that a Flanker Task could be adapted so that it would be perceived as either an "easy concentration test" or as a "very difficult task" resulting in different attributions for success or failure providing an adequate task structure to modify causal ascriptions (Weiner, 1992).

Based on Fiehler et al. (2005) we developed an adaptive algorithm, aiming to deliver negative (for late and error responses) and positive feedback at about chance level. This was required to achieve equal performance levels in the different groups and to correct for individual differences. Additionally, we expected instructions (such as; the task is easy vs. difficult) to be quite plausible in an ambiguous situation when experience of previous success and failure during the task was balanced. In the study a two block design has been used with the manipulative instruction given after the first block. Due to this design task conditions were kept equivalent and the first blocks could serve as control conditions since no information on the nature of the task had been provided to either group. In order to avoid confounding expectancy and performance influences (Meyer, 1973; Phares, 1975) instructions that aimed to provoke ability ascription for failure (internal- stable- uncontrollable) in one group and difficulty attribution for failure (external- stable- uncontrollable) in the other group were used. Following Brocker and Guare (1985) and Weiner (1992) consensus information and task characteristic information were different between the two instructions, whereas instructions were otherwise equal. We hypothesized that under this arrangement a stable attribution manipulation could be achieved over a large number of trials with performance held at chance level by the adaptive algorithm without subjects being aware of this. Additionally, we expected differences in attribution exclusively on the locus of causality dimension. Explicitly, individuals who would receive the 'easy concentration test' information were expected to attribute errors to their own performance, whereas those persuaded that the task is difficult were expected to attribute mistakes to task characteristics.

2. Material and Methods

2.1 Participants

Twenty-four, healthy, students (female, mean age 25.13) who gave informed consent participated in this study. All participants had no history of neurological or psychiatric diseases and had normal or corrected to normal vision.

2.2 Task

An adapted, speeded arrowhead version of the Erikson Flanker Task (Erikson and Erikson, 1974) was employed using an in- house presentation software, running under Linux. Within each trial five white arrowheads were presented in a horizontal row against a black screen. The arrowheads consisted of two arms both 2 cm in length. The viewing distance of approximately 60 cm resulted in a 2° visual angle horizontally and vertically. Participants were instructed to concentrate on the central arrowhead and to ignore the other ones. To increase task difficulty a target stimulus could either point left, right, up, or down, whereas the distracters varied in pointing left or right. Participants had to respond with their left index finger if the target arrowhead pointed left or up and with their right index finger if the target pointed right or down. There were compatible trials, i.e. the flankers pointed in the same direction as the central target, and incompatible trials, i.e. the flankers were pointing to the opposite direction and with target ‘up’ to the right and ‘down’ to the left. Compatible and incompatible trials were presented in pseudo-random order having the same frequency. Subjects were informed that they could make two types of error, either pressing the wrong button or responding too slowly. With a delay of 1000ms following each target onset one of three different symbols in the centre of the screen indicated the actual performance. Green plus signs indicated correct responses in due courses and red minus signs incorrect ones. When the response was out of time a message appeared on screen 650 ms after stimulus onset saying, the response was tardy - please respond faster next time. This message was followed by a blue minus sign. There were two blocks, each of 350 trails, with a break of various lengths in between.

2.3 Adaptive Algorithm

As already mentioned an adaptive algorithm (Fiehler et al., 2005) was used in order to achieve a negative feedback (error responses and time outs) rate of about chance level (50%). According to this algorithm a response time value (RV) was dynamically adjusted within the range of 200 to 800ms in steps of 100ms always after 40 consecutive trials dependent on the subject’s actual performance value (PV). This performance value (PV) in turn was counted up or down by 1 for a positive or negative feedback respectively, with each single trial. Initially, RV was set to 500ms and PV to 0. With each 40^{th} trial RV was decreased by 100ms if PV was > 20 and RV > 200ms in order to enforce a higher rate of negative feedback - otherwise RV was increased by 100ms; in either case PV was then set to zero. <u>For an illustration of the algorithm see appendix</u> A. Full programming details for the flanker task and this algorithm are available from the authors.

2.4. Experimental Manipulation of Attribution

Subjects were randomly assigned to two groups. Both groups received the same standard task instructions before starting the experiment with a first block as a set of 'practice trials'. Thereafter, one of the two following instructions was given verbally in German language (Comments relevant to attribution are shown in italics):

Instruction A: 'The practice part is over and I will now tell you the experiment's purpose. *This is an ability test*. We will measure your ability for attention and concentration during the next block. As you must have realized during the practice part, *the test is quite easy*. You *simply have to press the left or the right button. People make very few errors,* because it is so easy.'

Instruction B: 'The practice part is over and I will now tell you the experiment's purpose. This is a *so called Flanker Task*. This task is deliberately designed in a way that people commit many errors. As you must have realized during the practice part, the *task is quite difficult. You have a very short time to respond, People make lots of errors,* because it is so difficult.'

With instruction A, a fake picture of a "concentration test" was also presented before starting the second block.

At the end of the second block participants were asked to complete an adapted version of the IE-SV-F (Fragebogen zur Erfassung von internalen/externalen und stabilen/variablen Attributionen in Abhaengigkeit von Erfolg und Misserfolg, Dorrmann and Hinsch, 1983"; 'Questionnaire for capturing internal/external and stable/instable attributions depending on success and failure'). The questionnaire allowed the measurement of the locus as well as the stability dimensions in success and failure situations during the flanker task. We adopted nine statements to the flanker task situation, maintaining the original responses (e.g. "I think the failure was due to a lack of my ability."). This resulted in a 36 item questionnaire with a scale of 1 to 4 for each item ("Applies in no way" to "Applies completely"). At the end of the experiment participants were debriefed and informed about the true purpose of the study.

3. Results

3.1. Behavioral Data

Table 1 shows reaction time (RT) and performance data for each group pre and post instruction. RT was defined as the time between stimulus onset and the button press

Table 1: Mean proportions of correct, error, and 'time out' responses for compatible, incompatible, and all trials separated for blocks. (Standard Errors in parentheses)

	Compatible Trials		Incompatible Trials		All Trials	
	Response Rate (%)	Response Time (ms)	Response Rate (%)	Response Time (ms)	Response Rate (%)	Response Time (ms)
Performance data of <u>the first block</u>						
<u>Prior Instruction A</u>						
Correct	66.87 (6.64)	347.23 (50.71)	41.49 (10.03)	429.73 (31.10)	54.2 (5.19)	*
Error	6.52 (3.32)	*	19.18 (15.66)	317.95 (57.19)	12.91 (9.1)	*
Time out	26.52 (8.71)	*	39.25 (13.34)	*	32.89 (10.67)	*
<u>Prior Instruction B</u>						
Correct	65.1 (7.13)	350.46 (52.13)	42.23 (8.47)	433.07 (35.04)	53.64 (3.82)	*
Error	7.15 (4.48)	*	21.68 (13.54)	324.83 (68.35)	4.43 (8.01)	*
Time out	27.74 (9.82)	*	36.00 (8.49)	*	31.92 (8.97)	*
Performance data of the second block						
<u>Post Instruction A</u>						
Correct	73.36 (8.29)	321.55 (40.70)	43.55 (10.27)	394.2 (35.97)	58.51 (5.26)	*
Error	5.30 (2.30)	*	23.83 (17.20)	286.08 (37.44)	14.51 (8.65)	*
Time out	21.34 (8.65)	*	32.62 (11.52)	*	27.00 (9.39)	*
<u>Post Instruction B</u>						
Correct	70.75 (7.47)	314.97 (48.90)	42.20 (9.67)	376.38 (56.08)	56.46 (4.31)	*
Error	6.77 (6.13)	*	26.36 (18.18)	285.54 (49.26)	16.75 (11.42)	*
Time out	22.48 (9.82)	*	31.44 (11.15)	*	26.97 (9.90)	*

Note: In most participants the number of errors on congruent trials was too small for further analysis.

As can be seen in Table 1 performance effects typical for flanker tasks in general were found with no significant differences between the groups. Independent of the instructions, participants committed more errors on incompatible trials in both blocks.

Using a three-way repeated measures ANOVA with the between subject factor Instruction (2 levels: Instruction A or B), and three within factors: Response (2 levels: correct and incorrect), Block (2 levels: block 1 and block 2), and Compatibility (2 levels: compatible and incompatible) significant interactions Compatibility × Response ($F(2, 21) = 71.6$, $p<0.000$) and Response × Block ($F(2, 21) = 12.5$, $p<0.000$) were found. The latter possibly indicated practicing over time. No interaction with the between subject factor Instruction reached the level of significance even after setting alpha to 0.2. Thus, the different instructions did not lead to differences in accuracy.

Typical effects were also observed for reaction time. RTs were longer for incompatible than for compatible trials. This observation was statistically confirmed using a repeated measure ANOVA for correct responses with the 'within' factors Compatibility and Block and Instruction as a between subject factor. It revealed a significant main effect of Compatibility ($F(1, 20) = 205.13$, $p<0.000$). The ANOVA for RTs of incompatible trials only, with the 'within'-factors Response and Block and Instruction as a between subject factor, resulted in a significant main effect of factor Response ($F(1, 20) = 40.26$, $p<0.000$). That demonstrated that errors were associated with shorter reaction times. Again the main effect of the factor Block ($F(1, 20) = 309.33$, $p<0.000$) indicated practicing effects over blocks. Importantly, no significant interaction was found ascribable to Instruction, which emphasized that RT was not influenced by the instructions.

However, since performance might have been influenced by the balanced control of negative/positive feedback, the two groups were compared additionally on the performance and RT data of the first 40 trials of the second block (immediately after instruction A or B was given). As noted earlier, the first adjustment of the response window occurred after the 40^{th} trial. Therefore, responses to these 40 initial trials were not influenced by the adaptive algorithm.

Table 2: Mean proportions of correct, error, and 'time out' responses, separated by instructions. (Standard Errors in parentheses)

	All Trials (40) Response Rate (%)	Incompatible Trials Response Time (ms)
The first 40 trials of the second block were chosen, since the effect of the adaptive algorithm was not yet present.		
Post Instruction A		
Correct	75.00 (15.25)	290.80 (49.50)
Error	15.75 (12.75)	417.50 (50.90)
Time out	9.50 (9.00)	*
Post Instruction B		
Correct	69.75 (11.25)	299.3 (82.80)
Error	19.75 (11.75)	401.5 (59.30)
Time out	10.50 (9.00)	*

Note, that response times were only computed for incompatible trials, because the number of errors on compatible trials was insufficient for further analysis.

As can be seen in Table 2, there were no differences in performance and RT ascribable to the different instructions. This was again confirmed by ANOVAs using these first 40 trials. The analysis on performance data did not yield a significant interaction Instruction x Response ($F(2, 19) = .392$, $p = .618$). Equally no significant interaction Instruction x Response ($F(20, 1) = 1.385$, $p = .253$) was found for RT data, demonstrating that the different instructions had no influence in this respect.

Additionally, as can be seen in Table 1 when taking all negative feedback trials (error and late response) into account, the adaptive algorithm indeed led to approximately 50% negative feedbacks in all conditions. And, importantly, after debriefing at the end of the experiment, all participants reported that they had not been aware of the effects of this control algorithm.

3.2. Manipulation Check

For each attribution factor; chance, ability, difficulty and effort, an average score of corresponding items of the adapted IE-SV-F (see above) was calculated for each subject individually.

Table 3: Mann-Whitney U-test statistics for the attribution questionnaire data

	Condition					
	Instruction A		Instruction B			
	n	Mean Rank	n	Mean Rank	U	Z
Average Scores						
Success Ability	12	9.83	12	15.17	40.00	-1.89
Success Difficulty	12	12.96	12	12.04	66.50	-.33
Success Chance	12	10.75	12	14.25	70.00	-.12
Success Effort	12	12.67	12	12.33	51.00	-1.24
Failure Ability	12	16.33	12	8.67	26.00	-2.70**
Failure Difficulty	12	7.50	12	17.50	12.00	-3.45**
Failure Chance	12	9.88	12	15.13	58.50	-.79
Failure Effort	12	11.38	12	13.63	40.50	-1.87

p<.05; ** p<.01

Mann- Whitley U-test statistics yielded significant differences depending on the instructions. As shown in Table 3 Instruction A provoked significantly more failure attributions to ‘ability’ than Instruction B (U=26.00, Z=-2.69, p<.01). In addition, Instruction B led to fewer failure attributions to ‘task difficulty’ than Instruction A (U=12.00, Z=-3.49, p<.000). There were no significant differences on the dimension ‘stability’ (chance and effort attributions) and in ‘success’ attributions. It is noticeable, that the group differences were highly significant (p<.000; P<.01), especially in comparison to previous manipulations of causality (e.g. Brokner, 1983, Stiensmeier-Pelster, 1995; Van Dyck, 2005; Homsma, 2007). Following Newcombe´s (2006) method for calculating effect sizes and confidence intervals for non-parametric group comparisons, we found a large effect for failure attributions to ability (U=26.00, Z=-2.69, p<.01, θ=.18, [.07; .41]) and a very large one for failure attributions to task difficulty (U=12.00, Z=-3.49, p<.000, θ=.08, [.02; .29]).

4. Discussion

In this study an adapted version of the Erikson Flanker Task was developed and tested where the individual error-levels were kept at approximately 50 percent. Using this method the investigation of state attributions and emotional consequences using neuroscience methods would be possible. The task was administered to two groups two times. After an initial block, members of one group were instructed that the task is an easy concentration test, while those of the other group received the instruction that the task is quite difficult.

While typical effects for flanker task performance in general were found, it could also be shown that the two groups differed significantly in their evaluation of the perceived causes of errors depending on the instruction they received. Since a manipulation check was administrated after the participants finished the second block, we can assume that the experimental manipulation of attribution remained stable over the 350 trials of the second block. It should be noted that previous attempts to manipulate achievement attribution were not capable of being used for numerous trials (e.g. Feather, 1967; Brokner and Guare, 1983; Van Dyck and Homsma, 2005; Homsma et al., 2007). The paradigm used in the present study changed attributions over numerous trials and therefore would be able to facilitate the acquisition of event related brain potentials (ERP). Furthermore it has been demonstrated that the groups solely differed in the localization dimension and not within the stability dimension. According to classical social psychology (e.g. Phares, 1957; Meyer, 1973) we concluded that there were no differences in expectations between the groups. In addition, according to the self reports and based on the subjects performance (error and time out responses) and reaction times, no differences were found on the effort dimension. Since performance was controlled by the adaptive algorithm we additionally compared performance data and reaction times of the first 40 trials of the second block, in order to avoid a possible bias due to the adaptive control. Again, no performance and reaction time differences were found indicating that the two groups did not differ in effort. This experimental paradigm, therefore, successfully evoked isolated differences in the locus of causality dimension by suppression of potential confounds, which is essential for an unambiguous interpretation of imaging data in cognitive neuroscience research (Cacioppo, 2003; Kok et al., 2006). Changes in attribution, however, would be expected to influence subsequent emotional responses (Weiner, 1992).

Our approach to the experimental manipulation of attribution could not be used in a within group experimental design since it would not be possible to persuade an individual that the same task was on one occasion easy and on another difficult. Although a between group design is generally less powerful than a within group comparison, our method produced a very large behavioral effect size with the possibility of a similarly large effect at the neural level. Our approach as well as techniques previously used to manipulate attribution are not compatible with counter balanced experimental designs, since manipulation of attribution can only be produced either immediately, or after an initial trial when the same task is involved (e.g. Feather, 1967; Brokner and Guare, 1983; Van Dyck and Homsma, 2005; Homsma et al., 2007). With our paradigm learning effects were shown not to differ between groups during the second block, which excluded at least one possible confound. It, therefore, appeared unlikely that the two groups would have differed significantly in any other time dependant variable, and thus differences in brain activity during the second block should reflect modification of attribution.

The Erikson Flanker Task, as a speeded reaction time task, has often been used to investigate event related potentials, associated with committing errors (e.g. Gehring, et al, 1993). Approximately 80 ms after committing an error, a negative deflection in the ongoing EEG can be observed. This event related potential (ERP) has maximal amplitudes at fronto-central electrode sites and has been referred to as Error Related Negativity (ERN). Following negative feedback, an equal distributed component can be observed on frontal- central recording sites approximately between 250 ms and 350 ms after feedback onset, named the, Feedback Related Negativity (fERN) (Holroyed &Coles, 2002). Numerous studies have found associations of the ERN amplitude with emotion and motivation (e.g. Hajack et al, 2004; Luu &Tucker, 2000), however, no study has yet investigated error related ERP-components and attribution.

Using our approach the neural basis of actor ascriptions in the achievement context and their emotional consequences could be further investigated. According to Weiner (1985) depending on the perceived cause of an event specific emotions can be elicited. Numerous studies have provided evidence for the coherence between causality ascriptions and emotions (i.e. McFarland & Ross, 1982; Weiner, 1997). Feather (1967) demonstrated that failure in a task that is perceived as being ability dependent is rated more aversive and unattractive for individuals than failure in a chance dependent task. Additionally, moral emotions, such as shame or guilt, associated with causal ascriptions (for an overview see Weiner, 1992) could be further explored. Using the methodology described, an “on-line” elicitation of attribution related affects could be achieved, since during the experiment participants actually feel the emotions associated with different attributions in the simulated achievement situation. This might avoid previously described limitations of using affective pictures to provoke affects, which always requires self reports of the actual emotional experience (Amodio and Frith, 2006). Moral emotions (guilt and embarrassment) have been investigated with fMRI by presenting sentences containing embarrassing, guilt, or neutral information. Importantly, both emotions were accompanied by activity in the medial prefrontal cortex and the left posterior superior temporal sulcus (STS). However, STS activation was also observed with the ascription of events to other people's dispositions or responsibility (Blackwood et. al.; 2003; Harris et. al., 2005). Following Weiner (1985) guilt is associated with self responsibility as reflected in internal attributions. We suspect that further research, using our approach could help to elucidate the neural basis of moral emotions clarifying these conflicting findings.

Appendix A:

Algorithm 1 lists the pseudo code for the Erikson Flanker Task and the adaptive algorithm. This algorithm was designed to achieve equal performance for the different groups and to correct for individual differences. Furthermore, the error rate (negative feedback) was held at approximately 50 percent throughout each block.

Algorithm 1. Adaptive Erikson Task()

```
Require: itemlist /* array of items */
Set: rv = 500 /* initial response time value */
Set: pv = 0 /* initial performance value */
foreach item in itemlist do
    /* item presentation*/
    Present: itemlist[item]
    rt <= collectReactiontime() /* in ms */
    answer <= collectAnswer()
    /* feedback and adaption of performance value*/
    if (rt <= rv & answer == 'correct') then
        Present: positiveFeedback()
        Set: pv = pv + 1
    elseif (rt <= rv & answer == 'wrong') then
        Present: negativeFeedback()
        Set: pv = pv - 1
    else
        Present: timeoutFeedback()
        Set: pv = pv - 1
    end if
    /* evaluation of subject's performance */
    if (item mod(40) = 0) then
        if (pv >= 20 & rv > 200 ) then
            /* decrease response time value */
            Set: rv = rv – 100
        elseif (pv < 20 & rv < 800 ) then
            /* increase response time value */
            Set: rv = rv + 100
        end if
        Set: pv = 0 /* reset performance value */
    endif
end foreach
```

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Hierzu im Anhang :

- ITACA Titelblatt (Leistungsmanipulation der Gruppe «intern »)
- Attributionsfragebogen (deutsch und englisch)
- Schematische Darstellung des experimentellen Designs
- SPSS Tabellen (Verhaltensdaten, Manipulations Check)

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Its effect on error and feedback processing in the brain.

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Experimental manipulation of causal ascription:
Its effect on error and feedback processing in the brain

Sylvia Terbeck [1]*
Florian Ph. S Fischmeister[1]
Paul Chesterman[2]
Herbert Bauer[1]

[1] Department of Clinical, Biological and Differential Psychology, University of Vienna, Liebiggasse 5, A-1010 Vienna, Austria

[2] School of Psychology, University of Wales Bangor, Adeilad Brigantia, Gwynedd LL57 2AS, UK

*Corresponding author:
Sylvia Terbeck, Department of Clinical, Biological and Differential Psychology, University of Vienna, Liebiggasse 5, A-1010 Vienna, Austria; Phone: +43-1-4277-47803; Fax: +43-1-4277-47939; E-Mail: sylviaterbeck@web.de

Abstract

The role of achievement attribution on error and feedback processing was examined. We used a recently developed method to manipulate the perceived causes of error occurrence. Subjects responded to a modified flanker task while electrophysiological data were recorded. After each trial subjects received additional feedback indicating the correctness of their responses. The Error related negativity (ERN), an early component associated with error commission, did not show differences according to the attribution manipulation. Importantly however, a fronto-medial negative deflection equal to the feedback related negativity (fERN) after the feedback stimulus onset discriminated between positive and negative feedback in all individuals of the group that, following the attribution manipulation, attributed errors to their ability. This suggests that the additional emotional valence of error commission associated with internal attribution, resulted in activation of brain regions concerned with the emotional significance of error and feedback in task performance leading to the elicitation of a negative deflection after the feedback. Furthermore, a significant reduction in the P300 amplitude was observed in association with external failure attribution suggesting that this was perceived to be of less relevant to the subject. Since achievement attribution has not previously been investigated in neuroscience research, we suggest attaching importance to the attribution concept in error processing models as a mediator between cognitive processes and emotional and behavioural outcomes.

1. Introduction

Attribution was a major focus for research in social psychology in the 70s and 80s. During this time a number of studies demonstrated the influence of causal ascriptions on related constructs such as emotion, behavior, motivation, expectation, and learning (i.e. Feather 1978; Mc Farland & Ross, 1983; Rotter, 1954; Wasserman, 1990; for an overview see Foersterling, 2002; Weiner, 1992).

In social neuroscience there are only a few studies, seeking to elucidate the neural basis of causality ascription and their consequences (for a review see Terbeck et al, 2008). As yet there has been no research on the effects of different self state attributions on a neural level. Given the major implications of attribution to related psychological constructs that have been demonstrated on a behavioral level, investigations on a neural level should contribute to the theoretical understanding of these cognitive processes.

After briefly describing attribution theory and recent EEG studies on error and feedback related potentials we will describe our study of the effects of causal ascriptions on error processing potential components using EEG methodology.

1.1. Attribution Theory in social psychology

1.2.

Attribution in social psychology was originally defined by Heider (1958) as the perceived causes of an event. Attribution theory had major implications for a variety of applied disciplines however, since our approach involves the manipulation of the perceived causes of error commission, we will here only focus on attributional determents of success and failure events. Weiner's classical attributional analysis of achievement behavior (1985) postulated four causes that Europeans most frequently used to explain success and failure outcomes (ability, task characteristics, effort and chance) (for an overview see Weiner, 1992). According to Weiner (1985) ability and task characteristics attributions are stable over the time, such that the expectation for further outcomes does not change. Additionally, aptitude attributions are internal ascriptions (a cause within the person) and task characteristics are external oriented attributions.

Behavioral studies in classical social psychology support the importance of attribution in guiding behavior and learning (Wasserman, 1990) by influencing motivation (i. e. Rotter, 1954, Weiner, 1985) and emotion (i. e. McFarland & Ross, 1983). Committing an error that is ascribed to one's own (low) ability has been reported to be judged more aversive than externally attributed errors (Feather, 1967). Whereas the importance and salience of errors has been shown to be reduced in external failure attribution (such as task difficulty), since the subject feels less responsible for their mistakes (Weiner, 1992).

1.3. Error and feedback related components

The ERN

A negative deflection in the ongoing EEG can be observed after error commission in speeded reaction time tasks, named the Error Related Negativity (ERN). The ERN peaks approximately 80 ms post response and is maximal at fronto-central recording sites (Fz, Fcz, Cz) (Falkenstein et al, 2000; Gehring et al, 1993; Holroyed & Coles 2002; Niewhuis 2001). Source localization analysis that allows a multivariate mathematical based estimation of the underlining neural generators of scalp recorded potentials has indicated that the ERN is generated in the anterior cingulate cortex (ACC) (Dehaene et al, 1994; Miltner et al, 1997; vanVeen & Carter, 2002). Furthermore fMRI studies have found ACC activation during error processing (Carter et. al, 1998; Ullsberger & Cramon, 2003).

Due to the close temporal relation to error commission, the ERN was originally considered to signal the detection of an error (Falkenstein et al, 1991). Holroyed & Coles (2002) suggested that the ERN is generated in reinforcement learning as a result of disinhibition of neurons in the ACC when an outcome is worse than expected and that the error signal is used "to train the ACC to optimize performance on the task at hand". Luu and Tucker (2004) however speculated that error related potentials reflect an affective evaluation of the situation with distress occurring when the expected outcome of an action fails to produce an emotional salient goal (Luu & Tucker, 2004).

Changes in the magnitude of the ERN amplitudes associated with changes in emotional or motivational states have been reported in numerous studies (Hajcak et al, 2005; Larson et al, 2006; Luu et al, 2003; Masaki et al, 2006; Pailing & Segalowitz 2003). Specifically, reduced motivation has been shown to result in lower ERN amplitudes in a number of studies (Hajcak, et al, 2005, Larson et al, 2006 and Pailing & Segalowitz, 2003). Personality factors, possibly mediating between emotional and motivational valence of error commission and feedback stimuli, have also been shown to influence the ERN (Boksem et al, 2006; Luu et al 2002; Pailing & Segalowitz 2003). These results are consistent with an early study by Gehring et al, (1993) who found that the ERN is sensitive to the importance of the error for the participant.

The fERN

After the onset of a feedback stimulus an equally distributed component can be observed at frontal-central recording sites between 250 ms and 350 ms after feedback onset, named the feedback related negativity (fERN) (Holroyed & Coles 2002; Miltner 1997). Fronto-medial negativity has also been reported with monetary losses in gambling tasks (Gehring & Willoughby 2002a), in response to “bad” as opposed to “good” targets (Tucker et al 1999), and when subjects evaluate a trait as bad rather than good (Tucker et al 2003). Whether these various negative components can be reliably distinguished from each other according to function or localization remains uncertain (Gehring & Willoughby 2004; Holroyed & Coles 2002; Luu et al 2004).

In addition to influencing the ERN some studies have also shown that motivation influences the fERN (Hajcak et al, 2005; Luu et al 2003, Masaki et al 2003). However the findings have been inconsistent. It has been suggested that the feedback related component might be insensitive to the valence of the outcome, such as the magnitude of monetary incentives (Hajcak et al, 2005). Nevertheless emotional and motivational factors may determine if an fERN component occurs. Luu et al (2003) demonstrated that a medial frontal negativity differentiated between different types of feedback where the feedback was restricted to the emotional value of the subject’s performance.

In accordance with the impact of emotion and motivation on error potentials, abnormalities in these components (ERN and fERN) have also been found in a variety of psychiatric conditions associated with changes in mood and error salience including obsessive compulsive disorder (Gehring & Willoughby 2002b), anxiety disorders (Landouceur et al 2006), paranoid schizophrenia (Kopp & Rist, 1999) and major depressive disorder (Tucker et al 2003).

1.4. Error processing in the brain and causal ascriptions

As yet an investigation of causality ascriptions for error occurrence has not been conducted on a neural level. However, this has been approached indirectly by Ulsberger et al (2006) who simulated technical malfunctions leading to failure that was externally attributed. The authors found that malfunctions and internally induced errors led to equal activation patterns in the medial prefrontal cortex. The authors concluded that since they had explicitly mentioned the possibility of malfunctions in the instructions subjects were able to compensate for externally induced errors. However, achievement attribution was not specifically addressed in this study.

As noted earlier, at a behavioral level attribution was related influence and mediate emotion, motivation, expectation, behavior, and learning, as also reflected in different personality styles (Rotter 1954) and a number of psychiatric disorders (Foersterling 1988). For example changes in attribution has been shown to be a significant factor, as reflected in deviant attributional styles (increased internal failure attribution), especially in major depressive disorder (for an overview see i.e. Sweeney et al, 1986). Since on a neural level it has been demonstrated that depression is associated with increased fERN amplitude (Tucker et al, 2003a) it could be hypothesized that this effect is mediated by the attributional style.

Since the value of the error is hypothesized to be affected by different motivational and emotional states (Hajcak et al, 2005; Larson et al, 2006; Luu et al, 2003; Masaki et al, 2006; Pailing & Segalowitz 2003) personality factors (Boksem et al, 2006; Luu et al 2002; Pailing & Segalowitz 2003) and psychiatric conditions (such that error sensitivity is increased) (Gehring & Willoughby 2002b; Kopp & Rist, 1999; Landoucer et al 2006; Tucker et al 2003) it is important also to consider changes in attribution since this has been shown to modify error valence on a behavioral level (i.e. Feather 1967; Weiner 1985; see Weiner 1992 for an overview).

Furthermore, based on the finding of Luu et al (2003), that an fERN component is seen with feedback that is emotionally significant it may anticipated that an fERN would occur following feedback for internally attributed errors.

1.5. The present study

We have argued that the achievement attribution concept is crucial for learning and behavior as mediated through emotion and motivation and that those factors also play an important role in the neural processes of error and feedback processing, therefore assessing the role of causality ascriptions on error and feedback perception and processing on a neural level becomes an important area of research.

Given that internal attribution of an error is associated with greater distress and the feedback has more emotional significance we hypothesized that the importance of error and the feedback would differ among different causal attributions of performance errors. Specifically we expected a larger amplitude for internal vs. external attribution on the ERN component and a negative deflection after negative feedback solely for the internal manipulation.

We understand that the elicitation of two error signals (ERN and fERN) within one experimental design has been reported to be difficult since subjects generally already realize during their response that an error has been made and therefore performance feedback would be expected to provide little additional information (Holroyed & Coles, 2002). Nevertheless, in accordance to the findings of Luu et al (2003), we suspected that the emotional valence of the feedback for the internal attribution condition would be retained and therefore a visible negative deflection could be elicited within this experimental arrangement.

To investigate the effect of causal ascription on error processing we used a recently developed method (Terbeck et al 2008) to experimental manipulate the perceived causes of error occurrence.

2. Method

2.1. Participants

Twenty four, neurologically healthy, right handed, female student volunteers participated in this study (mean age 25.13). Participants had normal or corrected- to normal vision. After receiving written and oral information about the procedures participants gave written informed consent. Importantly subjects were naive to the experiment; they had never participated in a study inducing causality ascriptions before. Since the average of responses required a minimum of trials for meaningful analysis two subjects had to be excluded (one of each group) because they had too few error trials (less than 5% in each block). Thus a total number of 22 participants were included in the further analysis.

2.1. Stimuli and Procedure

An adapted, speeded, arrowhead version of the Erikson Flanker Task (Erikson & Erikson, 1974) was administrated. Sets of five arrowheads (i.e. >>>>>) were presented on a computer screen with a 2° visual angle horizontal and vertical for each stimulus at a viewing distance of 60 cm. Participants had to respond with their left index finger if the central arrowhead pointed left or up while they had to respond with the right index finger if the target arrow pointed right or down. Compatible (<<<<<, >>>>>, <<^<<, >>v>>) and incompatible (<< > <<, >> < >>, <<v<<, >>^>>) trials were presented randomly such that they were 50% incompatible trials. The onset of the flanker stimuli preceded the onset of the target flanker stimuli by 100ms. Each flanker set remained on the screen for 200ms and disappeared simultaneously. Subjects received the information that both responding too slowly and pressing the wrong key would be judged as an error. According to the subject's performance three types of symbolic feedback (blue and red minus indicating late or wrong response) were presented 1000ms after each target stimulus onset. The inter stimulus interval for the flanker set onset was randomised between 800ms and 2800ms with 1800ms on average. There were two blocks, each of 350 trials, with a break of various lengths in between.

Based on the work of Fiehler et al. (2005) we developed a modified adaptive algorithm (Terbeck et al 2008) that increased the error rate by manipulating, depending on the current participants performance, the available time to respond such that subjects received approximately 50 % negative feedback (wrong key press and late response/ performance and time out error) in all conditions. If an individual was for example quite good in the flanker task performance the time window, in which an error was judged as an error, was increased, making time out errors more likely (for the programming description of the algorithm see Terbeck et al 2008). We could show that under this arrangement the subjects had an overall error and time out rate of 50 % within each block, without being aware of the manipulation.

An error rate of 50 % was necessary for the attribution manipulation because confounds could be avoided and failure experience were held equal for both groups. Additionally the attributionally relevant instructions, such as the task is difficult (see section 2.2) could just be made believable if subjects had the experience of balanced success and failure events during their performance before (for a detailed description see Terbeck et al 2008).

2.2. Manipulation of Attribution

Subjects were randomly sorted to two groups both received the same standard task instructions before starting. After an initial block which was introduced as a practice session (note again, that due to the adaptive control, subjects experienced 50% performance and time out errors in this block), half of the subjects received the information that the task was a very easy concentration test (Instruction A/ "internal group") while for the others the task was described as being very difficult (Instruction B/ "external group") (for the precise instructions see Terbeck et al 2008). After the instructions, subjects performed the second block, again under the adaptive control.

We could show that these different attributionaly relevant introductions between the blocks provoked internal state attribution for failure in one group and an external error ascription in the other group during the second block (Terbeck et al 2008). This means that one and the same task was differently perceived for the two groups.

In order to ascertain whether attribution had been modified by the different introductions subjects completed a questionnaire that was constructed by adapting the IE-SV-F (Ein Fragebogen zur Erfassung von internalen vs. externalen und stabilen vs. variablen Attributionen in Abhaengigkeit von Erfolg und Misserfolg, 'Questionnaire for capturing internal/external and stable/instable attributions depending on success and failure'; Dorrmann & Hinsch, 1983). The questionnaire contained 36 items that we adapted to the flanker task situation on a four point scale, assessing the degree of causal ascriptions to chance, ability, difficulty, and effort (see also here Terbeck et al 2008 for further descriptions). After the experiment the participants were informed of the true purpose of the study.

2.3. EEG Recording and Analysis

The EEG was recorded using 64 channels placed in an elastic cap (Easy-cap® system). All electrodes were referenced to a sterno-vertebral electrode. Vertical and horizontal EOG were registered from the outer canthin of each eye and above and below the right eye. Electrode impedance was kept below 3 kΩ. A DC-amplifier with input impedance of 100 GΩ was used for data recording. Sampling rate of 3 kHz was used for initial recording with on-line filtering at 100Hz. Data were subsequently digitalised at 250 Hz.

Off-line the EEG Data were band pass filtered (0.16 Hz-12Hz); secondary eye movement and blink artefacts were eliminated using a linear regression approach (Lamm et al, 2005). Afterwards trials were visually inspected such that trials with remaining artefacts (i.e. heart and muscle artefacts) were excluded from further analysis. An EEG segment from -200ms and 2000ms before the onset of the key press was isolated and further analysed. ERPs were obtained by averaging the data according to output (correct response, incorrect response, time out), group (instruction A, instruction B), and time (pre- and post instruction).

For the computations of the ERN data were baseline corrected to a -200ms and 0 ms interval before the key press. The ERN was defined as the minimum peak within a time window ranging from 0ms to 200ms after the subjects response. For the analysis of the fERN component the EEG was baseline corrected to an interval between -200ms and 0ms before the feedback onset. The FERN was defined as the minimum value within a time window ranging from 250ms to 400ms after the feedback onset. Because measures of the FERN confound with other ERP components such as P300 (i.e. Niewhuis et al, 2004) we additionally measured the peak- to- peak differences between those components. Here the amplitude of the determent fERN amplitude was subtracted from the P300 magnitude. The P300 was defined as the maximal amplitude within a time window of 150ms to 350 ms after the feedback onset. If a difference could not be identified (since the fERN could not be established in every individual (see Holroyed & Coles, 2002)) the fERN was judged as zero. Due to intra-individual latency differences of the P300 and fERN amplitude the fERN and P300 was assessed on the individual averages.

2.4. Statistical Analysis

For the manipulation check the average scores of each subject were computed and assessed using a non parametric test (Mann Whitley U-statistics). Performance data for the flanker task were conducted using repeated measure analyse of variance (ANOVA) the same procedure was used on average ERP data. All statistical analysis were based on electrode Cz since visual inspection of the individual averages showed the most sharp peak deflection at this scalp point additionally the chosen electrode has been selected for statistical analysis elsewhere (i.e. Holroyed & Coles, 2002).

3. Results

3.1. Behavioral Data

3.2.

The manipulation of attribution resulted in different failure attributions according to the instructions the subjects received during the blocks. Specifically the instruction describing the task as very easy resulted in significant higher failure ascriptions to ability ($U=16.5$, $Z=-2.933$, $p=.002$) and lower attribution to task difficulty ($U=12$, $Z=-3.213$, $p=.001$) than instruction B. (see also Terbeck et al, 2008).

Flanker task behavioral results showed typical effects of flanker task performance previously reported in a number of studies (Bruijn, et al, 2004, Ehils et al, 2005, Hajcak et al, 2005, Pailing & Segalowitz, 2003and Ullsperger & Cramon, 2006). Incompatible trials were associated with more errors ($F_{(1,20)}=66.453$, $p<.001$) and an increased reaction time ($F_{(1,20)}=$, $p<.001$) in comparison to congruent trials. No differences between the groups according to response time and accuracy could be determined (Alpha=.2).

3.3. Event Related Potentials

The ERN

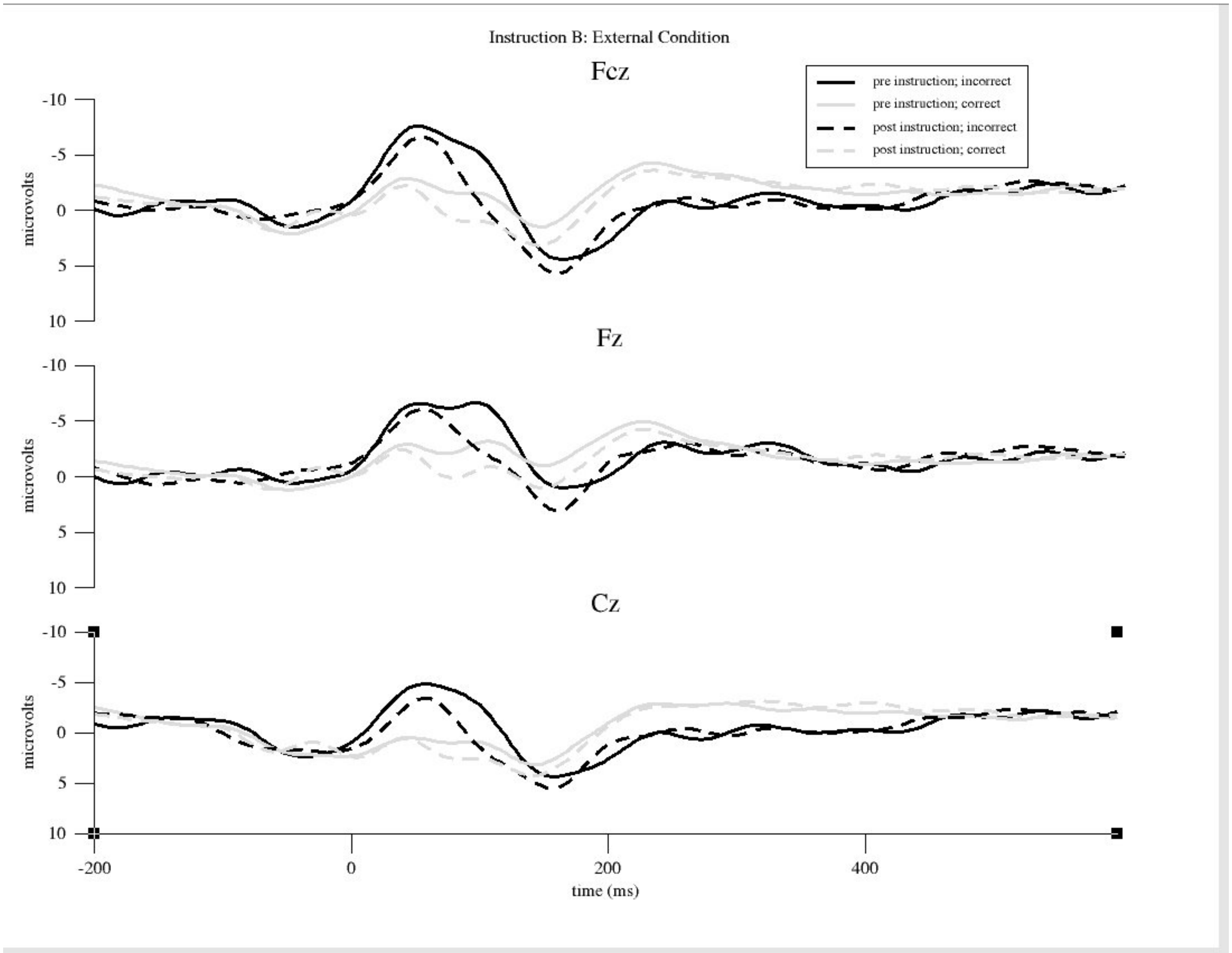

Figure 1a

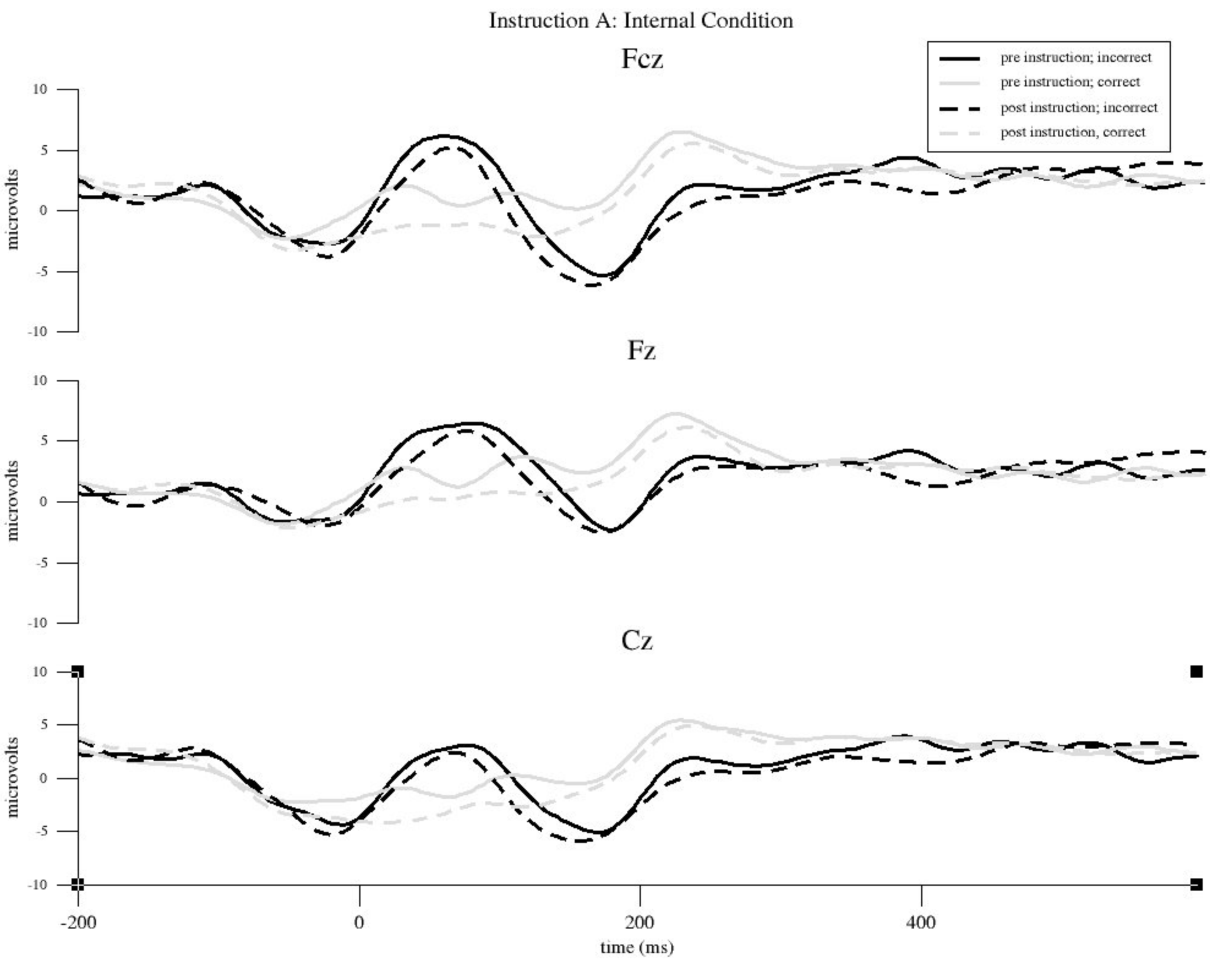

Figure 1b

Figure 1a, Figure 1b: Response locked error related negativity at electrodes Fcz, Fz, Cz. Instruction A (top), instruction B (bottom). Key press occurred at time zero. The output × group interaction yield no significant effect ($F(1,20)=.068$, $p=.797$).

In Figure 1a/b ERP waveforms at fronto-central recording sites (Fcz, Fz, Cz) are shown for each condition. The response locked average was conducted separately for each outcome (correct, incorrect) and each block (pre and post instruction). The grand average for the group presented with instruction A is shown on the top panel of the figure the external condition (associated with instruction B) on the bottom panel.

As can be seen in Figure 1 approximately 80ms after the response onset the ERN could be elicited during error trials in each group before and after the manipulation. We performed a repeated measure analysis ANOVA for the amplitude at Cz having the output (correct/incorrect) as within and the groups as between factors. Before the instruction a significant main effect of output (correct vs. incorrect response) ($F(1,20)=27.668$, $p<.000$) but no significant group output interaction ($F(1,20)=2,675$, $p=.118$) was found. As expected the groups showed no differences in the ERN amplitude before the manipulation. Post instruction again a main effect of "output" could be found ($F(1,20)=17.661$, $p<.000$). Additionally the results of the output × group interaction yield no significant differences ($F(1,20)=.068$, $p=.797$) suggesting that the instruction did not lead to differences in the ERN amplitude.

Additionally, to specifically demonstrate the absolute effect of error and correct responses, and to account for a possible small number of subjects, we evaluated the ERN effect on difference waves.

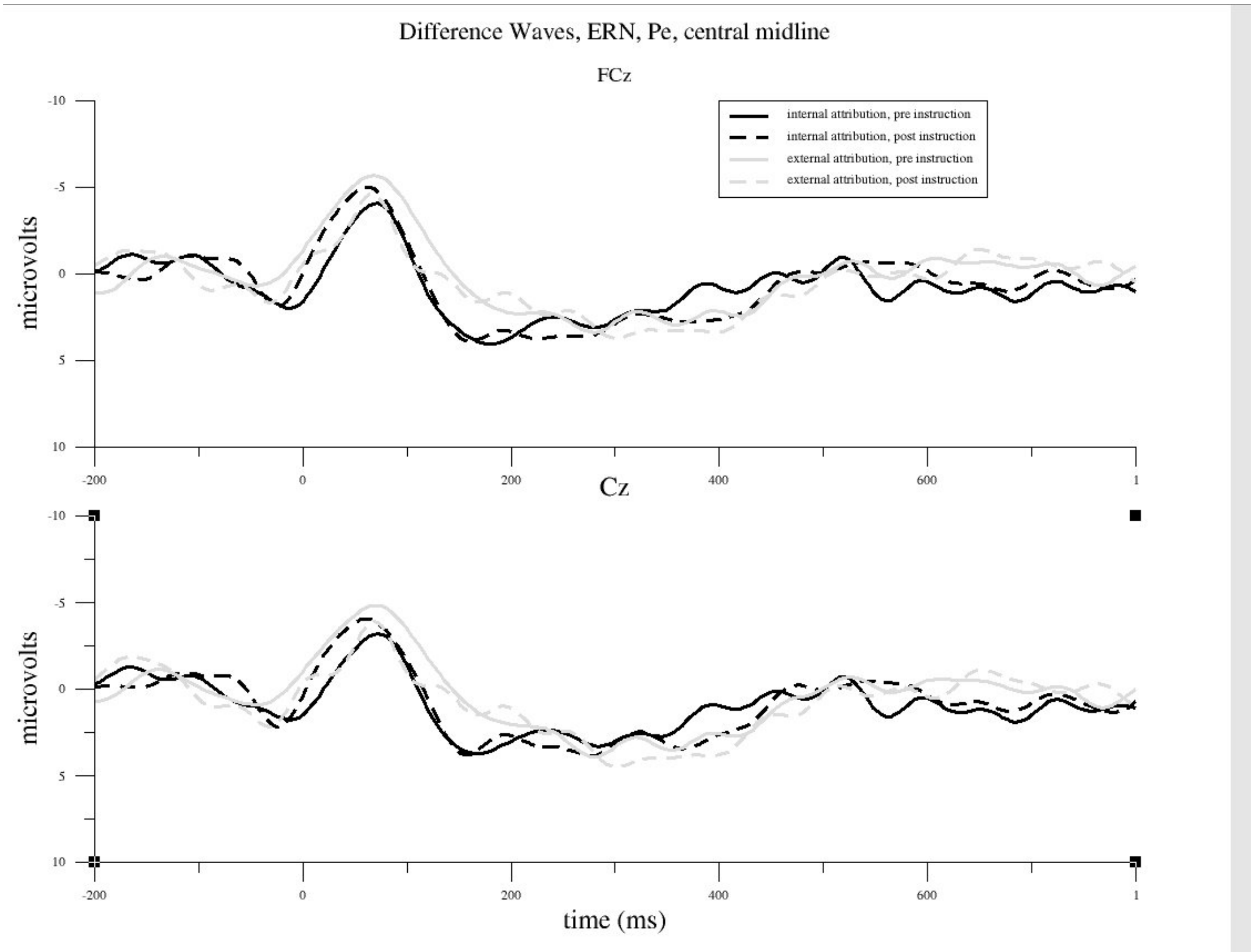

Figure 2: Difference waves for the ERN on central midline electrodes

In Figure 2 a trend can be seen; such that the difference of internal group (black lines) increases post instruction (dashed line), while the difference of the external group (grey lines) reduces post instruction. However, repeated measure ANOVA did not reach significance level here $F (20,1)=.77$, $p>.2$.

The feedback related component

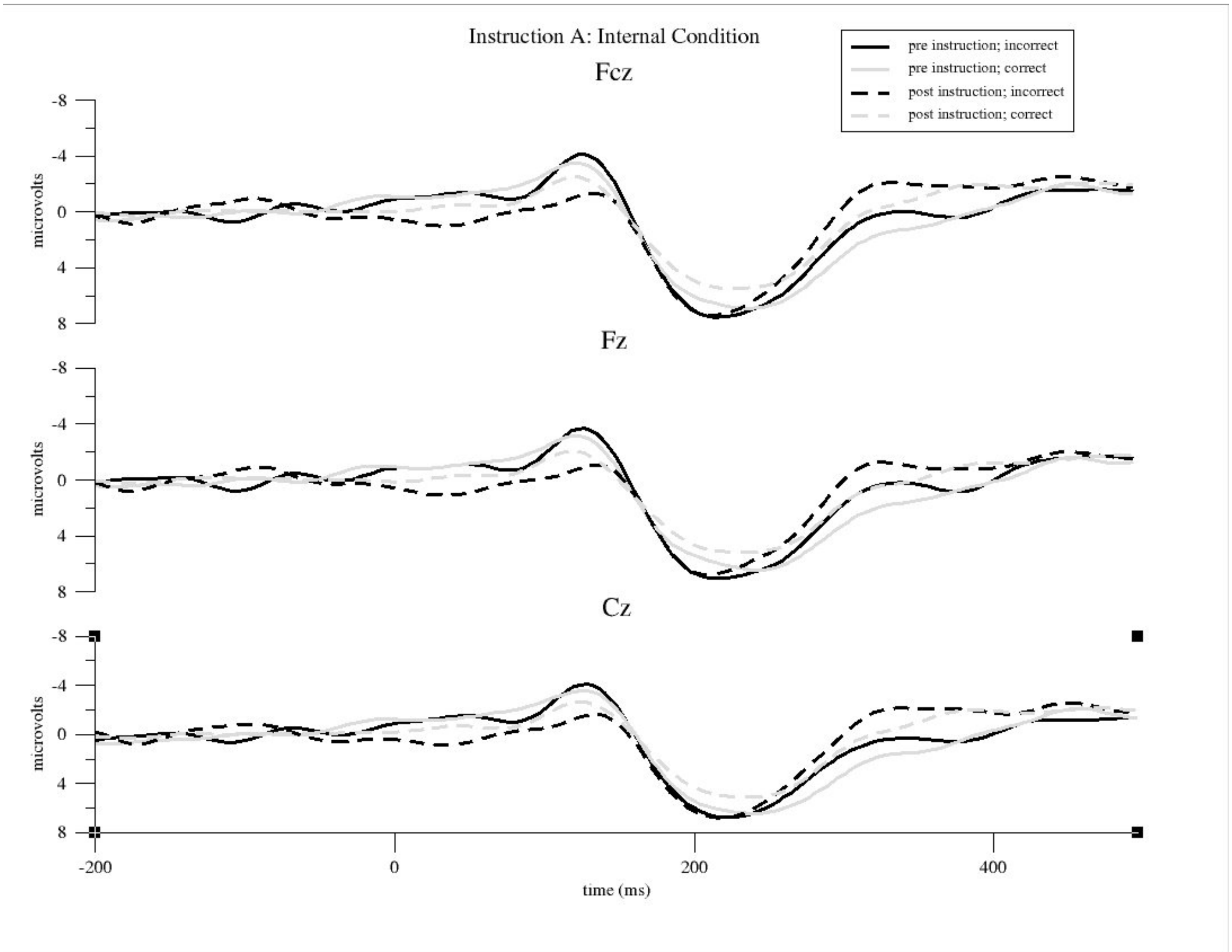

Figure 3a

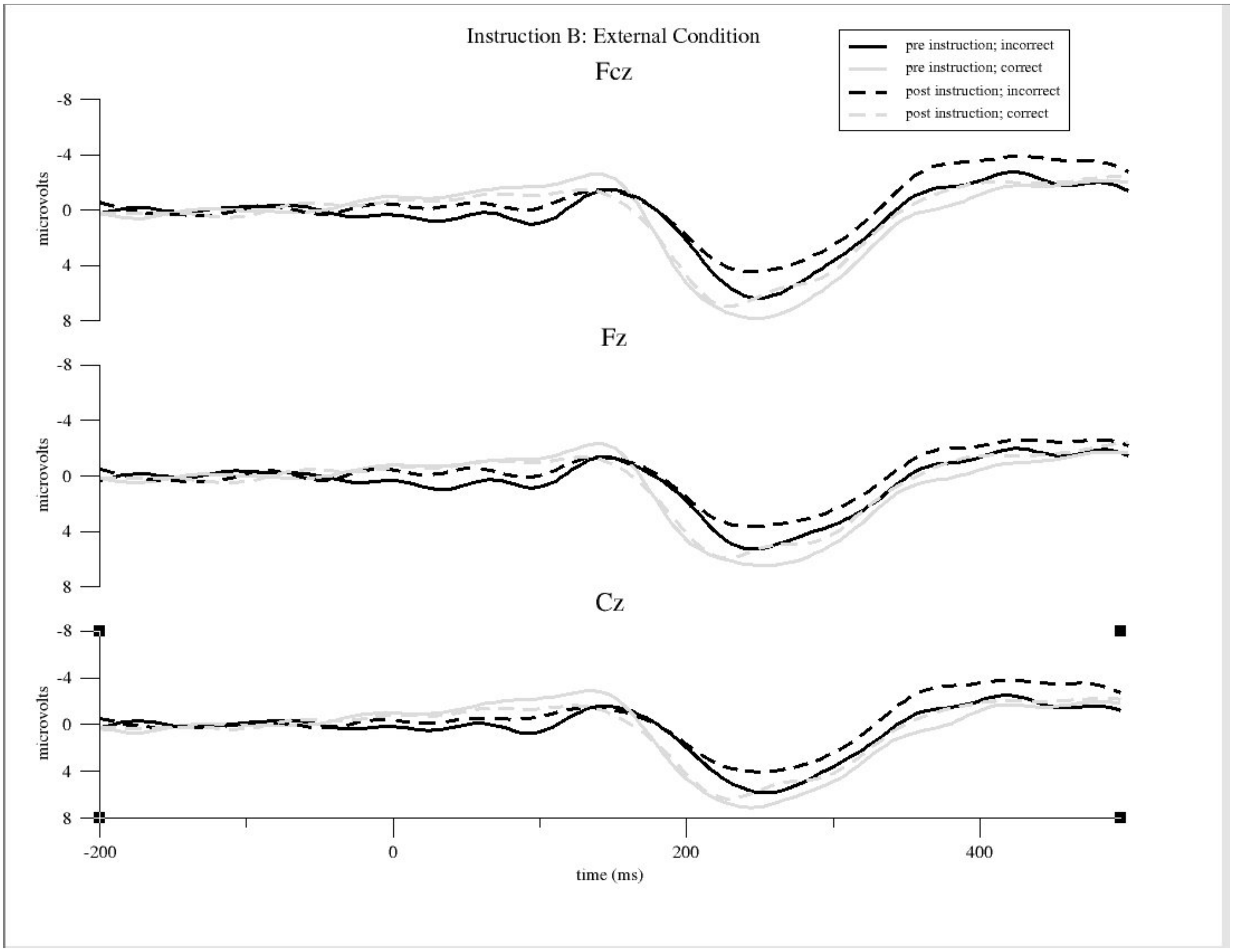

Figure 3b

Figure 3a, Figure 3b: Feedback-locked grand averages at electrodes Fcz, Fz, Cz. Instruction A (top), instruction B (bottom). Feedback onset is at 0 ms. An increased negative deflection, peaking roughly 300ms after negative feedback, was just constantly visible in the group receiving instruction A. Repeated ANOVA revealed significant interaction output × group post instruction ($F(20, 1)=5.151$, $p<0.05$).

Figure 3 presents the feedback locked ERP averages assessed at Fz, Cz and Fzc for correct and incorrect trials before and after the manipulation instructions separated for each group (top and bottom panel). As expected, due to less informative value of the feedback, the fERN component is reduced and less visible in both groups before the instructions. Importantly, an increased negative deflection, peaking roughly 300ms after negative feedback, was just constantly visible in the group receiving instruction A (internal group). These results were confirmed using repeated measure analysis of variance for each time course (pre and post instruction). Before the attributionally relevant instructions there was neither a main effect of output (positive vs. negative feedback) ($F(1,20)=.620$, $p=.440$) nor an interaction with the group factor (instruction A vs. Instruction B) ($F(1,20)=.187$, $p=.670$). As we predicted, after the manipulation, a significant output × group interaction could be determent ($F(1, 20)=5.151$, $p<0.05$) suggesting that the attribution manipulation had a different effect on the two groups during feedback processing. As reported previously (see for example Niewhuis, 2004) the fERN component is affected by changes in the P300 amplitude. To eliminate this confound we also assessed the P300 amplitude.

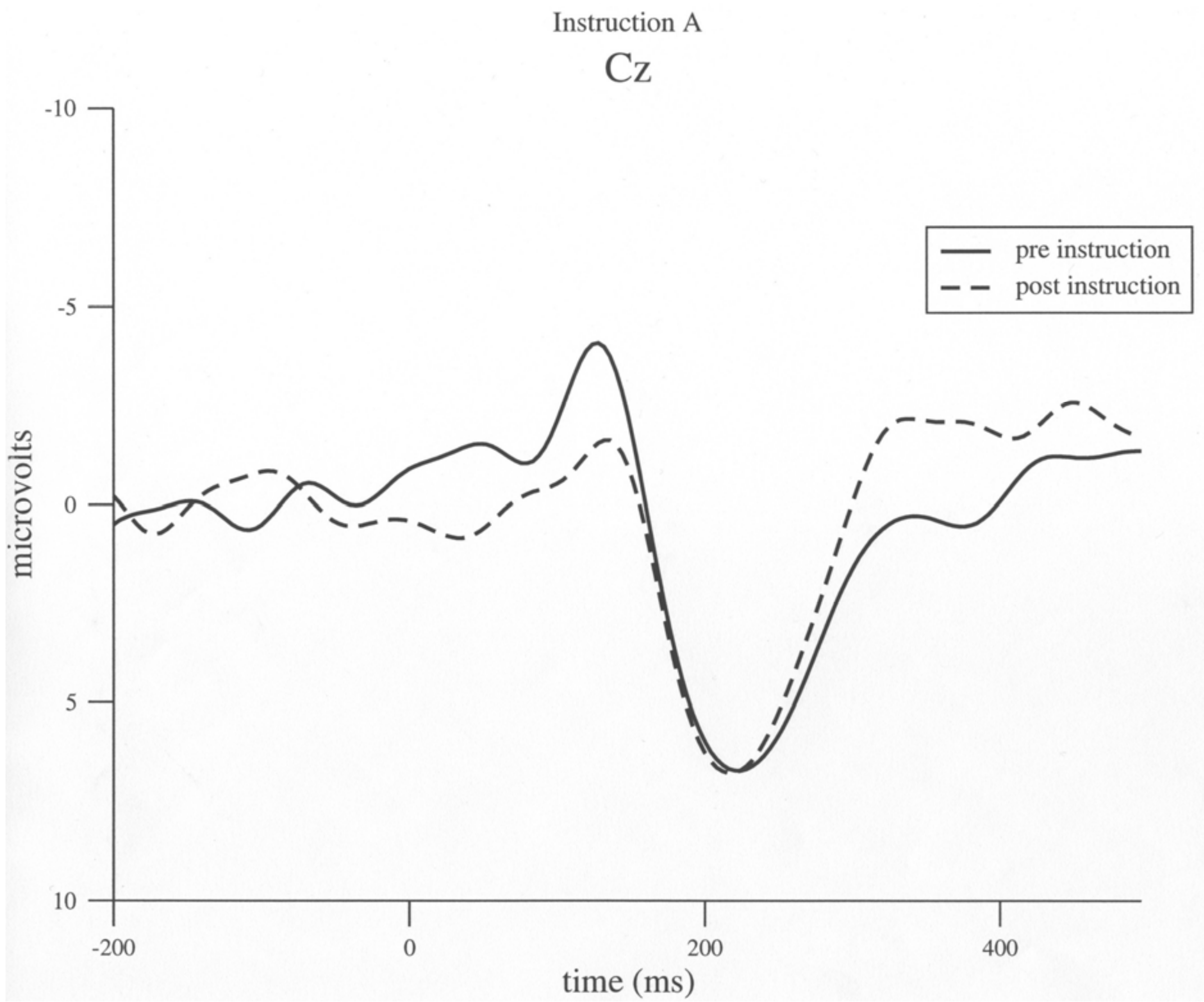
Instruction A
Cz
-10
-5
0
5
10
microvolts
pre instruction
post instruction
-200
0
200
400
time (ms)

Figure 4a

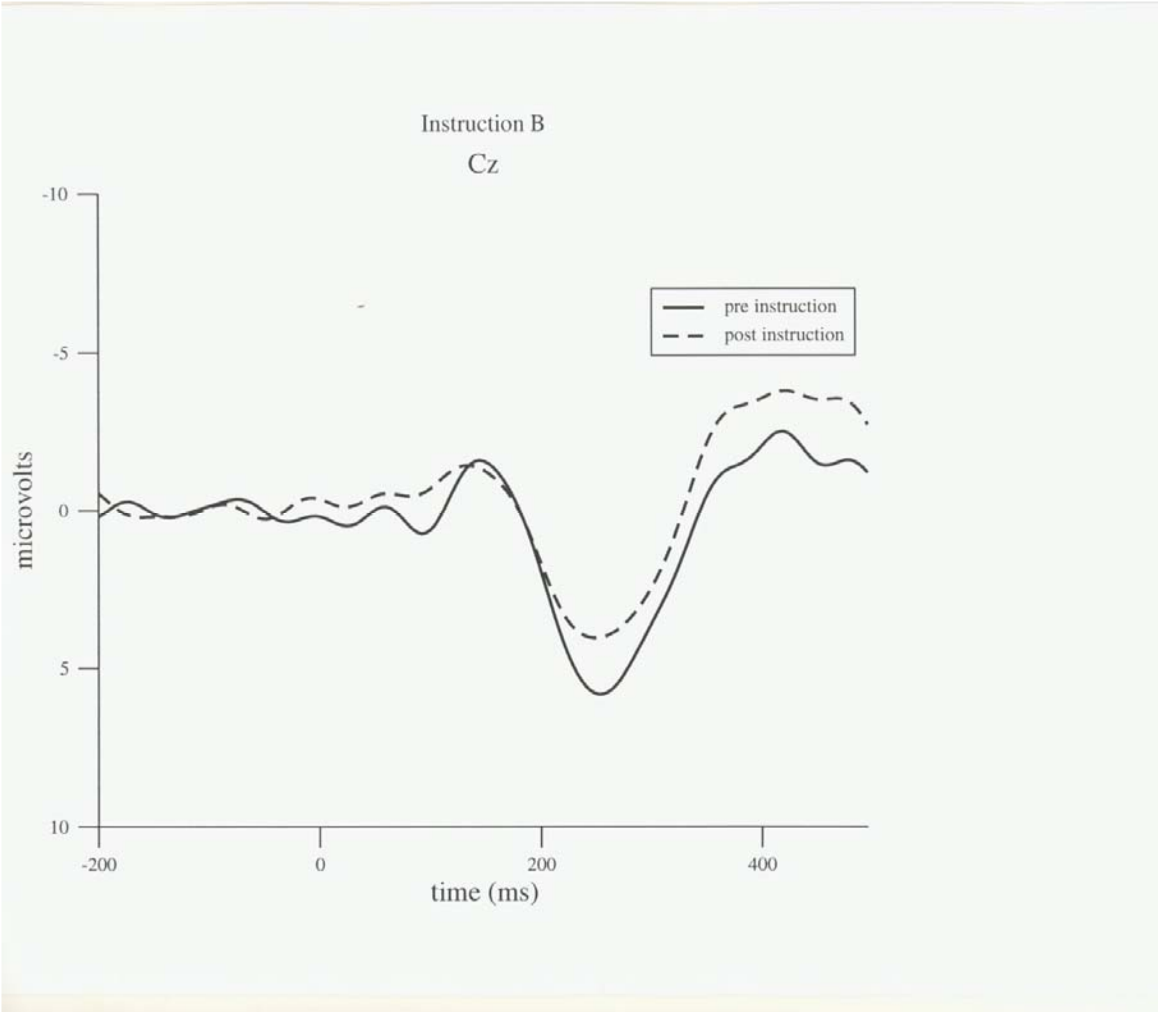

Figure 4b

Figure 4a, Figure 4b: Feedback- locked ERPs at electrode Cz. Instruction A (top), instruction B (bottom). These measures also show P300 magnitude differences affecting fERN amplitudes. A significant reduction in the P300 magnitude was assessed for the external condition post instruction $F(20,1)=6.364$, $p<0.05$. A peak to peak analysis (P300, fERN) revealed a significant interaction time × output× group effect ($F(20,1)=4.943$, $p<0.05$).

The grand average of error trials before and after the manipulation at electrode Cz for both groups is shown is Figure 4. It can be seen that after the instruction the P300 amplitude peaking approximately at 250ms after feedback onset is reduced in the external group while the deflection remains the same in the internal group. Confirming this we conducted an ANOVA for the time period after the instructions according to the P300 amplitude values resulting in a significant interaction output × group ($F(1, 20)=6.364$, $p<0.05$) suggesting that the attribution manipulation had a different effect on the P300 amplitude according to the feedback type.

To rule out an alternative explanation due to confounding of the P300 amplitude with the fERN amplitude we measured the fERN deflection also based on peak-to peak differences by subtracting the P300 amplitude from the fERN component. Taking this into account a two factorial ANOVA (output (positive/negative feedback); time (before and after the instruction) and within factor group (instruction A, instruction B) for fERN amplitude yielded a significant interaction of output × time × group ($F(20,1)=4.943$, $p<0.05$). As we predicted, the attribution differently affected the feedback processing of positive and negative feedback.

4. Discussion

As we have also shown before (Terbeck et al 2008), manipulation of attribution resulted in significantly different causal ascriptions. The group receiving the introduction that described the task as a relatively easy concentration test attributed mistakes in the second block of the flanker task to their ability, while the group receiving an instruction describing the task as difficult attributed errors to task difficulty. Typical behavioral effects for flanker task performance could be found, whilst the experimental manipulation of attribution had no effects on flanker task performance or reaction time.

We found a sharp, constant, medio-frontal negativity after the feedback onset, equivalent to the fERN, which discriminated significantly between positive and negative feedback only in the group that attributed errors to their ability. There were no significant differences between positive and negative feedback for any other conditions.

The absence of a visible negative deflection after additional feedback in a flanker task has also been reported by Bruijn et al (2004). As noted earlier, the difficulty of producing two error signals (ERN, fERN) within one experiment has been discussed by Holryed & Coles (2002) suggesting that the less information the feedback stimulus provides, the less constant and visible is the magnitude of the fERN. Using a gambling task with different mappings (100% mapping if participants were contingently rewarded associated with a particular button press vs. 50% mapping if subjects were randomly rewarded regardless of the key press). Holroyed & Coles (2002) showed that the 100% mapping resulted in an increased ERN and a reduced fERN over time while the 50 % mapping showed an opposite pattern. The authors suggested that by the time subjects had learned the association between key press and reward the fERN would decrease because it would not contain any additionally information about the subject's performance. This is consistent with our finding that there was no visible fERN component in the external group as well as in the internal group before the manipulation. However, since we found a sharp negative deflection after feedback onset in the group that attributed errors to their ability we suggest that the additional emotional valence associated with internal attribution as reported in classical social psychology studies (Feather et al, 1967, Rotter, 1954, Weiner, 1992) elicited the feedback component. This finding is consistent with Luu et al (2003), who reported fronto-medial negativity after feedback which they postulated only contained emotional valence. In their study,

Luu et al (2003) used a delayed-feedback paradigm so that the performance information, which was presented prior to a target arrow, did not provide relevant information related to the immediate response but they suggested that the emotional valence as a performance indicator would be retained. The authors found a feedback related negativity, suggesting that the fERN tracked the negative affective response to the feedback. Therefore we speculate that the negative deflection after the feedback, only following internal attribution could be ascribed to the elicitation of medio-frontal negativity caused by emotional significance of the feedback, which is associated with internal attribution (i.e. Feather et al 1967).

As reported by Nieuwenhuis et al, (2004), the fERN amplitude is likely to vary with the magnitude of the P300 amplitude. We also assessed the amplitude of the P300, showing that a significant reduction of the P300 amplitude could be observed for external attribution. The P300 component has been reported to be associated with basic information processing, reflecting working memory processes and attention (Sutton et al, 1965). It could be hypothesized that the reduced P300 after instruction B reflected less attention and interest in the feedback stimulus. P300 amplitude changes have also been seen when there are fluctuations in the arousal state of the subject (see for example Polich & Kok, 1995). In our study external attribution may well have reduced arousal. Additionally Olofsson et al (2007) suggested that intense emotional pictures (pleasant and unpleasant) elicited an increased P300 in comparison to neutral stimuli. Furthermore Yeung & Sanfey, (2004) have reported a reduced P300 amplitude as the magnitude of the error decreased. Thus the reduced P300 amplitude we found with external attribution for errors could be interpreted as reflecting less emotional significance to the negative feedback stimulus. Importantly however, we also evaluated the fERN component peak to peak amplitude in order to separate the different component effects. We found, that the effect of differences between the fERN and the locus of causality persisted even when the confounding effect of the P300 was considered.

Even though we also expected differences in the ERN magnitude, since numerous studies have reported changes in the ERN associated with error valence (Falkenstein et al, 2000; Gehring, et al, 1993; Niewhuis, 2001) we could not find significant differences in the ERN between the two groups. It could be postulated that the recall of the information given in the pre-task instruction and the evaluation and judgment about the cause of the error occurred subsequently to error awareness and therefore did not influence the early components. Seeking to identify, the affective context induced modulations of the ERN Larson, et al (2006) reported significantly larger and earlier peaking amplitudes of the ERN in the context of pleasant backgrounds. In contrast Moser et al, (2005) could not find any impact on the ERN amplitude in fear induced vs. control conditions. Additionally, motivational related changes of the ERN amplitude have been reported to be mediated by personality differences (Pailing & Segalowitz, 2003). Further studies evaluating the effect of the attributional personality style, could possibly clarify these findings.

Additionally, it might be suspected that differences in the amplitude of early and later error and feedback signals differ in state vs. trait factors, such that the state manipulation of attribution cannot affect early potentials, while a deviate attributional style (as noted before to be also present in various psychiatric conditions) would lead to ERN differences. Since abnormalities in the error signals have been in clinical conditions such as major depressive disorder for the ERN and the fERN, further research could investigate, whether these abnormalities in error and feedback component amplitudes are still present after attribution manipulation or attributional retraining (Foersteling, 1988).

Since this has been the first investigation of the influence of causality ascriptions on error related components further research is needed to support these initial findings. However, since numerous behavioral studies have reported that attribution influences emotion, motivation, cognition and behavior (i.e. Feather 1978; Mc Farland & Ross, 1983; Rotter, 1954; Wasserman, 1990; for an overview see Foersterling, 2002; Weiner, 1992) we therefore suggest that attribution is an important topic for neuroscience research.

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Hierzu im Anhang:

SPSS Tabellen (ERN, Differenzwellen ERN, fERN, Differenz ERN-P300)

4) ZUSAMMENFASSUNG DER ARBEIT

In dieser Arbeit wurde ein experimentelles Design zur neurowissenschaftlichen Erfassung von Attribution entwickelt, evaluiert und im Zuge von EEG-Messungen zur Untersuchung von Attributionseffekten auf die neurophysiologischen Korrelate der Fehlerverarbeitung verwendet.

Es wurde eine klassische „Flanker - Aufgabe“ durch einen adaptiven Algorithmus so verändert, dass die Leistung der Versuchspersonen auf Zufallsniveau gehalten wurde. Einunddieselbe Aufgabe wurde dabei - nach einem Block ohne Manipulation - einer Versuchsgruppe als schwierig und der anderen Gruppe als einfach beschrieben. Damit konnte ermöglicht werden, stabile, differenzielle Ursachenwahrnehmungen für die Fehler zu induzieren. Die Gruppen unterschieden sich signifikant zwischen externer und interner Attribution über eine große Anzahl von Durchgängen; dabei blieben aber Anstrengung und Reaktionszeit konstant. Das verwendete Design erfüllt optimale Ansprüche für neurowissenschaftliche Studien und bietet damit eine neue Möglichkeit, das aktuelle Erlebnis unterschiedlicher Attributionen in kontrolliertem Setting zu untersuchen.

Unter Verwendung der neu entwickelten Methode wurden ereigniskorrelierte Potenziale ermittelt, um den Einfluss von Attribution auf Fehler- und Feedbackverarbeitung zu untersuchen. Die ERN, eine frühe Komponente, welche mit Fehlerverarbeitung im Zusammenhang steht, war durch die unterschiedlichen Attributionen nicht verändert.

Bedeutsam ist die Erkenntnis, dass die fERN - eine Komponente, die nach Feedbackverarbeitung auftritt, - nur in der intern attributierenden Gruppe nach der Manipulation aufgetreten ist. Die fERN unterschied sich hier signifikant zwischen positivem und negativem Feedback. Dies bestätigt auch vorherige Befunde, die ebenfalls zeigen, dass für die fERN auch der emotionale Wert entscheidend ist.
Die geringere Bedeutung des Fehlers und des Feedbacks für externe Manipulation zeigte sich zusätzliche in einer signifikant reduzierten P300 Amplitude bei Versuchspersonen, welche die Fehlerursache nicht sich selbst zuschrieben.

Zwei Publikationen sind im Zuge dieser Diplomarbeit von mir erstellt worden:

Terbeck, S., Chesterman, P., Fischmeister, F., Leodolter, U., Bauer, H. (2008). Attribution and Social Cognitive Neuroscience: A new Approach for "online assessment" of causality ascriptions and their emotional consequences. *Journal of Neuroscience Methods*, 173 (1), 13-19

Terbeck, S., Fischmeister, F., Chesterman, P., Bauer. H. Experimental manipulation of causal ascription: Its effect on error and feedback processing in the brain *(to be submitted)*

5) Anhang

1. Attributionsmanipulation

1.1. ITACA Titelblatt (Praesentation vor der Flanker Task; Gruppe intern)

ITACA- CV III reversed

International Test Attention-Concentration Ability

Computer Version

Internationaler Test Aufmerksamkeits-konzentrations- Fähigkeit

Option: Deutsch
Manual: Deutsch
Computer Version

1.2. Attributionsfragebogen

Fragebogen

Erläuterungen

Auf den folgenden Seiten finden Sie kurze Beschreibungen von Situationen von den vorherigen Aufgaben. Zu jeder Situation ist eine kleine Auswahl von Gedanken und Gefühlen angeführt, die man damit verbinden könnte.

Sie sollen Sie nun in diese Situationen möglichst gut zurückversetzen, oder in sie hineinversetzen, auch wenn Sie bei Ihnen nicht so aufgetreten sind. Anschließend sollen Sie ganz gefühlsmäßig entscheiden, inwieweit die angeführten Gedanken sinngemäß auch für Sie persönlich zutreffen.

Es werden also zu jeder Situation verschiedene Gedankengänge angeführt. Kreuzen Sie bitte für jeden an, inwieweit er für Sie zutrifft. Dabei stehen Ihnen vier Möglichkeiten zur Auswahl, die gleiche Abstufungen von „trifft vollkommen zu“ bis „trifft auf keinen Fall zu“ bedeuten:

Trifft auf keinen Fall zu	trifft kaum zu	trifft oft zu	trifft vollkommen zu
1	2	3	4

Beispiel:

Stellen Sie sich vor, Sie hätten einige Fehler gemacht.

a) „ Das ist ja Pech“--------------------------------------1----------2----------3----------4

b) „ Ich habe mich auch nicht sehr angestrengt“--------1----------2----------3----------4

Beachten Sie, dass es keine „richtigen“ und „falschen“ Antworten gibt !

Bearbeiten Sie die Fragen zügig und spontan, ohne lange nachzudenken.

Trifft auf keinen Fall zu | Trifft vollkommen zu

1. Stellen Sie sich vor, Sie hätten bei den Aufgaben insgesamt viele **richtig** gemacht.

a) Ich habe eben eine sehr gute Konzentrationsfähigkeit ------------------------1--------------2-------------3-------------4

b) Das war ja auch nicht so schwer, jeder Andere hätte das auch gekonnt --------------1--------------2-------------3------------4

c) Ich habe eben hart gearbeitet. -----------------------1--------------2-------------3------------4

d) Da hat das Glück wahrscheinlich eine große Rolle gespielt ---------------------------1--------------2-------------3------------4

Trifft auf keinen Fall zu | Trifft vollkommen zu

2. Was ist Ihnen in den Sinn gekommen, wenn Sie Aufgaben **falsch** gelöst haben?

a) Scheinbar ist meine Aufmerksamkeits- und Konzentrationsfähigkeit wohl nicht so hoch-----------------------------------1------------2---------------3----------------4

b) Bei diesen schweren Aufgaben muss man ja Fehler machen-------------------------------------1--------------2--------------3---------------4

c) Warum muss ich immer vom Pech verfolgt sein-----------------------------1---------------2------------3---------------4

d) Das nächste Mal strenge ich mich mehr an---1--------------2-------------3-------------4

Trifft auf keinen Fall zu | Trifft vollkommen zu

3. Stellen Sie sich vor, Sie hätten insgesamt sehr viele Aufgaben **falsch** gemacht.

a) Sicher war das nur Zufall, und hat nichts mit mir zutun--------------------------------1---------------2-------------3-----------------4

b) Ich habe eben keine hohe Konzentration und Aufmerksamkeit----------------------------------1---------------2-------------3-----------------4

c) Wenn ich mehr angestrengt hätte, wäre das sicher nicht so gekommen----------------------1--------------2-------------3-----------------4

d) Die Anforderungen waren ja auch extra hoch---1--------------2--------------3-----------------4

4. Stellen Sie sich vor, der Versuchsleiter würde Ihnen mitteilen, dass man aufgrund der Aufgaben festgestellt hätte, dass Sie eine **geringe** Konzentrationsfähigkeit haben

Trifft auf keinen Fall zu | Trifft vollkommen zu

a) Vielleicht war ich doch zu demotiviert und faul-------------------------------1-------------2--------------3------------------4

b) Das kann man nicht so sagen, bei diesen Aufgaben schneiden ja viele schlecht ab.---------------------1------------2---------------3----------------4

c) Er hätte mich ebenso gut loben können, das kann man vorher nie wissen.------------------1------------2----------------3--------------4

d) Ich bin nicht so gut, wenn ich unter Druck stehe.---1-------------2-------------3----------------4

	Trifft auf keinen Fall zu			Trifft vollkommen zu
5. Was haben Sie gedacht, wenn Sie **Fehler** gemacht haben?				
a) So was passiert halt. Alles nur Schicksal	1	2	3	4
b) Mir gelingt es einfach nicht das jetzt richtig zu machen	1	2	3	4
c) „Mist" ich hätte mir mehr Mühe geben sollen	1	2	3	4
d) Das macht nix, die Aufgaben machen ja viele falsch	1	2	3	4

	Trifft auf keinen Fall zu			Trifft vollkommen zu
6. Stellen Sie sich nun bitte vor, dass Sie mitgeteilt bekommen, sehr viele Aufgaben **richtig** gelöst haben				
a) Ich bin eben besonders geeignet für solche Aufgaben	1	2	3	4
b) Das hätte ja jeder gekonnt	1	2	3	4
c) Erfolg ist eine Sache harter Arbeit	1	2	3	4
d) Mir eh egal, das hätte jedem passieren können, ich habe darauf keinen Einfluss	1	2	3	4

Trifft auf keinen Fall zu

Trifft vollkommen zu

7. Woran haben Sie gedacht, wenn Sie **positives** Feedback (grünes Plus) bekommen haben?

a) Ich habe Talent für solche Aufgaben--1-----------2-------------3---------------4

b) Das waren ja auch einfach ----------------------1-----------2-------------3---------------4

c) Alles nur Zufall------------------------------------1-----------2------------3--------------4

d) Ich habe mich auch schließlich bemüht ---------1------------2------------3--------------4

1.3.Attributionsfragebogen (englisch), freie Uebersetzung

Questionnaire

Explanations

On the following pages you will find a brief description of situations during the recent task. For each situation there is a little selection of thoughts and feelings one could associate with the situation.

You should now think back to those situations, or put yourself into the situation even if it might have not occurred for you. In the following you should decide how you feel on it, and to witch extend the mentioned thoughts apply to you.

So there will be different thoughts for each situation, please mark for all, to witch extend they apply to you. Therefore you got four choices in the rage from “applies completely” to “applies in no way”.

1 = Applies in no way
2= Applies barley
3= Applies often
4= Applies completely

Example

Imagine you had committed some errors.

a) “That’s bad luck” 1----------2----------3----------4----------5
b) ”I did not try very hard.” 1----------2----------3----------4----------5

Attend, that there are not “right” or “wrong” answers!

Work on the questions speedy and spontaneously, without thinking about it to long.

1. Imagine, overall you got many answers **right.**

a) My concentration ability
is quite good. 1----------2----------3----------4----------5

b) That wasn't hard, other person could have done so as well 1----------2----------3----------4----------5

c) I have worked very hard 1----------2----------3----------4----------5

d) Luck played a major role 1----------2----------3----------4----------5

2. What came to your mind when you committed **errors**?

a) It seems that my attention
and concentration ability is not very well. 1----------2----------3----------4----------5

b) Because the task was difficult,
errors are likely. 1----------2----------3----------4----------5

c) Why does misfortune always
have to follow me? 1----------2----------3----------4----------5

d) Next time, I will work harder. 1----------2----------3----------4----------5

3. Imagine, overall you got many answers **wrong**

1. Sure that was just chance and
has got nothing to do with me. 1----------2----------3----------4----------5
2. I just don't have an excellent
concentration and attention ability. 1----------2----------3----------4----------5
3. If I had worked harder,
it wouldn't have happened. 1----------2----------3----------4----------5
4. The requirements were extra high. 1----------2----------3----------4----------5

4. Imagine, the experimentator would tell you, that because of the task, it has been discovered that you have a **low** concentration ability.

Maybe I have been to addle
and demotivated. 1----------2----------3----------4----------5

One can't say that,
lots of people perform badly on
those kind of tasks. 1----------2----------3----------4----------5

He could also have loaded me,
you cannot know that before. 1----------2----------3----------4----------5

I am not very good,
if I am under pressure. 1----------2----------3----------4----------5

5. What did you think about when you committed **errors**?

a) It happens. Everything is destiny. 1----------2----------3----------4----------5
b) I can't manage performing well. 1----------2----------3----------4----------5
c) "Damn", I should
 have taken more care. 1----------2----------3----------4----------5

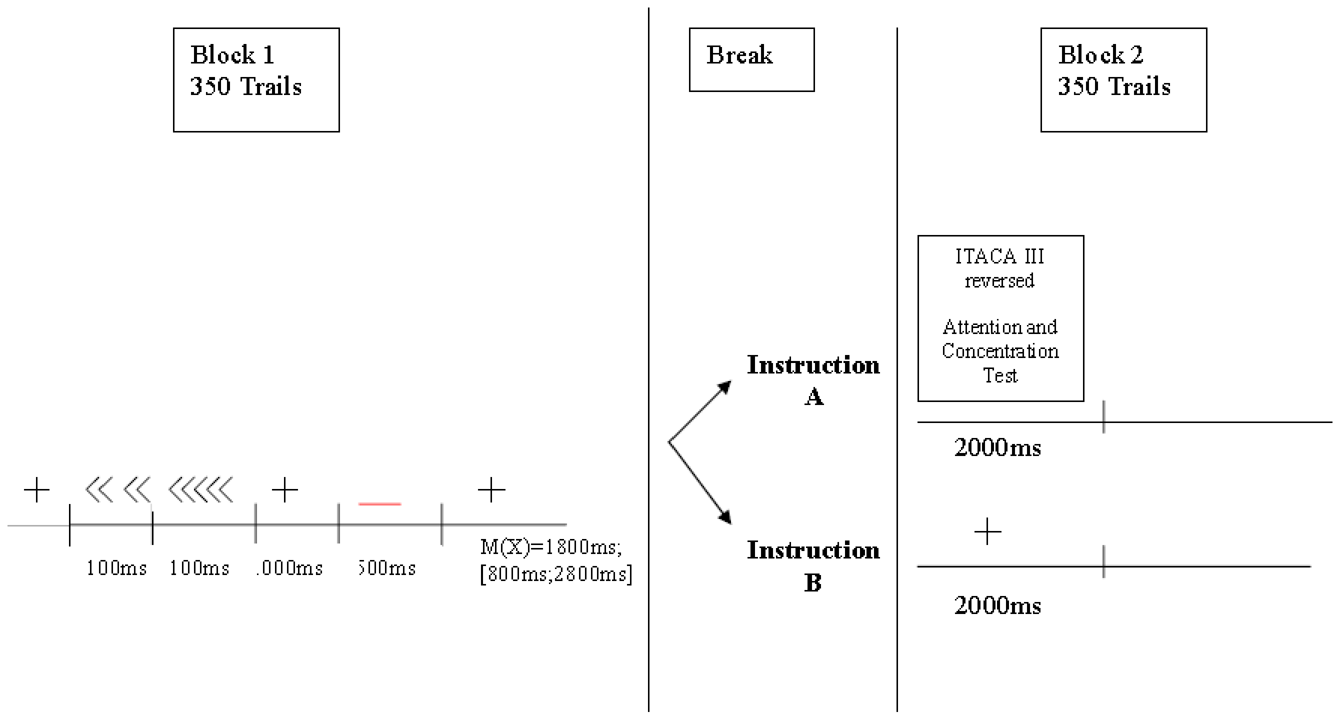
6. Now, imagine please, you would get the information that overall you would have done **well** in lots of trails.

a) I am applicative for those kind of tasks. 1----------2----------3----------4----------5
b) Everyone could have done so. 1----------2----------3----------4----------5
c) Success is a matter of hard work. 1----------2----------3----------4----------5
d) I don't care,
 that could have happened to everyone,
 I can't influence that. 1----------2----------3----------4----------5

7. What did you think about when you got **positive Feedback** during the task?

a) I am talented. 1----------2----------3----------4----------5
b) That was just easy. 1----------2----------3----------4----------5
c) Just Chance. 1----------2----------3----------4----------5
d) After all, I tried very hard. 1----------2----------3----------4----------5

1.4.Schematische Darstellung des Versuchsdesings



2) SPSS Tabellen

2.1. Tabelle Mann Whitney U-Test (Attributionsmanipulation)

NPar Tests

Mann-Whitney Test

Ranks

	Group	N	Mean Rank	Sum of Ranks
Average Score Success Ability	Instruction A	12	9,83	118,00
	Instruction B	12	15,17	182,00
	Total	24		
Average Score Success Difficulty	Instruction A	12	12,96	155,50
	Instruction B	12	12,04	144,50
	Total	24		
Average Score Success Effort	Instruction A	12	12,67	152,00
	Instruction B	12	12,33	148,00
	Total	24		
Average Score Success Chance	Instruction A	12	10,75	129,00
	Instruction B	12	14,25	171,00
	Total	24		
Average Score Failure Ability	Instruction A	12	16,33	196,00
	Instruction B	12	8,67	104,00
	Total	24		
Average Score Failure Difficulty	Instruction A	12	7,50	90,00
	Instruction B	12	17,50	210,00
	Total	24		
Average Score Failure Effort	Instruction A	12	11,38	136,50
	Instruction B	12	13,63	163,50
	Total	24		
Average Score Failure Chance	Instruction A	12	9,88	118,50
	Instruction B	12	15,13	181,50
	Total	24		

Test Statistics[b]

	Average Score Success Ability	Average Score Success Difficulty	Average Score Success Effort	Average Score Success Chance	Average Score Failure Ability	Average Score Failure Difficulty
Mann-Whitney U	40,000	66,500	70,000	51,000	26,000	12,000
Wilcoxon W	118,000	144,500	148,000	129,000	104,000	90,000
Z	-1,891	-,325	-,117	-1,239	-2,693	-3,488
Asymp. Sig. (2-tailed)	,059	,745	,907	,215	,007	,000
Exact Sig. [2*(1-tailed Sig.)]	,068[a]	,755[a]	,932[a]	,242[a]	,007[a]	,000[a]

2.2. SPSS Tabelle Verhaltensdaten (Flanker Task)

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

bed	cong	answer	Dependent Variable
1	1	1	BECR
		2	BECE
		3	BECT
	2	1	BEICR
		2	BEICE
		3	BEICT
2	1	1	BICR
		2	BICE
		3	BICT
	2	1	BIICR
		2	BIICE
		3	BIICT

Between-Subjects Factors

		Value Label	N
Gruppe	1	Instruktion A	12
	2	Instruktion B	12

Multivariate Tests[b]

Effect		Value	F	Hypothesis df
bed	Pillai's Trace	,030	,687[a]	1,000
	Wilks' Lambda	,970	,687[a]	1,000
	Hotelling's Trace	,031	,687[a]	1,000
	Roy's Largest Root	,031	,687[a]	1,000
bed * Gruppe	Pillai's Trace	,024	,535[a]	1,000
	Wilks' Lambda	,976	,535[a]	1,000
	Hotelling's Trace	,024	,535[a]	1,000
	Roy's Largest Root	,024	,535[a]	1,000
cong	Pillai's Trace	,003	,064[a]	1,000
	Wilks' Lambda	,997	,064[a]	1,000
	Hotelling's Trace	,003	,064[a]	1,000
	Roy's Largest Root	,003	,064[a]	1,000
cong * Gruppe	Pillai's Trace	,067	1,592[a]	1,000
	Wilks' Lambda	,933	1,592[a]	1,000
	Hotelling's Trace	,072	1,592[a]	1,000
	Roy's Largest Root	,072	1,592[a]	1,000
answer	Pillai's Trace	,974	392,720[a]	2,000
	Wilks' Lambda	,026	392,720[a]	2,000
	Hotelling's Trace	37,402	392,720[a]	2,000
	Roy's Largest Root	37,402	392,720[a]	2,000
answer * Gruppe	Pillai's Trace	,031	,341[a]	2,000
	Wilks' Lambda	,969	,341[a]	2,000
	Hotelling's Trace	,032	,341[a]	2,000
	Roy's Largest Root	,032	,341[a]	2,000
bed * cong	Pillai's Trace	,012	,271[a]	1,000
	Wilks' Lambda	,988	,271[a]	1,000
	Hotelling's Trace	,012	,271[a]	1,000
	Roy's Largest Root	,012	,271[a]	1,000
bed * cong * Gruppe	Pillai's Trace	,033	,752[a]	1,000
	Wilks' Lambda	,967	,752[a]	1,000
	Hotelling's Trace	,034	,752[a]	1,000
	Roy's Largest Root	,034	,752[a]	1,000
bed * answer	Pillai's Trace	,544	12,502[a]	2,000
	Wilks' Lambda	,456	12,502[a]	2,000
	Hotelling's Trace	1,191	12,502[a]	2,000
	Roy's Largest Root	1,191	12,502[a]	2,000
bed * answer * Gruppe	Pillai's Trace	,025	,267[a]	2,000
	Wilks' Lambda	,975	,267[a]	2,000
	Hotelling's Trace	,025	,267[a]	2,000
	Roy's Largest Root	,025	,267[a]	2,000
cong * answer	Pillai's Trace	,872	71,602[a]	2,000
	Wilks' Lambda	,128	71,602[a]	2,000
	Hotelling's Trace	6,819	71,602[a]	2,000
	Roy's Largest Root	6,819	71,602[a]	2,000
cong * answer * Gruppe	Pillai's Trace	,084	,968[a]	2,000
	Wilks' Lambda	,916	,968[a]	2,000
	Hotelling's Trace	,092	,968[a]	2,000
	Roy's Largest Root	,092	,968[a]	2,000
bed * cong * answer	Pillai's Trace	,153	1,890[a]	2,000
	Wilks' Lambda	,847	1,890[a]	2,000
	Hotelling's Trace	,180	1,890[a]	2,000
	Roy's Largest Root	,180	1,890[a]	2,000
bed * cong * answer * Gruppe	Pillai's Trace	,024	,253[a]	2,000
	Wilks' Lambda	,976	,253[a]	2,000
	Hotelling's Trace	,024	,253[a]	2,000
	Roy's Largest Root	,024	,253[a]	2,000

Multivariate Tests[b]

Effect		Error df	Sig.
bed	Pillai's Trace	22,000	,416
	Wilks' Lambda	22,000	,416
	Hotelling's Trace	22,000	,416
	Roy's Largest Root	22,000	,416
bed * Gruppe	Pillai's Trace	22,000	,472
	Wilks' Lambda	22,000	,472
	Hotelling's Trace	22,000	,472
	Roy's Largest Root	22,000	,472
cong	Pillai's Trace	22,000	,803
	Wilks' Lambda	22,000	,803
	Hotelling's Trace	22,000	,803
	Roy's Largest Root	22,000	,803
cong * Gruppe	Pillai's Trace	22,000	,220
	Wilks' Lambda	22,000	,220
	Hotelling's Trace	22,000	,220
	Roy's Largest Root	22,000	,220
answer	Pillai's Trace	21,000	,000
	Wilks' Lambda	21,000	,000
	Hotelling's Trace	21,000	,000
	Roy's Largest Root	21,000	,000
answer * Gruppe	Pillai's Trace	21,000	,715
	Wilks' Lambda	21,000	,715
	Hotelling's Trace	21,000	,715
	Roy's Largest Root	21,000	,715
bed * cong	Pillai's Trace	22,000	,608
	Wilks' Lambda	22,000	,608
	Hotelling's Trace	22,000	,608
	Roy's Largest Root	22,000	,608
bed * cong * Gruppe	Pillai's Trace	22,000	,395
	Wilks' Lambda	22,000	,395
	Hotelling's Trace	22,000	,395
	Roy's Largest Root	22,000	,395
bed * answer	Pillai's Trace	21,000	,000
	Wilks' Lambda	21,000	,000
	Hotelling's Trace	21,000	,000
	Roy's Largest Root	21,000	,000
bed * answer * Gruppe	Pillai's Trace	21,000	,768
	Wilks' Lambda	21,000	,768
	Hotelling's Trace	21,000	,768
	Roy's Largest Root	21,000	,768
cong * answer	Pillai's Trace	21,000	,000
	Wilks' Lambda	21,000	,000
	Hotelling's Trace	21,000	,000
	Roy's Largest Root	21,000	,000
cong * answer * Gruppe	Pillai's Trace	21,000	,396
	Wilks' Lambda	21,000	,396
	Hotelling's Trace	21,000	,396
	Roy's Largest Root	21,000	,396
bed * cong * answer	Pillai's Trace	21,000	,176
	Wilks' Lambda	21,000	,176
	Hotelling's Trace	21,000	,176
	Roy's Largest Root	21,000	,176
bed * cong * answer * Gruppe	Pillai's Trace	21,000	,779
	Wilks' Lambda	21,000	,779
	Hotelling's Trace	21,000	,779
	Roy's Largest Root	21,000	,779

a. Exact statistic

2.3. SPSS Tabelle ERN

```
GLM
  E48.BlockeFalsch.AERN E48.BlockeRichtig.AERN BY VAR00001
  /WSFACTOR = output 2 Polynomial
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = output
  /DESIGN = VAR00001 .
```

General Linear Model

```
[DataSet1] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\ERN.sav
```

Within-Subjects Factors

Measure: MEASURE_1

output	Dependent Variable
1	E48. Blocke Falsch.AERN
2	E48. Blocke Richtig.AERN

Between-Subjects Factors

		N
VAR00001	1,00	11
	2,00	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
output	Pillai's Trace	,580	27,668[a]	1,000	20,000	,000
	Wilks' Lambda	,420	27,668[a]	1,000	20,000	,000
	Hotelling's Trace	1,383	27,668[a]	1,000	20,000	,000
	Roy's Largest Root	1,383	27,668[a]	1,000	20,000	,000
output * VAR00001	Pillai's Trace	,118	2,675[a]	1,000	20,000	,118
	Wilks' Lambda	,882	2,675[a]	1,000	20,000	,118
	Hotelling's Trace	,134	2,675[a]	1,000	20,000	,118
	Roy's Largest Root	,134	2,675[a]	1,000	20,000	,118

a. Exact statistic

b.

Design: Intercept+VAR00001
Within Subjects Design: output

```
GLM
  E48.BlockiFalsch.AERN E48.BlockiRichtig.AERN BY VAR00001
  /WSFACTOR = output 2 Polynomial
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = output
  /DESIGN = VAR00001 .
```

General Linear Model

```
[DataSet1] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\ERN.sav
```

Within-Subjects Factors

Measure: MEASURE_1

output	Dependent Variable
1	E48. BlockiFalsch. AERN
2	E48. BlockiRichtig. AERN

Between-Subjects Factors

		N
VAR00001	1,00	11
	2,00	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
output	Pillai's Trace	,469	17,661[a]	1,000	20,000	,000
	Wilks' Lambda	,531	17,661[a]	1,000	20,000	,000
	Hotelling's Trace	,883	17,661[a]	1,000	20,000	,000
	Roy's Largest Root	,883	17,661[a]	1,000	20,000	,000
output * VAR00001	Pillai's Trace	,003	,068[a]	1,000	20,000	,797
	Wilks' Lambda	,997	,068[a]	1,000	20,000	,797
	Hotelling's Trace	,003	,068[a]	1,000	20,000	,797
	Roy's Largest Root	,003	,068[a]	1,000	20,000	,797

a. Exact statistic

b.

Design: Intercept+VAR00001
Within Subjects Design: output

2.4. SPSS Tabelle Differenzwellen ERN

```
GLM
  Cz.Blockediff.AERN Cz.Blockidiff.AERN BY Group
  /WSFACTOR = Time 2 Polynomial
  /METHOD = SSTYPE(3)
  /PLOT = PROFILE( Group*Time )
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = Time
  /DESIGN = Group .
```

General Linear Model

```
[DataSet1] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\ERN, PE, Diff.sav
```

Within-Subjects Factors

Measure: MEASURE_1

Time	Dependent Variable
1	Cz.Blockediff. AERN
2	Cz.Blockidiff. AERN

Between-Subjects Factors

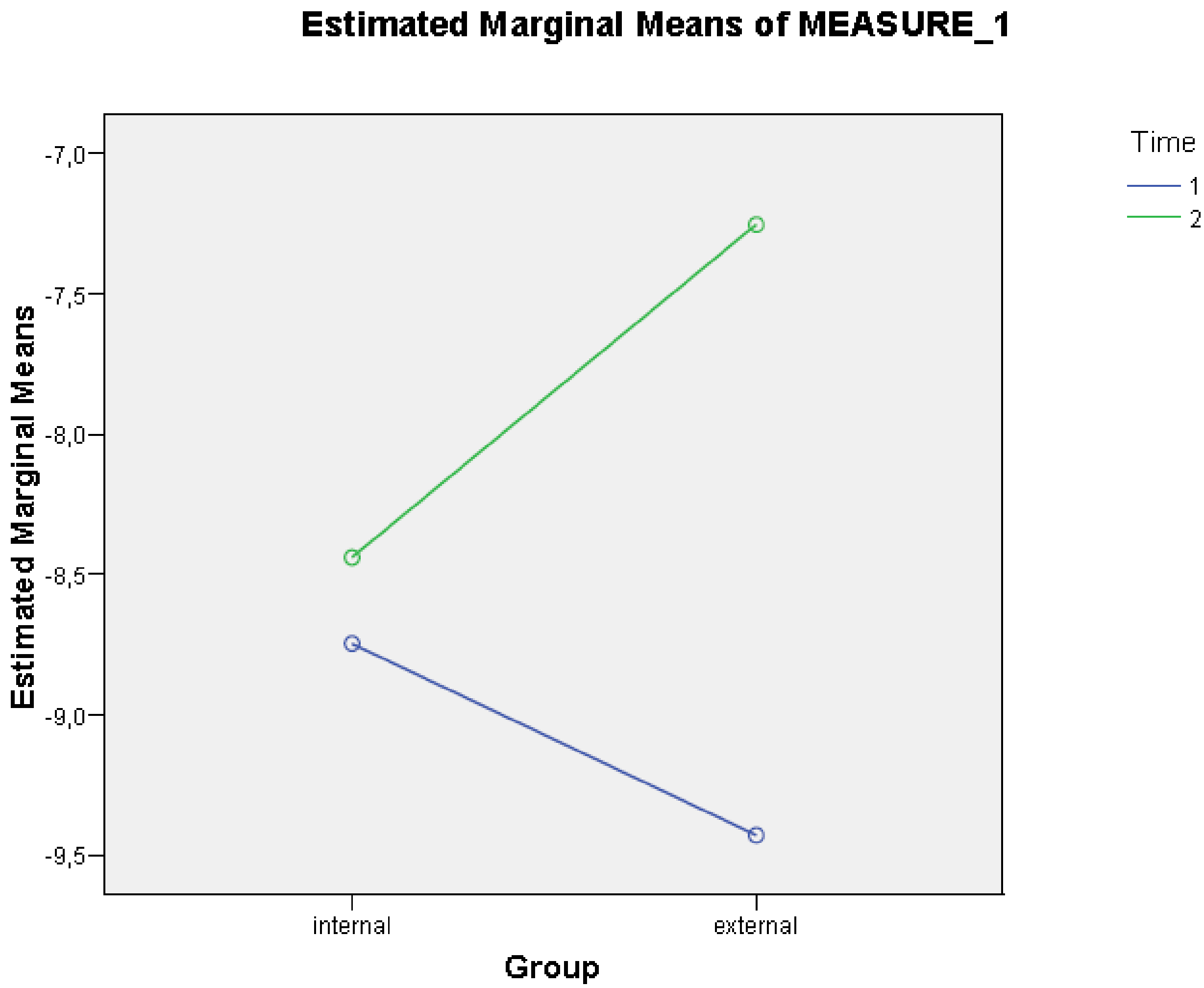
		Value Label	N
Group	1	internal	11
	2	external	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Pillai's Trace	,064	1,363[a]	1,000	20,000	,257
	Wilks' Lambda	,936	1,363[a]	1,000	20,000	,257
	Hotelling's Trace	,068	1,363[a]	1,000	20,000	,257
	Roy's Largest Root	,068	1,363[a]	1,000	20,000	,257
Time * Group	Pillai's Trace	,037	,772[a]	1,000	20,000	,390
	Wilks' Lambda	,963	,772[a]	1,000	20,000	,390
	Hotelling's Trace	,039	,772[a]	1,000	20,000	,390
	Roy's Largest Root	,039	,772[a]	1,000	20,000	,390

a. Exact statistic

b.
Design: Intercept+Group
Within Subjects Design: Time


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
-7,0
-7,5
-8,0
-8,5
-9,0
-9,5
internal
external
Group
Time
1
2

2.5. SPSS Tabelle fERN

```
GLM
  V9.BlockeRichtig.AfERN V9.BlockeFalsch.AfERN BY Gruppe
  /WSFACTOR = output 2 Polynomial
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = output
  /DESIGN = Gruppe .
```

General Linear Model

```
[DataSet1] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\FERN.sav
```

Within-Subjects Factors

Measure: MEASURE_1

output	Dependent Variable
1	V9. Blocke Richtig. AfERN
2	V9. Blocke Falsch. AfERN

Between-Subjects Factors

		Value Label	N
Gruppe	1,00	Internal	11
	2,00	External	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
output	Pillai's Trace	,030	,620[a]	1,000	20,000	,440
	Wilks' Lambda	,970	,620[a]	1,000	20,000	,440
	Hotelling's Trace	,031	,620[a]	1,000	20,000	,440
	Roy's Largest Root	,031	,620[a]	1,000	20,000	,440
output * Gruppe	Pillai's Trace	,009	,187[a]	1,000	20,000	,670
	Wilks' Lambda	,991	,187[a]	1,000	20,000	,670
	Hotelling's Trace	,009	,187[a]	1,000	20,000	,670
	Roy's Largest Root	,009	,187[a]	1,000	20,000	,670

a. Exact statistic

b.
Design: Intercept+Gruppe
Within Subjects Design: output

```
GLM
  V9.BlockiRichtig.AfERN V9.BlockiFalsch.AfERN BY VAR00001
  /WSFACTOR = output 2 Polynomial
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = output
  /DESIGN = VAR00001 .
```

General Linear Model

```
[DataSet1] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\FERNac.sav
```

Within-Subjects Factors

Measure: MEASURE_1

output	Dependent Variable
1	V9. BlockiRichtig. AfERN
2	V9. BlockiFalsch. AfERN

Between-Subjects Factors

		N
VAR00001	1,00	11
	2,00	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
output	Pillai's Trace	,258	6,939[a]	1,000	20,000	,016
	Wilks' Lambda	,742	6,939[a]	1,000	20,000	,016
	Hotelling's Trace	,347	6,939[a]	1,000	20,000	,016
	Roy's Largest Root	,347	6,939[a]	1,000	20,000	,016
output * VAR00001	Pillai's Trace	,205	5,151[a]	1,000	20,000	,034
	Wilks' Lambda	,795	5,151[a]	1,000	20,000	,034
	Hotelling's Trace	,258	5,151[a]	1,000	20,000	,034
	Roy's Largest Root	,258	5,151[a]	1,000	20,000	,034

a. Exact statistic

b.

2.6. SPSS Tabelle P300

General Linear Model

[DataSet2] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\FERN.sav

Within-Subjects Factors

Measure: MEASURE_1

output	Dependent Variable
1	V9. BlockiFalsch. APOS
2	V9. BlockiRichtig. APOS

Between-Subjects Factors

		Value Label	N
Gruppe	1,00	Internal	11
	2,00	External	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
output	Pillai's Trace	,066	1,424[a]	1,000	20,000	,247
	Wilks' Lambda	,934	1,424[a]	1,000	20,000	,247
	Hotelling's Trace	,071	1,424[a]	1,000	20,000	,247
	Roy's Largest Root	,071	1,424[a]	1,000	20,000	,247
output * Gruppe	Pillai's Trace	,241	6,364[a]	1,000	20,000	,020
	Wilks' Lambda	,759	6,364[a]	1,000	20,000	,020
	Hotelling's Trace	,318	6,364[a]	1,000	20,000	,020
	Roy's Largest Root	,318	6,364[a]	1,000	20,000	,020

a. Exact statistic

b.
Design: Intercept+Gruppe
Within Subjects Design: output

2.7. SPSS Tabelle: Differenz fERN P300 (Peak to peak Analyse)

```
GLM
  BlockiRichtigDiff BlockeRichtigDiff BlockiFalschDiff BlockeFalschDiff BY
  Gruppe
  /WSFACTOR = output 2 Polynomial block 2 Polynomial
  /METHOD = SSTYPE(3)
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = output block output*block
  /DESIGN = Gruppe .
```

General Linear Model

```
[DataSet1] F:\Dokumente und Einstellungen\sterbeck.BRL\Eigene Dateien\MinusP300
```

Within-Subjects Factors

Measure: MEASURE_1

output	block	Dependent Variable
1	1	Blocki RichtigDiff
	2	Blocke RichtigDiff
2	1	Blocki FalschDiff
	2	Blocke FalschDiff

Between-Subjects Factors

		N
Gruppe	1,00	11
	2,00	11

Multivariate Tests[b]

Effect		Value	F	Hypothesis df
output	Pillai's Trace	,104	2,316[a]	1,000
	Wilks' Lambda	,896	2,316[a]	1,000
	Hotelling's Trace	,116	2,316[a]	1,000
	Roy's Largest Root	,116	2,316[a]	1,000
output * Gruppe	Pillai's Trace	,163	3,902[a]	1,000
	Wilks' Lambda	,837	3,902[a]	1,000
	Hotelling's Trace	,195	3,902[a]	1,000
	Roy's Largest Root	,195	3,902[a]	1,000
block	Pillai's Trace	,502	20,152[a]	1,000
	Wilks' Lambda	,498	20,152[a]	1,000
	Hotelling's Trace	1,008	20,152[a]	1,000
	Roy's Largest Root	1,008	20,152[a]	1,000
block * Gruppe	Pillai's Trace	,024	,501[a]	1,000
	Wilks' Lambda	,976	,501[a]	1,000
	Hotelling's Trace	,025	,501[a]	1,000
	Roy's Largest Root	,025	,501[a]	1,000
output * block	Pillai's Trace	,196	4,864[a]	1,000
	Wilks' Lambda	,804	4,864[a]	1,000
	Hotelling's Trace	,243	4,864[a]	1,000
	Roy's Largest Root	,243	4,864[a]	1,000
output * block * Gruppe	Pillai's Trace	,198	4,943[a]	1,000
	Wilks' Lambda	,802	4,943[a]	1,000
	Hotelling's Trace	,247	4,943[a]	1,000
	Roy's Largest Root	,247	4,943[a]	1,000

Multivariate Tests[b]

Effect		Error df	Sig.
output	Pillai's Trace	20,000	,144
	Wilks' Lambda	20,000	,144
	Hotelling's Trace	20,000	,144
	Roy's Largest Root	20,000	,144
output * Gruppe	Pillai's Trace	20,000	,062
	Wilks' Lambda	20,000	,062
	Hotelling's Trace	20,000	,062
	Roy's Largest Root	20,000	,062
block	Pillai's Trace	20,000	,000
	Wilks' Lambda	20,000	,000
	Hotelling's Trace	20,000	,000
	Roy's Largest Root	20,000	,000
block * Gruppe	Pillai's Trace	20,000	,487
	Wilks' Lambda	20,000	,487
	Hotelling's Trace	20,000	,487
	Roy's Largest Root	20,000	,487
output * block	Pillai's Trace	20,000	,039
	Wilks' Lambda	20,000	,039
	Hotelling's Trace	20,000	,039
	Roy's Largest Root	20,000	,039
output * block * Gruppe	Pillai's Trace	20,000	,038
	Wilks' Lambda	20,000	,038
	Hotelling's Trace	20,000	,038
	Roy's Largest Root	20,000	,038

a. Exact statistic

b.
Design: Intercept+Gruppe
Within Subjects Design: output+block+output*block

6)

CURRICULUM VITAE

Sylvia Terbeck

Date of Birth: 15.02.1983
Place of Birth: Münster/ Germany
Home Adress: Strudelhofgasse 8/4
Telephone: 0043-1-3101179
E-Mail: sylviaterbeck@web.de

Vienna, 20.10.2008

Terbeck, Sylvia
Strudelhofgasse 8/4
1090 Wien
Telephone: 0043-1-3101179
E-Mail: sylviaterbeck@web.de

Tertiary Education:

01.10.2003- 31.03.2006	University Kiel/Germany, Psychology Educational Qualification: “Vordiplom Psychologie” *Grade: 1 (sehr gut)*
Since 31.03.2006 Expected to 01.12.2008	University Vienna/Austria, Psychology *approximately one semester earlier as scheduled* *Average Grades: 1* Educational Qualification: “Magistra rer. nat.” (=Dipl. Psychologie)

Scholarships:

01.03.2006- 01.07.2006	DAAD (German academic Exchange Office): One semester “Free Mover scholarship”

Applied Psychology Work Experience:

01.11.2005- 31.03.2006	Social Psychiatry Residential Unit Kiel (Germany) *Part time assistant (Assigned Assessment of patients with chronic schizophrenia)*

Research Experience:

01.09.2004- 01.03.2005	Research Placement University Kiel *Criminal and Personality Psychology,* *Rating suggestive Interviews*
01.10.2006- 01.03.2007	Research Placement University Vienna *Brain Research Labor*

Terbeck, Sylvia
Strudelhofgasse 8/4
1090 Wien
Telephone: 0043-1-3101179
E-Mail: sylviaterbeck@web.de

Acquired Neuroscience Techniques:

- 64 channel Electroencephalogram (EEG)- Application
- LINUX- based- EEG- Data Analysis (Average, component analysis, filtering,)
- EEGLAB-software
- SPSS application for EEG Data

Professional Organizations:

Since 2005 German Psychological Society

International English Language Testing System (IELTS):

First Attempt: 05.2008 Overall Score: 7.5

Research Interest:

My major interest lies in combining neuroscience methodology to classical social psychology concepts. Specifically I see the findings twofold: A better understanding in prefrontal neural circlets associated with higher order processes, and additionally increasing the understanding of the psychological concept by using a measure that is unobtrusive in nature.
Investigations associated with attribution theory have been my major concern in previous work.

Terbeck, Sylvia
Strudelhofgasse 8/4
1090 Wien
Telephone: 0043-1-3101179
E-Mail: sylviaterbeck@web.de

Publication list

Terbeck, S., Chesterman, P., Leodolter, U., Fischmeister, F., Bauer, H. (2008). Attribution and Social Cognitive Neuroscience: A new approach for the "online- assessment of causality ascriptions and their emotional consequences. *Journal of Neuroscience Methods*, 173 (1), 13-19

Chesterman, P., **Terbeck, S**., Vaughan, F., Malingered Psychosis. (2008). *Journal of forensic Psychiatry and Psychology,* in press

Terbeck, S., Fischmeister, F., Chesterman, P., Bauer. H. Experimental manipulation of causal ascription: Its effect on error and feedback processing in the brain *(to be submitted)*

Work in progress

Terbeck, S., Causal Attribution and health beliefs of parents with ADHD children: An internet forum content analysis. (Submitting to *Journal of Medical Internet Research*)

Chesterman, P., **Terbeck, S.** Amnesia and Crime (Submitting to *Journal of forensic psychiatry and psychology*)

Vienna, 20.10.2008