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Houtveen, J.H.

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Alexithymia: A disruption in a cortical network?
-an EEG power and coherence analysis-

Jan H. Houtveen, Bob Bermond, & Martin R. Elton

Abstract

This study was designed to test the hypothesis that alexithymia reflects reduced interaction between modules of the integrated cortical neural network responsible for emotional processing. Two groups of 10 high and low scoring subjects were formed from undergraduates using their responses on an alexithymia questionnaire in a double-blind design. The EEG was recorded continuously from homologous occipital, parietal, temporal, and frontal recording sites during the presentation of film excerpts, one of neutral and two of emotional content. For each film, the last two minutes of EEG was digitally saved for off-line power and partial multiple intra- and interhemispheric coherence analysis of the alpha and beta frequency bands. It was found that alexithymics have reduced coherence between the right frontal lobe and the left hemisphere, independent of film. Power demonstrated a significant reduction of alpha for both emotional films, which was most pronounced at the parietal leads.
Chapter 7

Introduction

Alexithymia can be defined as a cognitive-affective disturbance characterized by difficulties in the capacity to experience and express emotions (Taylor, 1984; Krystal, 1988). Alexithymic individuals show a difficulty in identifying and describing affects, have an inability to use affects as signals of inner conflicts or of responses to external situations, have restricted imaginative processes, and they have an externally-oriented cognitive style (Taylor, Bagby, & Parker, 1989).

A neurophysiological model for alexithymia posits that it has as a contributory neurophysiological basis a deficit in the interhemispheric communication (Hoppe & Bogen, 1977; TenHouten, Walter, Hoppe, & Bogen, 1987,1988; Zeitlin, Lane, O'Leary, & Schrift, 1989; Dewaraja & Sasaki, 1990; Bermond, 1995). The model rests on the assumptions that, in normal right-handed persons, the right hemisphere is required for emotional information processing, while the left hemisphere is required for verbal and conscious information processing. Therefore, the production of a normal affective response requires a normal interaction between the two hemispheres (Krystal, 1988; TenHouten et al., 1987,1988; Zeitlin et al., 1989; Bermond, 1995). In their review article, Gainotti, Caltagirone, and Zoccolotti (1993) suggested a complementary role for the right and left hemispheres in emotional behaviour, with a relatively superior role for the right hemisphere in the regulation of emotional arousal and autonomic response to emotional stimuli, and a relatively superior role for the left hemisphere for both the cognitive and communicative aspects of emotions. They further postulated a magnification of the specific roles played by the right and left hemispheres in the processing and regulating of emotions at the level of the frontal lobes.

A study by Zeitlin et al. (1989) showed a deficit in interhemispheric transfer for alexithymic, neurologically-intact subjects (Vietnam veterans) on a tactile finger location task. They interpreted this impairment for alexithymics as due to a 'functional disconnection' of the two cerebral hemispheres. Dewaraja and Sasaki (1990) also found an indication for a deficit in the interhemispheric transfer for alexithymics, but specifically from the right to the left hemisphere.

In a more general model, alexithymia is considered to be a disruption in the integrated cortical neural network responsible for emotional processing. For emotional processes, a hierarchy of multiple networks is assumed that is distributed across the brainstem, limbic, paralimbic, and neocortical regions (Bear, 1991; Derryberry & Tucker, 1992; Tucker, 1993). For alexithymic individuals a dysfunction at the highest neocortical level of this hierarchy is hypothesized. Modules at this level (located mainly at the frontal neocortical regions) are essential for the highest level of emotional processing (Fuster, 1989).

Bermond (1995) distinguished two forms of alexithymia based on the presence or absence of what he defined as the emotional experience (the undifferentiated mental emotional arousal that can be experienced as a component of an emotion). Type I alexithymia is characterized by the absence of the
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emotional experience and, consequently, by the absence of the emotion accompanying cognitions. Type II alexithymia is characterized by the presence of the emotional experience and the absence of the normally accompanying cognitions. Bermond (1995) argued that particularly Type II alexithymia reflects an interhemispheric transfer deficit, and may be the result of a corpus callosum dysfunction. This thesis is based on the split brain studies of Gazzaniga and LeDoux (1978). Gazzaniga and LeDoux postulated that the cognitive components of stimuli presented to the right hemisphere reach the conscious left hemisphere directly by means of the corpus callosum, while the emotional value is first projected downwards to the limbic system and from there reaches the left hemisphere by the anterior commissure. Consequently, blocking the function of the corpus callosum can result in a specific type of alexithymia (Type II) in which the person still experiences emotional feelings, but has, beside this undifferentiated emotional arousal, no conscious cognitions concerning these emotional feelings.

The present study was designed to test the hypothesis that Type II alexithymia reflects reduced interaction between the modules of the integrated cortical neural network responsible for emotional processing in a neurologically intact population. Interhemispheric communication (between modules located in the frontal right and left cerebral hemispheres of the brain) may be impaired in Type II alexithymic individuals.

Differences between experimental conditions in the power distribution of EEG-frequencies, such as suppression of the alpha rhythm, may be used to detect a change in the subject's state of arousal or attention, and can be detected by performing a power spectral analysis (Cooper, Osselton, & Shaw, 1980). Additionally, coherence analysis may be conducted to describe the relationship between brain regions as expressed by their synchronous EEG activity. Coherence is a measure of the correlation of spectral energies between any pair of channels as a function of frequency, and is obtained by normalising the cross-spectrum of two channels by the product of their auto-power spectra (Enochson & Otnes, 1968; Dumermuth, 1977; Chatfield, 1980; Cooper et al., 1980; Gottman, 1981; Dumermuth & Molinari, 1987,1991). Coherence may be understood as a measure of the similarity of wave shape in a given frequency band between two signals, allowing a time shift between them. This value is always between 0 and 1 and is closely analogous to the square of the correlation coefficient. The advantage of coherence analysis over power data is its dependency on the spatial properties of a neural network. Disadvantages are the dependency of the coherence values on the choice of the reference (French & Beaumont, 1984; Nunez, et al., 1994), and volume conduction that can confound the coherence values and may be misinterpreted as shared activity of brain tissue (Nunez, et al., 1994). However, although an explanation of coherence solely by spherical volume conduction would predict a spatial homogeneous distribution of EEG coherence, Thatcher, Krause, and Hrybyk (1989) demonstrated a considerable lack of homogeneity in
the spatial distribution of EEG coherence recorded from the scalp. As a result, they concluded that the contribution of various fibre systems must be considered in the formulation of any model of human EEG coherence and that, in addition to volume conduction, both local and distant coupling between cortical neural generators are reflected in coherence. It is for this reason that this measure is chosen in this study.

It is, however, controversial whether coherence between electro-physiological signals from different parts of the brain may be interpreted as dependent on a structural connectivity or as an indication of functional coupling (task dependent) between these parts (Cooper et al., 1980). Researchers have applied power and coherence analyses to detect task dependent changes within or between the hemispheres, as well as to differentiate clinical groups (Beaumont, Mayes, & Rugg, 1978; Shaw, O'Connor, & Ongley, 1978; French & Beaumont, 1984). In their review of EEG coherence studies, French and Beaumont (1984) concluded that a differentiation of clinical groups is a valid application for coherence, although the question of whether performance on a specific task leads to a general increase in coherence in comparison to a 'resting' state has not been answered conclusively. Schellberg, Besthorn, Klos, and Gasser (1990) measured the EEG power as well as the intra- and interhemispheric coherences of right-handed, male subjects while they watched emotional (positive and negative) and neutral video films. Power analysis revealed a significant decrease of alpha power for the emotional films. Coherences demonstrated no main effect for film. They, however, found an interaction between film and the coherence topography. In studies of Tucker and Dawson (1984) and Hinrichs and Machleidt (1992), emotional states were induced by recollection and imagination. In both studies, changes in alpha power and coherences were found between emotion conditions, but in different relations to each other. The vast majority of studies, reviewed in French and Beaumont (1984), demonstrated no straightforward task-related coherence effects. However, Tucker, Roth, and Bair (1986) found parallels between asymmetries in the coherence topography and anatomical asymmetries of the human cortex, and TenHouten et al. (1987,1988) found differences between corpus callosotomy patients and controls in interhemispheric alpha-band coherences while both groups watched a symbolic emotional film. Thus, although it is doubtful whether coherence varies with cognitive activity, it may be used as a measure for structural connectivity between cortical regions.

A problem in the interpretation of the interhemispheric coherences exists. This problem is based on the estimation that the majority of fibres entering the gray matter of the cortex arise from within the same hemisphere (Nunez, 1981). As a result of this, most of the variance of a specific channel (area) is accounted for by the other channels (areas) of this hemisphere. This may mask the interhemispheric coherence. In most previous coherence research, coherence has been computed between pairs of channels, usually for the alpha frequency band (see French & Beaumont, 1984). This approach results in an enormous number of coherences to
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Analyse. A possible solution to these problems is factoring of the coherence matrix (Tucker & Roth, 1984). An alternative approach is the computation of the partial multiple coherences (Enochson & Ottes, 1968; Tucker et al., 1986). This approach offers the possibility to compute for each channel the intrahemispheric partial multiple coherence, representing the coherence between that channel and all other ipsilateral channels, after the variance accounted for by all contralateral electrodes has been partialled out, and to compute the interhemispheric partial multiple coherence, reflecting the coherence between that channel and all other contralateral channels, after the variance accounted for by all the other ipsilateral electrodes has been partialled out (Tucker et al., 1986). This might also reduce the contribution of volume conduction to coherence values.

In this study the power-spectra and the intra- and interhemispheric partial multiple coherences, as described in Tucker et al. (1986), are computed for the alpha and beta frequency bands. These measures are used to examine differences between alexithymic (Type II) and non-alexithymic individuals while they watch neutral and emotional video films. Insofar as EEG power and coherence measures are modulated by the emotional content of films a decrease in alpha power, independent of group, as an indication of emotional activation is hypothesized for emotional films relative to a neutral film. For reasons presented above, specifically lower frontal interhemispheric partial multiple coherences are hypothesized for the alexithymic individuals compared with controls while they watch emotional video films. No differences for the interhemispheric partial multiple coherences are hypothesized for the other leads. Since Dewaraja and Sasaki (1990) only found a right to left transfer deficit for alexithymic individuals for nonlinguistic, symbolic information (in the assumption that the right hemisphere is more specialised in symbolic information processing), the expected effect might be specific for a symbolic emotional video film compared to a blatant emotional video film.

Methods

Alexithymia assessment
Alexithymia was measured using the Bermond-Vorst-Alexithymia-Questionnaire (BVAQ), developed by the faculty of Psychology of the University of Amsterdam. The items loaded in a group of 465 first-year psychology students on five factors, which together explained 49% of the variance, producing five subscales each measuring a component of alexithymia. These subscales were interpreted as relating to the capacity to experience emotional feelings, the capacity to verbalise these experiences, the capacity to differentiate among various emotional feelings, the capacity to reflect about or analyse emotional experiences, and the capacity to fantasize about them. Each subscale consists of eight items (four positive and four negative). The internal reliability of the total scale is .89. Reliabilities for the
subscales varies between .77 and .89. By the aid of this questionnaire we were able to measure the various components of alexithymia, and to make a distinction between type I alexithymia (scoring low on all traits) and type II alexithymia (scoring high on the capacity to experience emotional feelings, but low on the other traits) as outlined in the introduction.

Subjects
First-year psychology students from the intake 1994 (n=373) of the University of Amsterdam were screened using the BVAQ. For four of the subscales, the population was divided in three equal parts scoring low, average, or high on that particular scale. The non-alexithymic individuals were selected by scoring high on the capacity to experience emotional feelings, high on the capacity to verbalise these experiences, high on the capacity to differentiate among various emotional feelings, and high on the capacity to fantasize about them. The alexithymic individuals (Type II) were selected by scoring high on the capacity to experience emotional feelings, but low on the other three subscales. No distinction is made based on the subscale measuring the capacity to analyse emotional experiences. Since psychology stresses the importance of analysing emotional experiences, psychology students probably don’t easily indicate that they fail to do so. Likewise, it is our experience that alexithymic people who have been in psychotherapy (in which they have been taught that analysing is important) score high on this subscale while scoring low on the other subscales of the questionnaire. Subjects were further selected for right-handedness (Oldfield, 1971), absence of neurological history, and no usage of medication known to affect the EEG. The final sample consisted of 10 subjects who were considered to be highly alexithymic (1 male, 9 females; mean age = 22.6 $SD = 2.18$), and 10 subjects who were considered to be non-alexithymic (2 males, 8 females; mean age = 21.6 $SD = 1.65$). 16 out of 20 subjects received course credit for participating. The remaining 4 subjects were paid.

Film stimuli
The selection of the clips was based on an evaluation in a pilot study in the laboratory. The warming-up video clip showed a documentary about art and lasted 10 minutes. The emotionally neutral (control) film clip lasted four minutes and showed old buildings and scenery in and around a Dutch village. The original sound was replaced by quiet chamber music. The symbolic anxiety film clip showed the first eight minutes of the film 'Don’t look now'. The film portrayed a child playing at the water side, while visual symbols and the music powerfully suggested frightening expectations concerning the well-being of the child. The (blatant) film clip, used to elicit fear, was composed of the first nine minutes of the film 'Cujo'. In this film a wild dog with rabies attacks a woman and her child
sitting in their car. In the last two minutes the woman cautiously leaves her car, with music creating a strong atmosphere of fear. All three experimental video clips were controlled so that no spoken words occurred during the last two minutes (EEG recording).

Procedure
In this double-blind experiment, subjects (unaware of the fact that they were selected on basis of their alexithymia scores) were told that the purpose of the experiment was to measure their EEG activation while they were watching the video film clips. Subjects were seated in a comfortable armchair in a dimly-lit, sound-attenuated room. First, they were shown the warming-up video. No measurements were taken during this video clip. Afterwards, the three experimental video clips were shown in randomized order so that all possible sequences of film clips occurred equally often. Prior to showing each experimental video clip, subjects were instructed that they had to write down the emotional feelings they experienced during the video after it had ended. This instruction was given to ensure that subjects attended to the film content. After the presentation of each video clip, sufficient time was given for the subjects to return to a baseline emotional state. EEG was recorded during the last two minutes of the experimental video clips. Finally, subjects completed additional questionnaires.

Apparatus and EEG recordings
The film segments were presented to the subjects on a 19 inch standard PAL colour video monitor at a distance of approximately two meters from the subject. A speaker for monophonic sound was located next to the monitor. EEG and EOG recordings were made using a 10 channel polygraph (Nihon Kohden 5208). The EEG was recorded from F3,F4,T3,T4,P3,P4,O1,O2 according to the international 10-20 system using tin electrodes mounted in an electrode-cap. Because a dependency of the coherence on the selection of the reference exists, and reliable coherence effects can only be found when a nonephalic reference electrode is used (French & Beaumont, 1984; Nunez et al., 1994), all the EEG derivations were referenced to the linked earlobes that were each initially buffered with operational amplifiers before they were connected. The choice of the buffered and linked earlobes (this equals averaging the earlobes) is supported by the simulation study of Rappelsberger (1989), who found reliable coherence results when reference recording was used. Nunez et al. (1994), on the contrary, found a dependency on the choice of the reference in simulation studies, even with a 'quiet' reference. However, as Rappelsberger (1989) argues, the choice of linked earlobes as reference is not compromised when, as in the present study, emphasis is directed to relative, rather than absolute, coherence values, e.g. between groups or conditions. In addition to EEG, bipolar vertical and horizontal EOG's were
recorded, using tin electrodes, from above and below the right eye, and lateral to the outer canthus of each eye. Impedance was kept below 5KΩ for all leads. EEG's and EOG's were recorded using a 1.0 second time constant and a lowpass filter setting of 35 Hz.

Power and coherence data analysis
For each film the two minutes of EEG and EOG data were digitized (128 Hz) into 15 epochs of eight seconds (15 x 1024 samples) for each channel. Epochs with clips, drift, artefacts, or (EEG only) flat lines were discarded from further analysis. Ocular artefacts in the EEG time series were controlled by regression analysis in the time domain. The remaining time series obtained were tapered with a cosine-bell (Hanning) window for the whole epoch to correct for leakage. The mean voltage was subtracted from each data point. EEG data segments were submitted to Fast Fourier Transformation. The power and cross spectra were computed and averaged over the successive epochs for each film, and over the adjacent frequencies for the alpha (6.875-11.5 Hz) and beta (11.625-15.0 Hz) frequency bands.

For each channel, film, and frequency band the inter- and intrahemispheric partial multiple coherence were computed, as described in Tucker et al. (1986).

Statistical analysis
Power and coherences were transformed toward the normal distribution using Ln(x+1) for power, and a Fisher's Z-transformation for the two types of coherences. A repeated measure MANOVA was conducted for power, intra- and interhemispheric coherence, with alexithymia(2) as the between-group factor and frequency(2), film(3), hemisphere(2), and lead(4) as repeated measures factors (alpha=.05). As a follow-up procedure a MANOVA was conducted for each of the two frequency bands. The alpha-level for these tests was adjusted to .05/2 = .025 (Bonferroni procedure). In a follow-up procedure for the interhemispheric coherence, a MANOVA was conducted separately for each of the four leads (alpha-level set to .05/4=.0125).

Results
The emotional manipulation of the video clips was checked by content analysis of the descriptions of the subjects' emotional states which they wrote down after each video clip. A significant effect for film was found \( F(2,36)=5.50, \ p<.01 \) indicating an increase in the usage of emotion-related words for the two emotional video clips compared with the neutral video clip. A more detailed analysis involving
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group and type of words produced was conducted, but these results are not relevant to this study.

**Film**
The MANOVA analysis for power yielded a significant interaction between film and lead ($F(6,13)=3.81$, $p<.025$), indicating a reduction in power for both emotional films at the parietal leads. This analysis also yielded a significant interaction between frequency band and film ($F(2,17)=9.75$, $p<.01$). Analyses for power per frequency band yielded a trend for film in the alpha frequency band ($F(2,17)=4.02$, $p=.037$), indicating a reduction in alpha power for both emotional films (see Figure 1). The analysis for the alpha frequency band also yielded a significant interaction between film and lead ($F(6,13)=3.72$, $p<.025$), indicating that the reduction in alpha power for both emotional films was more pronounced for the parietal leads.

![Figure 1](image.png)

**Figure 1.** Mean alpha and beta power values for the neutral, symbolic-emotional, and blatant-emotional video clip.

The MANOVA analysis for the intrahemispheric coherence yielded a significant interaction between film and lead ($F(6,13)=6.04$, $p<.01$), indicating a reduction in the intrahemispheric coherence for the parietal and occipital leads for the symbolic
anxiety film compared with the two other films (Table 1). Finally, the MANOVA analysis for the interhemispheric coherence yielded no significant film effects.

**Alexithymia**

The MANOVA analysis for the interhemispheric coherence yielded a trend for the three-way interaction between alexithymia, hemisphere, and lead ($F(3,16)=4.52$, $p=.093$). The follow-up MANOVA analyses for the interhemispheric coherence for each of the four leads yielded a significant interaction between alexithymia and hemisphere only for the frontal lead ($F(1,18)=7.80$, $p<.0125$), indicating that the non-alexithymic individuals had a higher coherence (pooled over all films) between the right frontal lead and the left hemisphere than the alexithymic individuals (see Figure 2). This interhemispheric coherence effect is specific for the frontal lead. The MANOVA analyses for power and the intrahemispheric coherences yielded no significant alexithymia effects.

**Table 1.** Grand means for the intra- and interhemispheric multiple partial coherences for each film and electrode location, averaged over the hemispheres and the two frequency bands.

<table>
<thead>
<tr>
<th>intrahemispheric coherence</th>
<th>O</th>
<th>P</th>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
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<td>.780</td>
<td>.604</td>
<td>.471</td>
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<tr>
<td>symbolic anxiety film</td>
<td>.689</td>
<td>.763</td>
<td>.597</td>
<td>.472</td>
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<tr>
<td>blatant anxiety film</td>
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<td>.777</td>
<td>.581</td>
<td>.477</td>
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<tr>
<td>interhemispheric coherence</td>
<td>O</td>
<td>P</td>
<td>T</td>
<td>F</td>
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<td>.536</td>
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<td>.740</td>
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<td>.364</td>
<td>.733</td>
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<td>.544</td>
<td>.353</td>
<td>.741</td>
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</table>

*Note: O = occipital  P = parietal  T = temporal  F = frontal*

**Frequency band**

The MANOVA analyses for power yielded a significant main effect for frequency band ($F(1,18)=53.92$, $p<.001$), indicating a lower power for the beta frequency band (Table 2). Significant lower values for the beta band were also obtained for both the intrahemispheric coherence ($F(1,18)=28.68$, $p<.001$) and for the interhemispheric coherence ($F(1,18)=131.56$, $p<.001$).
Table 2. Grand means for power and the intra- and interhemispheric multiple partial coherences, for each electrode location and the two frequency bands.

<table>
<thead>
<tr>
<th></th>
<th>O1</th>
<th>O2</th>
<th>P3</th>
<th>P4</th>
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<td>13.6</td>
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<td>10.9</td>
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<td>alpha</td>
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<td>.790</td>
<td>.656</td>
<td>.654</td>
<td>.497</td>
<td>.514</td>
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<td>.328</td>
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<td>.711</td>
</tr>
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</table>

Note: O = occipital  P = parietal  T = temporal  F = frontal

Figure 2. Mean frontal left to right and frontal right to left interhemispheric multiple partial coherence values, for the non-alexithymic and alexithymic subjects.

**Lead**

The MANOVA analysis for power yielded a significant main effect for lead ($F(3,16)=17.68, p<.001$), indicating a decrease in power across leads in the order: parietal, frontal, occipital, temporal. The interaction between frequency band and lead was significant as well ($F(3,16)=29.39, p<.001$). Analyses for power per
frequency band yielded a significant main effect for lead in the alpha frequency band ($F(3,16)=40.43, p<.001$), indicating a decrease in power across leads in the order: parietal, frontal, occipital, temporal. It also yielded a significant main effect for lead in the beta frequency band ($F(3,16)=7.23, p<.01$), indicating a decrease in power across leads in the order: parietal, occipital, frontal, temporal.

The MANOVA analysis for the intrahemispheric coherence also yielded a significant main effect for lead ($F(3,16)=120.46, p<.001$), indicating a decrease in intrahemispheric coherence across leads in the order: parietal, occipital, temporal, frontal. Thus, the intrahemispheric coherence appears to vary according to the anterior-posterior location, with the highest intrahemispheric coherence for the parietal lead, and the lowest intrahemispheric coherence for the frontal lead. The interaction between frequency band and lead was significant ($F(3,16)=26.52, p<.001$). Analyses per frequency band yielded a significant main effect for lead in the alpha frequency band ($F(3,16)=123.37, p<.001$), and a significant main effect for lead in the beta frequency band ($F(3,16)=98.07, p<.001$), both indicating a decrease in intrahemispheric coherence following the same order of leads, but with a different slope.

Finally, the MANOVA analysis for the interhemispheric coherence yielded a significant main effect for lead ($F(3,16)=173.83, p<.001$), indicating a decrease in interhemispheric coherence across leads in the order: frontal, occipital, parietal, temporal. For this measure the highest values were found for the frontal lead and the lowest values for the temporal lead. The interaction between frequency band and lead was significant ($F(3,16)=4.55, p<.025$). Analyses per frequency band yielded a significant main effect for lead in the alpha frequency band ($F(3,16)=186.57, p<.001$) and a significant main effect for lead in the beta frequency band ($F(3,16)=133.25, p<.001$), both indicating a decrease in interhemispheric coherence following the same order of leads, but again with a different slope.

**Hemisphere**

The MANOVA analysis for power only showed a significant three-way interaction between frequency band, lead, and hemisphere ($F(3,16)=7.93, p<.01$). Analyses per frequency band yielded no significant power effects for hemisphere. The MANOVA analysis for the intrahemispheric coherence yielded a significant interaction between hemisphere and lead ($F(3,16)=7.54, p<.01$), indicating a higher right than left intrahemispheric coherence for the frontal lead. Finally, the MANOVA analysis for the interhemispheric coherence yielded no significant hemisphere effects.
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Discussion

The results demonstrate that the EEG alpha power can be modulated by the content of films. A reduction was found in the right frontal to left interhemispheric communication for the alexithymic individuals compared to controls. However, no differences dependent on film content were found between groups. These results are discussed in more detail below.

A decrease of alpha power was found for both emotional films relative to the neutral film. This effect was more pronounced at the parietal leads. Because the films were presented in randomized order and sufficient time was given after the presentation of each video clip to allow subjects to return to a baseline emotional state, the reduction in alpha power was most likely caused by the contents of the films. However, the fact that the reduction of alpha power was more pronounced at the parietal lobes does not exclude the possibility that the effect was caused by a variation in semantic and pictorial content between the emotional and neutral film clips. The parietal lobes play a major role in visual orientation and recognition or formation of abstract concepts, while the temporal and (pre)frontal lobes are more involved in emotion-related processing (Kolb & Whishaw, 1990). Because the emotional content of the films did vary (an interpretation supported by the significant differences between films in the production of emotional words), the reduction in alpha power could also be the result of differences in emotional arousal produced by the films. If desynchronization of the alpha rhythm may be interpreted as indicating higher cortical activation, then this result might indicate increased activation of the brain while watching the emotional films as compared to a neutral film. This interpretation is in line with the study of Schellberg et al. (1990) where an increasing modulation of alpha power for film in the order: neutral, negative-emotional, positive-emotional was found. The interaction for alpha power between film and lead was, however, not significant in the Schellberg et al. study.

We also demonstrated that alexithymic individuals have reduced coherence between the right frontal lobe and the left hemisphere compared with controls (non-alexithymic individuals), independent of film. It is of interest that the coherences for alexithymic individuals between either frontal region and the contralateral hemisphere are approximately equal, while for non-alexithymic individuals the right frontal region is more coherent with the left hemisphere than the left frontal region with the right hemisphere. A higher interhemispheric coherence between the right frontal region and the left hemisphere was also found by Tucker et al. (1986), when the intra- and interhemispheric coherence topography was measured for 14 healthy right-handed men. Hopftman and Davidson (1994) described a meta-analysis of Marzi et al. (1991). In this meta-analysis simple reaction-time studies were analyzed, measuring the Inter-Hemispheric Transfer Times (IHTT) for visual information. The meta-analysis suggested that transfer of simple information, as measured by the IHTT, is faster...
from the right hemisphere to the left hemisphere, than in the opposite direction (13 of the 16 studies). Intuitively, faster IHTT seems compatible with the idea of higher interhemispheric coherences as measured in the EEG. Hence, the IHTT results are in line with the coherence results of Tucker et al. (1986), and the coherence results for the non-alexithymic individuals of the present study. Based on these results, the conclusion can be drawn that the interhemispheric transfer deficit in alexithymic individuals is manifested by the absence of a higher level of interhemispheric communication between the right frontal lobe and the left hemisphere than between the left frontal lobe and the right hemisphere.

In the study of TenHouten et al. (1987, 1988), the interhemispheric alpha band coherence was measured for commissurotomized patients, and neurologically intact controls while they watched a symbolic emotional film. In their study, indications were found for lower interhemispheric coherences in the commissurotomized patients for the frontal, parietal, and temporal leads. For the central leads, a higher interhemispheric coherence was obtained for commissurotomized patients. Because coherence is considered here as a measure that reflects differences in structural connectivity among cortical areas, corpus callosotomy patients may be expected to demonstrate lower interhemispheric coherences for all regions of the brain (anterior and posterior). Thus, a comparison of the results of TenHouten et al. with those of this study, where coherences were measured in neurologically intact alexithymic subjects, is problematic.

The interpretation of coherence results requires great care (French & Beaumont, 1984). If coherence reflects differences in structural connectivity between cortical areas, then the results of this study indicate reduced cortical connectivity between the right frontal lobe and the left hemisphere for alexithymic individuals compared with controls. Because the corpus callosum appears to be necessary for the transfer of higher level (more complex) information between the hemispheres (Hoptman & Davidson, 1994), there is some indication for reduced corpus callosal function between the right frontal region and the left hemisphere in Type II alexithymic individuals.

In the integrated cortical neural network, hypothesized as responsible for the highest neurophysiological level of emotional processing, modules located in the right hemisphere, particularly the right frontal region, are probably more involved in the (nonverbal) regulation of emotional arousal and the regulation of autonomic response to emotional stimuli, while modules located in the left hemisphere are probably more involved in the (verbal) cognitive and communicative aspects of emotions (Fuster, 1989; Gainotti et al., 1993; Kolb & Whishaw, 1990). Note that the general neurophysiological model for alexithymia posits that alexithymia can be considered to be a disruption in this integrated cortical neural network. Different types of alexithymia can be the result of impairments in different modules or connections within this network. This is in line with Bermond (1995) who makes a distinction between different types of alexithymia dependent on different neurophysiological dysfunctions. In his distinction Type II alexithymia is
characterized by the presence of the emotional experience (transported to the left hemisphere by the anterior commissure) but in the absence of the normally accompanying cognitions (transported to the left hemisphere by the corpus callosum). It is this type of alexithymia, according to Bermond (1995), that could reflect a reduced function of the corpus callosum. Therefore, in the present study the alexithymic individuals were selected for high scores on the capacity to experience emotional feelings, but low on the accompanying cognitions. Consequently, it is expected that this particular group must have an impairment in the (emotional) information transfer from the right frontal region, where the emotionality itself is regulated, to the left hemisphere, where the verbal, cognitive, and communicative aspects of the emotion are regulated. The lower interhemispheric cortical connectivity between the right frontal region and the left hemisphere found in this study for alexithymic individuals compared with controls is in accord with this expectation. This result is also in line with the reduction in interhemispheric alpha band coherence found by TenHouten et al. (1987,1988) for commissurotomized, and thus alexithymic, patients.

A possible explanation for the small differences in mean coherence values in the alexithymia-by-hemisphere interaction in the present study may be found in the selection of the participants of this study. Although they were extremely alexithymic in the population of first year psychology students, they were not extremely alexithymic when compared to the scores obtained from a clinical group. Another important issue is that no indications have been found for task-related alexithymia effects (no interactions with film). A possible explanation for the absence of any film-related alexithymia effect might be that coherence does not reflect task-related differences (functional coupling) in cortical activation (see also French & Beaumont, 1984). This explanation is supported by the finding that no straightforward film-related coherence effects were found, although a decrease of alpha power, as an indication of activation, was found for both emotional films. This suggests that coherence may only be used as a measure for structural connectivity between cortical regions. This is in line with the view of Lopes da Silva (1991) that EEG signals reflect more readily changes in the state of the underlying networks, particularly if these changes involve a relatively large area, than specific aspects of the information being processed. This explanation does not exclude the possibility that task-dependent alexithymia effects do exist. Another explanation for the absence of any film-related alexithymia effect might be that alexithymic individuals have a generalized deficit in interhemispheric transfer involving all types of information. This explanation is partly in line with the results of Zeitlin et al. (1989) who found a bidirectional interhemispheric transfer deficit for alexithymic individuals in the transfer of sensorimotor information.

In conclusion, it was found that alexithymics have reduced coherence between the right frontal lobe and the left hemisphere. It would be worthwhile to repeat this study with selection of the subjects from a clinical population of alexithymic patients.
Chapter 7

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References


