A STUDY OF THE IMPLICATIONS OF INTERHEMISPHERIC TRANSFER IN ALEXITHYMIA.

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Evidence From Reaction Times to a Laterally Presented Visual Matching Task.

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INTRODUCTION

In this study we propose to test the following physiological theories of alexithymia: (1) the hemispheric activation hypothesis; (2) the callosal transfer hypothesis, by using linguistic stimuli, pictorial stimuli and emotion laden pictorial stimuli. We also propose to compare the callosal transfer processes of low alexithymic subjects and psychosomatic patients. In the first part of the study, we propose to measure alexithymia in a non patient populations by using three alexithymia scales, the Shalling Sifneos Personality Scale-Revised, the Minnesota Multiphasic Personality Inventory, and the Toronto Alexithymia Scale.

Part 1., of this thesis is an introduction to the research topic. Chapter 1., introduces the concept of alexithymia and Chapter 2., introduces evidence for the lateralization of function in the brain.

We plan to measure hemispheric activation and callosal transfer by using reaction time scores to laterally presented visual matching tasks. In Part 2., of this thesis we introduce the methodology. Chapter 3., discusses the use of reaction time measures in psychology. Chapter 4., introduces the visual laterality technique used in this study.

Part 3., of this thesis describes the design and the

actual experiments of this study. In Chapter 5., the design of the current study is discussed in detail. In Chapters 6,7,8 and 9., the experiments 1,2, and 3, and the pilot Clinical Study are described and the results of each study are presented and discussed. In the final Chapter 10., we discuss our findings and make suggestions for further research.

PART ONE

GENERAL INTRODUCTION

CHAPTER 1

THE CONCEPT OF ALEXITHYMIA

Nemiah and Sifneos (1970), Sifneos (1973) coined the term "alexithymia", which literally means "no words for feelings" (Greek for "a" - no / "lexi" - word / "thymia" - mood or feelings) to describe a condition characterized by a difficulty in verbalizing symbols and a lack of ability to express feelings verbally. Other characteristics of alexithymia include an impoverished fantasy life, an overconformity in interpersonal relationships, an impaired or absent symbolic thinking capability and a literal cognitive style. Subsequent to Sifneos' initial formulation additional characteristics have been added to the original concept. These include reporting few dreams (Nemiah and Sifneos, 1970), difficulty of discriminating between emotional states and bodily sensations (Nemiah, Freyberger and Sifneos, 1973), little contact with ones own psychic reality (Nemiah, 1973), impaired capacity for empathy and the resulting difficulties in interpersonal relations (Krystal 1979).

The percentage of alexithymic subjects in the general population is less than 10% and it appears to be more prevalent in males than in females. The prevalence appears to increase with age (Feiguine et al., 1982; Martin et al., 1984). However, this has been disputed in a more

recent study (Parker, Taylor and Bagby 1989). It has been observed that the percentage of alexithymics may reach as high as 50% among patients who have psychosomatic illnesses (Shipko, 1982) and in medically ill subjects requiring psychiatric consultation (Smith, 1983). There is now considerable evidence that alexithymic characteristics are highly prevalent in patients suffering from psychosomatic disorders (Brautigam, 1977; Neill, 1982; von Rad, 1983; Taylor, 1984). Alexithymia has also been implicated in inflammatory bowl disease (Taylor et al., 1981), in migraine (Federman and Mohns 1984), and in hypertension (Smith 1983). A recent study by Todarello (1983) has found an association between breast cancer and alexithymic traits.

1.1. Theories Of Alexithymia

Psychological Theories

Cremerius, (1977) has suggested a sociological explanation of alexithymia. He observed that working class people are more likely to suffer from psychosomatic illnesses. Based on this findings, Cremerius, (1977) has suggested that alexithymic characteristics, and it's association with social class is an artifact; reflecting socialization practices in different classes, and of the

restricted verbal code of the working class (Bernstein, 1971). However a recent study by Parker, Taylor and Bagby (1989) using the newly developed Toronto Alexithymia Scale reported no association between alexithymia and IQ or sociodemographic variables.

Lindberg and Lindberg (1988) have suggested a developmental explanation of the relationship between psychosomatic diseases and the inability to express feelings. They trace the origin of psychosomatic illnesses to a person's pre-verbal childhood. Lindberg and Lindberg suggest that functional disturbances in childhood are the result of unresolved conflicts and needs. Since a child is unable to express any discomfort that it feels verbally, it must express it bodily. If such conflicts are not resolved in the first years of life, the non-verbal way of reacting to stress may prevail into adulthood. Expressing feelings through the soma is characteristic of psychosomatic illnesses.

Physiological Theories

Others have advanced physiological explanations of the relationship between the inability to verbally express feelings and psychosomatic diseases. These explanations of have implicated; (1) a deficit in the right hemisphere; (2) over activation of the right hemisphere and (3) deficit in callosal transfer; as the cause of alexithymia.

Under Active Right Hemisphere Hypothesis

Buchanan et al., (1980) suggested that alexithymia may be caused by an impaired function of the right hemisphere or a disconnection between the two hemispheres. Other studies have found alexithymic characteristics in patients with damage to the right hemisphere (Fricchione and Howanitz, 1985; Tucker, 1981) Van Balen (1989) have shown that patients with damage to the right hemisphere have difficulty with the comprehension and the expression of emotions through voice inflection and facial expression. Kaplan and Wogan (1976/77) used EEG alpha power ratios to measure cerebral activation in normal subjects with experimentally induced pain and showed that a predominance of left hemisphere activation and a lack of right hemisphere processing of painful stimulation may play a role in the development of psychosomatic disorders in alexithymics.

A recent study by Montreuil and Jouvent (1989) has used an innovative method of assessing the efficiency of right hemispheric functioning. They have developed a test of holistic attention: The Visual Parallel Information Processing Test; which is based on the finding that the right hemisphere is involved in parallel information processing. They compared 20 normal subjects and 20 matched psychosomatic subjects on this test, while the subjects were simultaneously engaging in a logical dis-

tractive task. The results showed that the psychosomatic subjects were inferior at the holistic processing task which is indicative of a right hemisphere deficit in these subjects.

Evidence from another line of investigation is indicative of a right hemisphere deficit in alexithymia. Bakan (1969) showed that the direction of conjugate lateral eye movements which people make as they begin to think of a problem is indicative of their habitual reliance on the left or the right hemisphere. Left eye movers habitually rely on the right hemisphere and right movers visa versa. Studies by Katkin (1985) using electrophysiological and cerebral blood flow studies have corroborated Bakan (1969).

It has been shown that left movers in comparison to right movers are more hypnotizable (Bakan 1969) and that they recall more dreams (Van Nuys 1969/1980). On the other hand it has been shown that alexithymics are not hypnotizable (Frankel at al. 1977) and cannot fantasize and recall their dreams (Nemiah 1975).

Overactive Right Hemisphere Hypothesis

Cole and Bakan (1985) hypothesized that if alexithymia is associated with a right hemisphere deficit, then there should be a predominance of right eye movements in alexithymics. Contrary to this expectation, their study

using 102 normal subjects indicated that left eye movers, (indicative of right hemisphere activation) had higher alexithymic scores as measured by the Schalling-Sifneos Alexithymia scale.

The authors interpreted this finding in terms of the limited capacity processing model of the brain (Mandler 1984). According to this idea when one stimulus occupy a part of the limited capacity system, the processing of other stimuli will suffer and be displaced from conscious processing. Thus, if the right hemisphere is involved in the facial and vocal expression of emotions, recall of fantasy and hypnotizability, an overactivation of the right hemisphere may result in the disruption of these processes.

The Callosal Transfer Deficit Hypothesis

The callosal transfer deficit hypothesis of alexithymia is based on the reasoning that emotions are lateralized in the right hemisphere and verbal expression in the left hemisphere. Any inefficiency in the transfer of information from the right to the left hemisphere could be expected to result in a deficiency in putting emotions into words. The unexpressed emotions could become somatized as described by Lindberg and Lindberg..pa

1.2. Alexithymia in Split Brain Patients

Hoppe (1977) hypothesized that if symbols, feelings and fantasies are lateralized in the right hemisphere to some extent, and verbal expression in the left hemisphere, cerebral commissurotomy which deconnects the two hemispheres could lead to a deficit in the verbalization of these perceptions. Thus if verbal expressiveness requires some contribution from the right hemisphere, disconnecting the hemispheres could result in some aspects of alexithymia.

Hoppe and Bogen (1977) were able to show that 12 commissurotomy patients were highly alexithymic, as measured by 6 of the 8 alexithymic items in the Beth Israel Psychosomatic Questionnaire. As assessed through personal interviews, commissurotomy patient's fantasies were unimaginative, utilitarian and tied to reality; their symbolizations were concrete, and rigid.

Tenhouten et al., (1985a; 1985b; 1985c; 1985d) used 8 of the same commissurotomy patients used by Hoppe and 8 precision matched normal control subjects. They showed these subjects a 3 minute video tape which symbolically depicted death. They carried out content analysis of the subject's spoken and written responses to the film. Factor analysis and other techniques indicated that the commissurotomy patients were more alexithymic than normal controls on a number of measures. However, one normal control was

also highly alexithymic. TenHouten et al., concluded that complete commissurotomy is a sufficient but not a necessary condition for a high level of alexithymia.

TenHouten et al (1987) made EEG recordings obtained while the subjects in the (1985) studies described above viewed the same film. Inter channel alpha band coherence to homologously placed electrodes over the right and the left frontal, parietal and temporal regions were calculated and used as indicators of the concept of interhemispheric communication. Their results showed that alpha band EEG coherence was reduced in commissurotomy patients. In such patients alexithymia was indicated by lexical level content analytic measures of the verbal responses to the film. Their results also showed some unexpected anomalous findings. For example one commissurotomy patient had a higher mean interhemispheric than intrahemispheric coherence. The authors feel that this is suggestive of the possibility that right hemispheric processes are articulated via the brain stem following commissurotomy.

TenHouten et al., (1988) followed-up their studies on the same subjects with graphologic psychogram analysis of four sentence written in response to seeing the same film. The subjects had disconnected, irregular and pictorial handwriting in comparison to controls. This is interpreted graphologically as an inability to connect experiences purposefully. A second EEG study on the same subjects by TenHouten et al., (1989) also suggested a possi-

ble interhemispheric inhibition in comparison to controls.

Based on these studies Tenhouten et al., concluded that alexithymia is more than a phenomenologically derived clinical concept; that it was not merely an artifact of social class. Alexithymia they felt has a neurological basis due to a relative lack of communication of feelings and symbols between the left and the right hemispheres of the brain.

The authors suggested that investigating the possibility of a functional commissurotomy as the next logical step in the study of the relationship between alexithymia and higher brain functions. According to this idea a functional lack of callosal connections is hypothesized to contribute to alexithymia in normal persons.

A recent study by Zeitlin et al (1989), investigated the possibility that alexithymia may be related to an information transfer deficit across the corpus callosum in normal subjects, who had not undergone commissurotomy. They used Vietnam war veterans with post traumatic stress disorder (PTSD), and compared those classified as alexithymic according to the Toronto Alexithymia Scale (scoring over 74 points), those classified as non alexithymic (scoring less than 62 points) matched for the severity of PTSD, and normal control subjects matched for IQ.

Interhemispheric transfer was measured with the use of a finger localization task (Quinn and Geffen 1986). This technique is based on the finding that fine sensory

and motor nerves in the fingers of each hand project to the contralateral hemisphere. In this experiment, the subjects were seated with the palms facing up. The experimenter touches the subjects finger tips. The subjects indicate which finger was touched by pointing with the thumb of the same hand, or the thumb of the other hand. When pointing with the thumb of the same hand the cerebral hemisphere receiving the sensation and the hemisphere making the motor response is the same. When indicating with the other hand, the cerebral hemisphere receiving the sensation and the one making the motor response are different, and information has to be transmitted across the corpus callosum from one to the other hemisphere.

Zeitlin et al., reported that when I.Q. and the severity of PTSD is controlled interhemispheric transfer accounted for 35.58% of the variance in alexithymia. They also reported on the basis of their experiment that alexithymia was not related to a deficiency of a specific hemisphere, and that the transfer deficit bidirectional. Based on this data Zeitlin et al., concluded that at least some cases of alexithymia was mediated by a "functional disconnection" of the two cerebral hemispheres. The authors felt that the interhemispheric transfer deficit in alexithymia falls half way between normal subjects and those who have undergone partial commissurotomy.

1.3. The Measurement of Alexithymia

A number of instruments have been developed to measure the degree of alexithymia.

(1) The Beth Israel Hospital Questionnaire; BIQ, Sifneos 1979 (See Appendix 1.1.).

This is a scale developed by Sifneos on which 17 questions are rated by the clinician after an interview which is designed to evaluate alexithymic characteristics. it is a forced choice questionnaire and ideally it should be standardized so that all interviewers ask the same questions. However, this is difficult because interviewing styles vary. In this questionnaire a score of 0-8 denotes alexithymia, a score of 0-5 is normal.

(2) The Shalling-Sifneos Personality Scale; SSPS, Apfel and Sifneos 1979. (See Appendix 1.2.).

This scale was developed to simplify the measurement of alexithymia. It is a questionnaire with four different choices given in answer to 20 questions. The SSPS has the advantage of avoiding interviewer bias that is inherent in the BIQ. One problem of this scale is it's lack of correlation with the BIQ.

(3) The Shalling-Sifneos Personality Scale-Revised; SSPS-R, Sifneos 1986 (See Appendix 1.3.).

The SSPS-R was devised to increase the correlation of the SSPS scale with the BIQ.

(4) The Minnesota Multiphasic Personality Inventory Alexithymia Scale. MMPI-Alexithymia Scale; Kliger and Kinsman 1980 (See Appendix 1.4.).

This scale has been derived from a pool of 556 MMPI items. It is a 22 item self report scale.

(5) The Toronto Alexithymia Scale; TAS, Taylor, Ryan & Bagby 1985 (See Appendix 1.5.).

This is a 26 item self report scale. The subjects use a 5 point Likert scale in responding to each item in this scale (1-strongly disagree; 5- strongly agree). Thus, scores can range from 26-130. It has been established that scores of 74 and above indicate alexithymia, and scores of 62 and below indicate no alexithymia (Taylor and Bagby (1988).

CHAPTER 2

LOCALIZATION OF FUNCTION IN THE BRAIN

Until recently data on the laterality of function in the brain was obtained by observing the behavior of patients with lesions localized in one of the hemispheres (lesion studies), or by observing patients with split brains, i.e., patients whose corpus callosum had been had been surgically sectioned (split brain studies).

Lesion Studies

In 1861 Broca presented the case of a patient with a lesion in the third frontal convolution in the left hemisphere who was unable to speak. Other patients with similar symptoms showed similar lesions at autopsy leading Broca (1865) to conclude that speech is localized in the left hemisphere. In people who are not left handed, ambidextrous, or who have no family history of lefthandedness, it is now generally believed that many functions related to verbal behavior are localized in the left hemisphere. It seems that much of the left hemisphere is organized to process verbal information and produce verbal behavior.

In recent times the role of the right hemisphere has also become clear through studies of patients with lesions in the right hemisphere. This hemisphere seems to special-

izes in non verbal functions. Lesions to the right hemisphere selectively impair a person's nonverbal task performance, such as the ability to remember music, nonsense figures and faces.

Dejerine (1892) and Liepmann (1906) reported cases of patients with left hand dyspraxia and alexia without agraphia. These authors believed that these symptoms were caused by lesions of the corpus callosum. Which has led to the disconnection of the speech areas of the left hemisphere from the motor cortex in the right hemisphere in the case of left hand dyspraxia and from the visual pathways on the right side in the case of alexia. These findings were however challenged by Akelaitis (1944).

Split Brain; The Contralateral Hemisphere Body Control

Sperry (1961) conducted a series of studies with animals whose corpus callosum had been sectioned. In these studies he was able to show that the corpus callosum does indeed relay information from one hemisphere to the other. Later studies by Sperry, Gazzaniga, Bogan and others on humans whose corpus callosum has been sectioned to prevent the spread of epileptic discharges from one hemisphere to the other, corroborated the results of the animal studies.

These commissurotomized patients provided an unique opportunity to investigate the performance of the right hemisphere on verbal tasks, in isolation from the influ-

ence of the left hemisphere. The testing procedure used by Sperry made use of the fact that each visual half field and the pathways conducting fine stereognostic and somesthetic information from the fingers project directly to the contralateral hemisphere. In addition, control of fine finger movements are also exerted only by the contralateral hemisphere (See Figure 2.1). By asking the subjects to indicate manually with the right or the left hand, objects corresponding to the verbal items presented to the right hemisphere, it was possible to determine the verbal capacity possesses by the right hemisphere. The word nut for example, was presented by flashing it tachistoscopically to the left visual field, thereby restricting it's access only to the right hemisphere. The subject was required to retrieve from an array of objects hidden from his sight, the object that corresponds to the word which was flashed. The subjects succeeded in performing this task only when they were using the left hand, controlled by the right hemisphere; not when using the right hand controlled by the left hemisphere. The subjects were also unable to tell vocally the name of the object that they had picked up. Since speech production is also a function of the left hemisphere. In these subjects whose two hemispheres are separated, it would seem that the left hemisphere was unaware of what the right hemisphere was doing. In a series of such experiments (Gazzaniga, 1970; Gazzaniga and Hillyard, 1971; Gazzaniga, 1972; Sperry, 1968) it was

Figure 2.1. A Schematic diagram showing the visual pathways to each hemisphere; the specializations of the left and the right hemispheres, and the control of the hands by the contralateral cerebral hemispheres of the brain.

shown that the right hemisphere possessed some verbal skills. But the verbal abilities of the right hemisphere were inferior to that of the left hemisphere. AS a result of these studies, a model of the lateralization of function was proposed in which language is represented in both hemispheres, though more strongly in the left.

A recent study by Loring et al (1990) using a 33 year old male corpus comissurotomy patient demonstrated a right hand advantage in the processing of a verbal task and better left hand processing of a visual spatial task. Since the right hand is controlled by the left hemisphere and the left hand visa versa, this result is indicative of a right hemisphere advantage in visuospatial processing and a left hemisphere advantage in verbal processing.

It has been suggested that the reliance on exclusively clinical populations in these studies effect conclusions regarding the laterality of function. Injuries to the brain may cause it's functioning to change. Epilepsy from which the split brain patients have been suffering may have caused a change in the lateralization of function in these patients, or the split brain operation itself, may have caused a diffusion of function with each hemisphere taking over some of the functions of the other hemisphere. Denenberg (1980) has pointed out that results of studies on isolated hemispheres cannot be generalized to people whose hemispheres are intact. To overcome these difficulties Moscovitch (1973) has suggested the need to

experiment on normal people.

Two cognitive experimental methods have been developed to investigate laterality in normal people. The first is the dichotic listening paradigm. Here, stimuli are presented either to the right or the left ear (Kimura 1967). The second paradigm is the visual laterality method using a tachistoscopic (McKeever and Huling 1971). Since the auditory pathways are more complex than the visual pathways and since visual stimuli are easier to design inexpensive to produce and easy to manipulate, the second method has been used more often. Because this method is used in the current study it is discussed in detail in the next chapter.

Lateralization of Emotions in the Brain

A number of studies show that emotions are lateralized in the right hemisphere of the brain. Research has shown that an intact right hemisphere is essential for the comprehension and expression of emotions. Wechsler (1973) showed that right hemisphere damage impaired story recall when the story had an emotional content. Tucker, Watson and Heilman (1976) showed that right hemispheric damage impaired the ability to communicate emotions through the tone of voice.

Research on neurologically intact subjects have also shown evidence in favor of the idea of a right hemisphere

mediation of emotions. Observing lateral eye movements to question requiring internal reflections Schwartz, Davison and Maer (1975) found that emotional question evoked left lateral eye movements indicative of a right hemispheric activation. In a study by Safer and Laventhal (1977) a task requiring judgment of the question content and the speaker's tone of voice was administered monaurally either to the left or the right ear. A left ear advantage was found for emotional judgment indicative of right hemisphere mediation. A similar finding was reported by Carmon and Nachson (1973)

A study by Smokler and Shevrin (1979) selected college students who showed a strong hysteric (emotional) cognitive style and compared them with students who showed a strong obsessive compulsive (logical) emotional style. A subsequent analysis of lateral eye movements in response to self reflective questioning showed a predominance of left movement in students with an hysteric emotional style indicative of right hemispheric processing. Lay and Bryden (1981) suggested that the right hemisphere is more involved than the left in all types of affective processes.

In summery the lesion studies and the split brain studies quoted above indicate that language is a strongly localized in the left hemisphere but the right hemisphere can perform some linguistic tasks. Non verbal symbolic functions are localized in the right hemisphere but the

degree of localization is less than that of language. While other evidence indicate that emotions are localized in the right hemisphere; see Figure 2.2., (from Split Brain Approches to Learning Problems, in The Neurosciences. Quarton, G.C. MelMelneuchuk, T. and Schmitt, F.O. (Eds), N.Y. The Rockefeller Press, pp 714-722, 1966.)

The Function of the Corpus Callosum

As yet the exact role of the corpus callosum to cerebral integration has not been satisfactorily understood. Anatomical studies on cats and monkeys have indicated that there are a great number of cross connections that connect homotopic points in the two hemispheres. It seems that one function of the callosal connection is to duplicate the hemispheric activity and keep the two hemisphere equally advanced in learning and memory. From electrical studies on the cat (Bremer 1966) it appears that the callosum mediates the transfer of sensory information. On the other hand it is known that the callosal connections between the primary sensory and motor projections are spares, in comparison to the richness of connections between the associational cortical areas. This has been taken as evidence that the primary role of the corpus callosum has less to do with raw sensory and motor information and more to do with deeper stages of data processing (Sperry 1967). Others have speculated that the role of

Schematic representation of some of the main cerebral functions found to be lateralized following hemisphere disconnection.

Figure 2.2.

the corpus callosum may be inhibitory. It's purpose being to prevent interference from the opposite side when a process that is centered in one hemisphere is in command.

It has been repeatedly demonstrated that the corpus callosum mediates the transfer of learning and memory (Sperry 1967). However it is not known in what form the information from the trained hemisphere is carried over to the other side. It is possible that only an abstract representation of the information is carried over.

Callosal function can be demonstrated in experiments in which part of the sensory information required for performance enters one hemisphere and the other part the other hemisphere.

So far as it is known, it seems that many diverse functions: sensory, motor and associational, inhibitory and excitatory are mediated by the corpus callosum and that these are subject to individual and spices specific variations (Sperry 1967).

Based on the discussion in this chapter it is clear that a lateralization of function is present in the brain. It is also clear that the corpus callosum plays a role in the transfer of information from one part of the brain to the other. If a certain function needs an input of information from the other hemisphere for it's execution then it is logical to assume that a dysfunction of the corpus callosum in transmitting information from one to the other hemisphere will cause a disruption of that function. Thus,

if language is lateralized in the left hemisphere and the processing and the experience of emotions in the right hemisphere, the verbalization of emotional feelings will depend on the callosal bundle to transmit the emotional feelings to the verbal hemisphere. A lack of callosal transfer will lead to an inability to verbalize emotions.

PART TWO

INTRODUCTION TO THE METHOD

CHAPTER 3

THE USE OF REACTION TIME MEASURES

This study uses Reaction Time (RT) measures in responding to laterally presented stimuli as a dependent variable in investigating clinical paradigms related to neurological aspects of the brain. The use of RT measures in general and criticisms of the RT paradigm are discussed below in some detail.

The Definition of a Reaction Time Measure

The RT is operationally defined as the interval between the onset of a stimulus presentation to a subject and the initiation of the subject's response.

The stimulus can be introduced to any one of the five sensory modalities. The response can be any predetermined motor response. Studies using RT however, have most often relied on the visual and the auditory modalities for stimulus presentation. The commonly studied responses have been the button press response and the vocal response. In this technique, a clock counter is arranged to measure the interval between the stimulus presentation and the initiation of the response. A button press terminates the clock counter, or in case of the vocal response, a voice activated switch is used to terminate the clock

counter. This arrangement makes it possible to measure the interval between the onset of a stimulus and the initiation of a response.

Varieties of Reaction Time Measures

Three varieties of RT measures have been used in psychological research. These include: (1) the simple reaction time measure; (2) the choice reaction time measure and (3) the criterion-reaction time measure (C-RT).

In the simple RT paradigm the subject makes a single response to the onset of a stimulus. Pressing a button in response to the onset of a stimulus word is an example of this category. In the choice RT paradigm the subject has a choice of two responses and he makes the appropriate one in response to the onset of the stimulus. An example of a choice RT paradigm is, pressing a left placed button in response to a stimulus which contains two words that are the same, and pressing a right placed button in response to a stimulus which contains two words that are different.

The C-RT paradigm has been described by Egeth et al. (1973). In this paradigm, similar to the simple RT paradigm, each subject makes a single response to the onset of a stimuli. Unlike the simple RT paradigm however, on a given trial he responds to the onset of a particular class of stimuli and not to any other class of stimuli. In the example above, a single subject will respond only to

"same" stimuli without responding at all to "different" stimuli. A second subject will similarly respond only to "different" stimuli, without responding at all to "same" stimuli. Alternatively, the same subject may respond to "same" stimuli on one block of trials, and to "different" stimuli on a different block of trials. Thus in the C-RT task the subject makes the same physical response as in a simple RT task, but he makes a cognitive decision similar to that of a choice RT task. In this paradigm therefore, the response type "same" vs "different" is a between subject, or a between trial variable.

Egeth et al. (1973; 1972) have argued that the C-RT paradigm is more accurate than choice RT. The subject's task is simpler because he does not have to remember which button goes with which stimuli. Comparing the C-RT and the choice RT paradigms Egeth and Blecker (1971) have shown that the results using the two techniques are similar.

RT research in psychology have taken three forms. In the first type of research, the RT is used as a tool for investigating underlying psychological processes, the RT being the dependent variable. The RT paradigm assumes that cognitive processes intervening between a stimulus and a response, take a measurable amount of time. By experimentally manipulating a cognitive task, and measuring variations in the RT, the effect of the manipulation on the process under investigation is inferred. Using this technique, problems such as sensory coding, selective atten-

tion, retrieval of information from short and long term memory, parallel and serial processing, and the laterality of function have been investigated.

The second type of RT research scrutinize the RT itself. This research is concerned with defining the stimulus and other parameters which produce variations in RT without regard to any underlying processes. The purpose of this sort of investigation has been methodological; to describe the conditions under which RT measures can be most reliably collected and interpreted. Within this para digm, the effect of such factors as the number, the distribution, the presentation order of stimuli on RT, and the effect of emphasizing speed as opposed to accuracy on RT have been investigated.

3.2. Reaction Time as the Dependent Variable.

Depending on the experimental problem under investigation three different methods of using RT as the dependent variable have been developed. (1) the subtraction method; (2) the additive factor method and (3) the molar method.

The Subtraction Method

The subtraction method is used when the RT involves

processes other than the mediating process of interest. This method makes it possible to isolate the particular process of interest (Z) and to study it's duration. To do this, RT time for a task containing the mediational process Z as a subprocess is compared to the RT for an identical experimental task which differs only in the fact that the mediational process Z is absent. Subtracting the RT of the first task from the second gives an inference of the RT time for the process Z.

RT FOR TASK (A) = PROCESS X + PROCESS Y + PROCESS Z

RT FOR TASK (B) = PROCESS X + PROCESS Y

RT (A) - RT (B) = Time for performing the PROCESS Z

An experiment by Erickson, Pollack and Montague (1970) illustrates this reasoning. They were interested in the encoding times of one syllable words and three syllable words. The subjects were shown such words and were asked to simple name them. The time from the presentation of the stimulus to the onset of the response was measured. The results showed that three syllable words take longer to name than one syllable words. Because the naming task involved two processes: (1) encoding the word and (2) initiating a response, this result does not make it clear if subjects take longer to name three syllable words because encoding time for three syllable words is longer, or because it merely takes longer to initiate a response to three syllable words. To clarify this issue a second experiment was done. The subjects were again shown one and

three syllable words. This time they did not say the word but merely remembered (encoded)it. Following a short interval a light was shown and the subject responded by emitting the stimulus word. RT from the onset of the light to emitting the response was measured. In this condition responding to three syllable words did not take longer than responding to one syllable words. This result indicate clearly that encoding three syllable words in fact do take longer than encoding one syllable words. The second experiment made it clear that once encoded the initiation times were the same for both types of words.

The Additive Factor Method

The additive factor method is based on the conception that a RT interval is the total time for a sequence of independent stages of processing. Each stage receives an input from the various stage, transforms the input in some way, and sends it to the next stage of processing. It is assumed that irrespective of the input the same transformation will be performed at each stage of processing. At each stage the time taken to perform a transformation on a given input is assumed to be independent of the time taken to transform the information in the previous stage, or the time that will be taken in the next stage. The total RT is assumed to be the sum of the stage durations. Therefore: (1) when an experimental task affects the RT in

an information processing experiment, it does so by changing the duration of one or more of the stages of processing; (2) if two different tasks affect two different stages of processing, they will produce independent effects on the total RT and (3) if two experimental manipulations modify each other's effect they should affect a common stage of processing.

In using the additive factor method to interpret RT measures the above implications are applied to data from multifactor experiments. A well defined information processing task is embedded in a multifactor experimental design. Data from such experiments are analyzed to find pairs of factors that have an additive effect on RT. Each time an additive pair is discovered, it is assumed that they affect different stages of processing. If an interacting pair is discovered it is assumed that they affect the same stage of processing. By the pattern of interactions, it is possible to define the type of processing that is done in each stage.

Sternberg's (1969a 1969b) experiments on short term character recognition illustrate the additive factor method well. The task requires subjects to make positive responses if the stimulus is one of a set that was memorized before, and negative responses if otherwise. The effect of factors such as (1) stimulus quality (clear or degraded); (2) size of the memory set (1-6); (3) Response type (negative-positive); (4) and the frequency of re-

sponse type (a positive response 25 50 or 75% of the time) on RT were investigated. In a typical experimental trial these factors were systematically varied. The results of this experiment showed that all four factors had a significant effect on RT. Thus Sternberg concluded that a short term character recognition task consists of four stages of information processing.

The Molar Method

In the two types of RT measure discussed above the RT is subdivided into a number of parts and the effect of the parts on the total RT are analyzed. In the molar use of the RT, it is taken as a whole. This method is suitable when the purpose of the experiment is to determine how long it takes to perform a well defined sensory motor task. It is of value in research dealing with applied and clinical problems.

3.2. Criticisms of Reaction Time Measures

Pachella (1973) has criticized the use of RT measures in information processing research on several grounds. In addition to basic problems such as accurately defining a stimulus and a response, Pachella has made the fundamental criticism applicable to all research using RT; that the link between the time duration of a process and

what it is supposed to accomplish is assumed only on an intuitive basis. Without an explicit statement on how the RT is related to the ongoing process it is difficult to relate variations in observed RT to transformations and manipulations that are occurring in the hypothesized processing network. In the subtraction method for example, the investigator develops a comparison task without complete empirical knowledge of the sequence of events between the stimulus and the response, on an intuitive or a logical basis. Because of this reason conclusions from such experiments can be only as strong as the validity of the assumptions on which the experiment has been constructed.

Another related criticism involves the comparability of the experimental and the comparison task which Steinburg (1969b) has called the assumption of pure insertion. This refers to the assumption that it is possible to delete or insert mental events from an information processing task without affecting the nature of the other stages of the task. In comparing the RT in an experimental task with the RT in a comparison task, it is assumed that all aspects of the comparison task remains the same except for the deleted part. Such research is vulnerable to the extent that it can be argued that information processing in the comparison task is fundamentally different from that in the experimental task. This type of criticism is applicable to studies using the additive factor and the

subtraction methods.

A third line of criticism, common to all RT research involves what has been called by Pew (1969) the speed-accuracy operating characteristic. He has demonstrated that as a subject reacts faster he makes more errors, that the RT is inversely related to error rates. Pachella (1973) has suggested that subjects may choose an optimum operating speed at which he can maximize the response speed and minimize error rates. The subject may vary this speed from one experimental condition to the other. Obtained differences in RT across experimental conditions may indicate such artifacts and not the speed of underlying processes.

In RT time experiments different strategies are adopted to handle error rates, again with little empirical justification. The first method of dealing with errors is to ignore them. This is the method that is most often adopted. Most published data on RT measures deal only with correct responses and do not analyze operator error rates (Pachella, 1973). A second method of dealing with error is to minimize the number of errors by emphasizing accuracy. This measure is also problematic. Because of the nature of the speed accuracy curve, at the maximum accuracy level small differences in error can cause large differences in RT.

Other workers have studied stimulus characteristics which influence the RT. These studies are discussed in the

next chapter with special reference to stimulus characteristics that influence conclusions of RT research of laterality of function.

CHAPTER 4.

The Visual Laterality Technique.

The Technique.

The technique of visual laterality makes use of the fact that each visual field (VF) projects initially to the contralateral hemisphere via the geniculostriate pathways. Thus a stimulus presented to the right VF enters the left hemisphere and a stimulus presented to the left VF enters the right hemisphere; see Figure 4.1. (from Split Brain Approches to Learning Problems, in The Neurosciences. Quarton, G.C. MelMelneuchuk, T. and Schmitt, F.O. (Eds), N.Y. The Rockefeller Press, pp 714-722, 1966.)

In a typical experiment using the visual laterality paradigm the subject is seated with the head resting on a chin rest, facing a screen or peers inside a tachistoscope. When the subjects eyes are centered on a central fixation point, he is presented with a ready signal after which a stimulus appears. The stimulus appears 1-20 degrees to the left or the right of the fixation point. To prevent eye movements from bringing a stimulus presented in the periphery into central vision and thereby directing it to both hemispheres, exposure duration is kept under 200 ms. This is less than the time it takes to initiate an eye movement. To prevent the subject from scanning his

Schematic diagram of the classical visual system. On the top is a projection screen with a central point for gaze fixation. Images flashed on the left (L) project to the right hemisphere while images flashed on the right (R) project to the left hemisphere. The nasal part of the right eye and the temporal part of the left eye (black) transmit visual information to the left hemisphere; the nasal part of the left eye and the temporal part of the right eye (white) transmit visual information to the right hemisphere.

Figure 4.1.

iconic memory trace after the stimulus has disappeared from the screen, a visual masking slide is presented immediately following the stimulus slide, to erase the iconic memory trace. The stimuli may be presented two at a time, one on each side of the fixation point, or they may be presented unilaterally. The subjects respond by pressing a response button with the left or the right hand or by producing a vocal response. The dependent variable may be either the accuracy of the response, or the latency of the response as measured by reaction times (RT).

When using the visual laterality technique, it is critical that the stimulus is presented to the intended VF. If the subjects does not fixate his eyes on the central fixation point before the stimulus is presented, the stimulus will not enter the intended VF and the intended hemisphere. In order to ensure proper fixation, various techniques have been developed. These include monitoring by video camera, and monitoring by electrooculography. Another method of controlling fixation is to present a central stimulus at the fixation point which the subjects must identify in addition to the peripheral stimulus. A variation of this method has been reported by Moscovitch (1986). He presented the stimulus trials without fixation control. Presenting a small central stimulus on some catch trials which could be identified only if the subject was fixating properly. Subjects who failed to accurately report the fixation control stimulus on 10% of the trials

were excluded from the study. According to Moscovitch (1986) not a single nonclinical subject was excluded for this reason, indicating that normal subjects can routinely maintain fixation at the central fixation point.

These and other evidence indicate that most normal subjects can maintain accurate fixation until the stimulus is presented (Jones and Santi 1978). Because monitoring eye movements electronically is tedious, and because the presentation of a central stimulus may effect the processing of the peripheral stimuli, which are the real target of the experiment, many experimenters have dispensed with the use of fixation control altogether.

One purpose of experiments using the visual laterality technique is to compare the differential responses to stimuli presented to the left and the right hemispheres, as indicated by differences in latency measured by RT, or differences in perception measured by accuracy. There is strong evidence that such measures reflect differences in the processing capacities of the different hemispheres (Moscovitch 1986).

The second purpose of the use of the visual laterality technique is to study callosal transfer. When using hand responses it is known that each hand is controlled by the contralateral hemisphere of the brain and (2) information presented to each visual field enters the contralateral hemisphere. If a stimulus is presented to the right visual field and the subject responds with the right hand,

then the hemisphere processing the stimulus and the one controlling the responding hand is the same. If the subject responds with the left hand the information presented to the left visual field must cross the corpus callosum to the contralateral hemisphere before the left hand can initiate a response. When using vocal reaction times it is known that verbal responses are mediated by the left hemisphere. Information flashed to the left VF (which enters the right hemisphere) must pass this information to the left hemisphere across the corpus callosum in order to initiate a verbal response. This is not the case with information presented to the right VF which directly enters the left hemisphere. The difference between verbal RT to stimuli presented to the left VF and the right VF is assumed to be the transfer time across the corpus callosum. The study by Moscovitch and Catlin (1970) did obtain the predicted results. Vocal RT to stimuli presented to the right VF was faster by a duration of 10 ms. Gazzaniga (1969) and Mckeever and Gill (1972) have obtained similar results.

Visual Laterality Studies of the Localization of Function.

Using the visual laterality technique the function of the individual hemispheres in normal subjects have been clarified by a number of investigations. In experiments using right handed subjects, it has been shown that the

right hemisphere is faster at remembering common organized scenes, and that there is a disassociation in the right hemisphere between latency to organized and unorganized scenes indicating that these are processed differently (Zaidel, D.A. 1987); that there is a left hemisphere advantage for the recognition of English words (Fontenot 1973), and for Japanese Kana words (Hirata and Osaka 1967; Endo, Shimizu and Hori 1978) while a right hemisphere advantage has been reported for the recognition of Japanese Kanji words (Hatta 1978); for non verbal tasks such as random shape discrimination (Fontenot 1973) and line orientation (Umilta et al., 1974); the judgment of numbers using non verbal display formats such as bar graphs and dials have a right hemisphere superiority, while judgments using words have a left hemisphere superiority (Boles, 1986). These and a number of other studies complement the findings using clinical populations

Visual Laterality Technique in Clinical Research.

A number of studies have made use of the visual laterality technique to measure callosal transfer times, or hemispheric integration in the investigations related to clinical problems.

Gazzaniga (1972) suggested the possibility that dyslexia may be caused by an information transfer deficit across the corpus callosum. The two visual laterality

techniques have been used to investigate this possibility.

Vellutino, Scanlon and Bently (1983) used the second method; using vocal RT to stimuli presented to the left and the right VF. As predicted by Moscovitch and others both dyslexic and normal children were equally slow in reacting to stimuli presented to the left VF in comparison to stimuli presented to the right VF. However, the authors failed to find a significantly longer RT in reading impaired children in comparison to normals to stimuli presented to the left VF. This finding is incompatible with the idea that dyslexia is caused by a callosal transfer deficit.

Broman, Rudel, Helfgott and Kriger (1986) used the first visual laterality technique; using contralateral and ipsilateral hands; responding to laterally presented stimuli. They hypothesized that RT with the left hand to right VF and RT with the right hand to left VF presentations (cross hemisphere response) should take longer than RT with the left hand to left VF and with the right hand to right VF presentations (same hemisphere response), and that this difference would be greater for dyslexic children in comparison to normal children. Their results using both RT and error scores were also incompatible with the callosal transfer deficit hypothesis of dyslexia. Neither RT nor error scores were significantly faster or greater in the contralateral hand condition in comparison to the ipsilateral hand condition in dyslexic children.

Rosenthal and Bigelow (1972) used post-mortem data and demonstrated that schizophrenic patients have a statistically larger corpus callosum thickness. This finding led to a number of neuropsychological studies which suggested a defect in the callosal transfer of auditory visual and haptic information in schizophrenia. (Green, Glass and O'Callaghan, 1979; Green, 1978; Carr, 1980; Dimond and Scammel 1979).

This possibility has been investigated by a number of workers using the visual laterality technique for spatial (Lordahl et al., 1965) and lexical information (Dimond et al., 1979). Both authors reported evidence supportive of a callosal transfer deficit in schizophrenia. A study by Merriam and Gardner (1987) however, failed to find evidence to support the hypothesis of a corpus callosum dysfunction in schizophrenia. In their study, they used 80 pairs of letters (lexical stimulus) and 80 pairs of Brail like dots (spatial stimulus). Half the pairs matched, and the other half were different. The first member of a pair was projected to either the left or the right hemisphere and the second member was projected to the opposite hemisphere using a 3-field tachistoscope. 8 male and 8 female schizophrenic subjects and the same number of normal subjects indicated if the pairs were matching or different by pressing the appropriate of two buttons by using ipsilateral or contralateral hands. Using percentage of correct answers as the measure of callosal

transfer efficiency, they found no difference between normal and schizophrenic subjects in the percentage of correct responses when using the contralateral hand in compared to the ipsilateral hand, indicating that the two groups are the same with regard to the accuracy of callosal transfer.

Another study by Shelton and Knight (1984) using the technique of contralateral and ipsilateral hand response to lateralized visual stimuli also failed to find a difference between schizophrenics and normal subjects.

Critique of Visual Laterality Technique.

As described above, visual laterality studies depend on laterally presented stimuli entering the contralateral hemisphere. To ensure this, it is necessary to present the stimuli through a tachistoscope for a brief duration, usually under 200 ms. This procedure reduces the resolving power of the visual system. Some of the other factors affecting the visual resolution are; the luminance ratio of the background to the test stimuli, the visual angle subtended by the stimuli and the size of the stimuli.

A number of studies have shown that all the above factors may have an effect on visual field asymmetry. In investigating a lexical decision task, Bradshaw, Hicks and Rose (1979), and Pring (1981) found a shift in visual field advantage from the left VF (right hemisphere) to the

right VF (left hemisphere) as the exposure time increased. Sergent (1982c) found a similar shift in a facial categorization task. Sergent (1982b) reported that large letters were detected better in the left VF and that small letters were detected better in the right V.F. Sergent (1983) has shown that the acuity of the visual angle also effects VF advantages. He has suggested that the right hemisphere may be more efficient than the left hemisphere when the quality of the input is low and thus the amount of energy reaching the eye is low. This efficiency shifts to the left hemisphere when the amount of energy reaching the eye increases.

Tachistoscopic viewing in visual laterality studies is different from normal viewing since the first type of viewing demands responding to low energy stimuli. Because of this reason Sergent (1983) suggested caution in the extrapolating data from such studies to normal seeing.

In view of the cautions articulated by Pachella discussed in the last chapter, and by Sergent discussed in the present chapter, it is necessary to design visual laterality studies such that these difficulties are overcome. To do this, care must be taken to ensure that errors which may affect the results and the interpretation of visual laterality studies using RT are randomized across the experimental subjects and condition so that they will have no systematic effect on the results, or the interpretations and the conclusions of such studies.

PART THREE

THE EXPERIMENTS

CHAPTER 5

DESIGN

5.1. General Design Considerations

The current study makes use of the techniques discussed in the two preceding chapters; (1) reaction time measures and (2) visual laterality technique. In this study RTs in responding to a laterally presented visual matching task are used to investigate the physiological theories of alexithymia. In particular to investigate the following hypothesis. (1) Alexithymia is caused by a specific defect in the transmission of non linguistic pictorial information across the corpus callosum. (2) Alexithymia is caused by an over or an under activation of a specific cerebral hemisphere. (3) Alexithymia is caused by a defect in the transmission of emotion laden information across the corpus callosum.

The basic design used in all the studies presented in this thesis consists of presenting a visual matching task separately to the left or the right hemispheres. Time taken to emit a response indicating a "match" / "no match" decision through an action which is controlled by the hemisphere that is ipsilateral to the hemisphere processing the stimuli are recorded and compared with

response times of an action controlled by hemisphere that is contralateral to the hemisphere processing the stimuli. The difference between these two intervals are taken as an indication of the callosal transfer time.

Visual Masking Slide.

A visual masking slide was presented immediately following the presentation of the recognition slide to erase the iconic memory image that may be left behind by the recognition slide. The purpose of using the visual masking slide was to prevent the subject from scanning the iconic image before responding. The visual masking slide consisted of alternating black and white vertical lines.

Accuracy of Fixation and Accuracy of Measurements.

In the current study no effort was made to assess if the subjects were fixating on the central fixation point as instructed. As discussed previously, there is evidence that normal subjects can fixate on a central fixation point until the stimulus is presented. In addition in our study we decided to use well known previous findings as a measure of the accuracy of our experiment.

Error Scores.

In our study we decided to ignore all errors and absent scores and use only correct responses. Any reaction time over 1000 ms was considered as an error and ignored. Only correct responses under 1000 ms were averaged as described above and analyzed further.

The purpose of our experiment was to compare callosal transfer in high and low alexithymia. There is no theoretical bases for expecting a systematic difference in the error scores in the high and low alexithymia groups. We decided that considering error scores as a random variable in the two groups will not have a systematic effect on the conclusions of our study.

5.2. General Design of Experiments 1 and 2.

Stimulus and recognition Slides.

The stimuli used in our study consisted of slides containing either verbal or nonverbal stimuli. In all, 48 slides were used. These included 24 pairs of stimulus slides and 24 recognition slides.

Half the stimulus slides contained verbal stimuli and the other half non verbal stimuli. In the verbal category the stimulus slides contained three, 2 letter Japanese Hiragana (phonetic alphabet) words of the fol-

lowing classes: (1) names of animals; (2) names of flowers and (3) parts of the face. They were arranged vertically in the center of the slide. Slides in the non verbal category contained pictures of members of the same class, arranged in the same way. In both the verbal and the non verbal categories each slide was repeated 4 times making up the 24 slides (3 classes x 2 categories, verbal-non verbal x 4 = 24).

The recognition slide of each pair in the verbal category contained one word, and in the non verbal category one picture; located on the right hand edge in half the slides, and on the left hand edge in the other slides. Half the recognition slides contained a word or a picture of the same class as was contained in the stimulus slide of the pair (positive match). The other half contained a different word or a picture (negative match). When projected the stimuli in the matched recognition slides appeared approximately 5 c.m. to the right or the left of the fixation point, and they appeared 4 c.m. in length. When seen from a distance of 45 c.m., the stimuli transcended a visual angle of 6.5 degrees from the fixation point.

The 24 recognition slides were made up as follows:

3 pictorial/ left centered / positive match slides (PL+);
+ 3 pictorial/left centered/negative match slides (PL-);
+ 3 pictorial/right centered/positive match slides (PR+);
+ 3 pictorial/right centered/negative matched slides (PR-);
+ 3 verbal/right centered/ positive match slides (VR+);
+ 3 verbal right centered negative match slides (VR-);
+ 3 verbal left centered positive matched slides (VL+);
+ 3 verbal left centered negative match slides (VL-).

Each subject saw a block of 24 slide pairs repeated 4 times; in all 96 slides. The subjects viewed the 96 slides and responded to half in a given trial; only to the 12 negative matched slides with the left hand, only to the 12 positive matched slides with the left hand, only to the 12 negative matched slides with the right hand, only to the 12 positive matched slides with the right hand. Thus they responded to 48 slides; 24 with each hand.

Analysis of Data From Experiments 1 and 2.

Thus the design of the study was such that in an error free experiment each subject generated 48 individual sets of data which were averaged. The following example of a hypothetical data record for a single subject. It should make the composition of an individual data set clear.

TABLE 5.1.

An Example of Right Hand Reaction Times.

	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
	PR+	VR+	PR-	VR-	PL+	VL+	PL-	VL-
X	770	429	614	564	424	610	674	826
	814	623	475	542	563	523	632	652
	586	623	856	452	562	896	542	632
	SAME HEMISPHERE				CROSS HEMISPHERE			

TABLE 5.2.

An Example of Left Hand Reaction Times.

	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
SS	PR+	VR+	PR-	VR-	PL+	VL+	PL-	VL-
X	523	635	556	589	589	652	458	569
	562	876	458	635	457	567	852	654
	458	897	745	635	752	425	366	876
	CROSS HEMISPHERE				SAME HEMISPHERE			

TABLE 5.3.

Averaged Right Hand Reaction Times.

	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
Ss	PR+	VR+	PR-	VR-	PL+	VL+	PL-	VL-
X	723	558	648	519	516	676	616	703
	SAME HEMISPHERE				CROSS HEMISPHERE			

TABLE 5.4.

Averaged Left Hand Reaction Times.

Ss	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
	PR+	VR+	PR-	VR-	PL+	VL+	PL-	VL-
X	514	803	586	620	599	548	559	700
	CROSS HEMISPHERE				SAME HEMISPHERE			

Calculating Linguistic and Pictorial Reaction Times.

Stimuli in the right visual field enters the left hemisphere and stimuli in the left visual field visa versa. Averaging the RT for linguistic and non linguistic stimuli presented to each visual field, generated by the left and the right hand responses will give the average times in each hemisphere for linguistic and non linguistic processing. Thus in the above example average scores for subject X is calculated as follows.

TABLE 5.5.

Average Verbal and Non Verbal Reaction Times.

RIGHT HEMISPHERE					LEFT HEMISPHERE			
VERBAL		NON VERBAL			VERBAL		NON VERBAL	
VL+	VL-	PL+	PL-	RIGHT HAND	VR+	VR-	PR+	PR-
676	703	516	616		558	519	723	648
VL+	VL-	PL+	PL-	LEFT HAND	VR+	VR-	PR+	PR-
548	699	599	558		824	619	514	586
657		572		AVERAGE SCORE	630		618	

Calculating Same and Cross Hemispheric Reaction Times.

When responding with the right hand to stimuli in the right visual field and with the left hand to stimuli in the left visual field, the hemisphere controlling the responding hand and processing the stimuli are the same. Right handed responses to stimuli in the left visual field and left handed responses to stimuli in the right visual field have to cross the corpus callosum. Thus in the above example average same and cross hemispheric processing times of subject X are calculated as follows.

TABLE 5.6.

Average Same Hemisphere Reaction Times.

	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	RIGHT HAND SCORES				LEFT HAND SCORES			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
Ss	PR+	VR+	PR-	VR-	PL+	VL+	PL-	VL-
X	723	558	648	519	599	548	559	700
	AVERAGE 607							

TABLE 5.7.

Average Cross Hemisphere Reaction Times.

	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	LEFT HAND SCORES				RIGHT HAND SCORES			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
	PR+	VR+	PR-	VR-	PL+	VL+	PL-	VL-
X	514	824	803	622	516	676	616	703
	AVERAGE 629							

The results were analyzed using a series of analysis of variance and t-tests. Same and cross hemispheric processing was analyzed using a 2 x 2 analysis of variance (high and low alexithymia x same and cross hemispheric processing). Left and right hemispheric processing of linguistic and pictorial stimuli was similarly assessed. Left and right hemispheric processing of linguistic and pictorial stimuli as a factor of alexithymia was analyzed by using a 2 x 2 x 2 ANOVA. Interacting pairs of factors were then analyzed using t-tests.

5.3. The General Design of Experiment. 3

The general design of Experiment 3 was similar to the design of Experiments 1 and 2. It consisted of presenting a stimulus slide followed by a recognition slide. Then comparing the differences in the two response latencies; (1) when the responding hemisphere and the processing hemispheres are the same and (2) when they are different.

In Experiment 3 we presented the subjects with emotionally arousing and emotionally neutral stimuli. The response that we selected to measure the trans-callosal speed is the vocal response. This choice was made because the vocal response is logically closer to the concept of alexithymia, which is defined as an inability to verbally express emotions.

The Stimulus and the Recognition Slides.

The stimuli consisted of 24 pairs of slides. Instead of linguistic and non-linguistic information however, the slides contained emotionally laden, and emotionally neutral stimuli. The emotionally laden stimuli consisted of; (1) a joyfully smiling face (2) a extremely sad face and (3) a picture of a dismembered body. The neutral stimuli consisted of a picture of scissors, a picture of a stapler and a picture of a watch.

The slides were designated as emotion laden and neutral by showing 10 subjects 25 different photographs and asking them to separate them into the two categories. Those which were unanimously chosen as emotional and neutral were used.

As discussed in the introductory Chapter 2., it is known that language functions are mediated by the left cerebral hemisphere. If a stimulus is entered into the right cerebral hemisphere, information regarding the stimulus must crossover to the right cerebral hemisphere before a verbal response can be emitted. On the other hand, when a stimulus is presented to the left cerebral hemisphere, a verbal response can be emitted directly from the left hemisphere. Thus the difference in the vocal response latency to a stimulus presented to the right hemisphere and a stimulus presented to the left hemisphere gives an indication of the callosal transfer speed.

TABLE 5.8.

Calculating Same and Cross Hemispheric Reaction Times.

	RIGHT VISUAL FIELD				LEFT VISUAL FIELD			
	POSITIVE		NEGATIVE		POSITIVE		NEGATIVE	
Ss	E+	N+	E-	N-	E+	N+	E-	N-
X	770	429	614	564	424	610	674	826
	814	623	475	542	563	523	632	652
	586	623	856	452	562	896	542	632
	SAME HEMISPHERE				CROSS HEMISPHERE			

The reaction times of each subject was averaged and analyzed using a series of ANOVA and t-tests.

5.4. The Design of the Clinical Study.

The clinical study was designed to investigate callosal transfer in a clinical population by comparing psychosomatic patients with patients suffering from illnesses other than psychosomatic illnesses. The completion of the clinical study was not considered a part of the scope of the present thesis. Within the scope of the present thesis it was intended only to initiate the clinical study. The clinical study was considered the logical extension of the technique developed within the scope of this study.

All patients attending an outpatient clinic at the National Institute of Mental Health of Japan were tested using the procedure described in Chapter 9., Once a large enough sample of patients have been tested, reaction time scores of those patients who are diagnosed as suffering from psychosomatic illnesses are to be compared with the test scores of patients diagnosed as suffering from illnesses other than psychosomatic illnesses.

All stimulus slides used in the Clinical Study were similar to the stimulus slides used in Experiment 1 and 2. The response that was used in the clinical study was similar to the response used in Experiment 3. The data analysis technique in the Clinical Study was similar to Experiment 3.

CHAPTER 6

AN EXPERIMENT TO CALIBRATE AND VALIDATE THE PROCEDURE FOR INVESTIGATING CALLOSAL TRANSFER USING REACTION TIMES TO LATERALLY PRESENTED STIMULI

EXPERIMENT 1

Objective

The objective of the calibration study was to adjust the experimental procedure and equipment until it was possible to make the criterion observations.

Introduction

Experiment 1. was undertaken to provide evidence for the validity of the method used in the current study. It was based on the following two well documented findings.

(1) In right handed people, linguistic processing is strongly localized in the left hemisphere and nonlinguistic, symbolic, processing is localized in the right hemisphere, but less strongly.

(2) In a visual matching task, RT with the hand contralateral to the hemisphere processing the stimulus will be shorter than RT with the hand ipsilateral to the hemisphere processing the stimulus.

It was hypothesized that if our procedure was accurate and if our measurement techniques are precise, then we will obtain the following results from our experiment.

(1) A left hemispheric advantage for the processing of linguistic stimuli, and a right hemispheric advantage, but less than the advantage shown by the left hemisphere, for the processing of non linguistic stimuli.

(2) Longer response times for the ipsilateral (cross hemisphere) hand responses in comparison to the contralateral (same hemisphere) hand responses.

Equipment

The following equipment were used in the current study: (1) A three channel projector tachistoscope (Kodak Carousel); (2) An electromechanical timer (Gerbrands G1175); (3) A clock counter (Digitimer TW 7010A); (4) a digital printer (TKK-DP-9A); (5) a response button; (6) a chin rest.(7) a back projection screen.

Measuring Instruments

Japanese version of the H. N. Handedness Inventory

This is a 10 item questionnaire designed to measure hand preference which is indicative of cerebral dominance.

Subjects.

12 University undergraduate students (half female) took part. All were native speakers of Japanese who were strongly right handed as judged by the H.N. handedness inventory. They had normal or corrected vision.

Procedure

There were 24 stimulus slides, half containing linguistic, and half containing non-linguistic, symbolic, stimuli centered in the middle. The slides in the linguistic category contained 3 Japanese Hiragana (phonetic alphabet), 2 letter words. The slides in the non-linguistic, symbolic, category contained line drawings of the same objects.

We back projected the stimulus slide for a randomly variable duration of 3-4 seconds. A warning bell followed. Upon hearing the bell, we instructed the subjects to fixate both eyes on a central fixation point. Then we back projected the second (recognition) slide of the pair; which was of the same category as the stimulus slide.

The recognition slide contained one of the three words or pictures contained in the stimulus slide (positive match), or a different word or a picture (negative match). The stimulus in the recognition slide was centered

on the left or the right edge of the slide. When projected the stimulus extended for 4 c.m. When seen from a distance of 45 c.m. the stimulus transcended a visual angle of 6.5 degrees from the fixation point.

Half the recognition slides contained a positive match and the other half a negative match. Half the stimuli on the recognition slides were centered on the left edge of the slide, the other half on the right edge.

A visual masking slide back projected for 50 ms followed the recognition slide. The purpose of this slide was to erase the iconic memory trace of the recognition slide.

The subjects were seated 45 c.m. from the screen with their head resting on a chin rest. They decided if the two slides were a positive match or not and pressed the response button. The Digitimer recorded interval from the presentation of the recognition slide to the button press.

3 different linguistic, and 3 different nonlinguistic, stimulus slides were repeated 4 times (3+3=6, 6x4=24) each followed by the second member of the pair. The 24 pairs of slides were repeated 4 times in 4 blocks of trials (24x4=96). The subjects were instructed to respond as fast as possible to a positive match on half the blocks, and to a negative match on half the blocks. They responded with the right hand on half the blocks, and with the left hand on half the blocks. Presentation order of the slides, and the response blocks were randomized.

Thus each subject saw 96 slides in all and responded to half with each hand. Each generated 48 (24 with the left + 24 with the right hand) RT scores in an error free experiment.

The left and right hand response times for left and right VF presentations were averaged separately for linguistic and non-linguistic stimuli. See Table 5.1.- 5.5. We averaged left hand RT to right VF presentations and right hand RT to left VF presentations to get a measure of cross hemisphere RT. Similarly, we averaged left hand RT to left VF presentations and right hand RT right VF presentations to get a measure of same hemisphere RT. See Tables 5.6., and 5.7., All errors and reactions timed over 1000 ms were excluded from further analysis.

Results

It is clear from Figure 6.1., that linguistic processing is faster in the left hemisphere in comparison to the right, and that pictorial processing is faster in the right hemisphere in comparison to the left. An ANOVA indicated that there is a significant interaction between the two of processes ($F = 7.864$, df, 1, 11, $P<0.016$). See Appendix 6.1., for the ANOVA, the averaged data and the raw data of Experiment 1., A t-test revealed that the difference in linguistic processing in the two hemispheres was significant ($t = 1.5517$, $df = 11$, $P<0.05$). The difference in pictorial processing was not significant.

Figure 6.1. shows that processing of linguistic Stimuli is faster in the left hemisphere in comparison to the right. ($F = 7.864$, df, 1, 11, $p < 0.016$)

The reverse is true for the processing of pictorial stimuli, but this difference is not significant.

Figure 6.2. shows that cross hemispheric reaction times takes longer than same hemispheric reaction times ($t = 1.551$, $df = 11$ $P < 0.016$).

It can be seen from Figure 6.2., that same hemispheric processing is faster than cross hemispheric processing. A t-test revealed that these differences are significant ($t= 1.551$, $df= 11$, $P<0.0016$). See appendix 6.2 for the ANOVA and the averaged data.

Discussion

The results of the calibration study validated the experimental procedure that we have used.

As predicted, cross hemispheric processing takes longer than same hemispheric processing. Linguistic processing takes longer in the right hemisphere in comparison to the left hemisphere. Pictorial processing was faster in the right hemisphere although this difference was not significant.

These results replicate the common findings regarding the function of cerebral hemispheres. The fact that we have been able to replicate these findings give credence to our experimental procedure. It is problematic that pictorial processing times were not significantly faster in the right hemisphere in comparison to the left hemisphere. However, there is evidence that the processing of non verbal material is less well localized than the processing of language.

CHAPTER 7

AN EXPERIMENT TO MEASURE A POSSIBILE INTERHEMSPHERIC TRANSFER DEFICIT IN HIGHLY ALEXITHYMIC SUBJECTS

EXPERIMENT 2

Objective

We decided to use lateralized presentations of both linguistic and nonlinguistic, symbolic, stimuli to test the following hypothesis of: (1) an association between alexithymia and an over, or an under activation of a specific hemisphere; (2) an association between alexithymia and a specific defect in the interhemispheric transmission of symbolic information and (3) the possibility that the transfer deficit is bidirectional.

Introduction

As predicted by the studies of TenHouten et al., Zeitlin et al., and others discussed above, there is evidence for an association between alexithymia and an interhemispheric transfer deficiency. Experiment 2., was designed to investigate this possibility.

We decided to use ipsilateral and contralateral hand

reaction times (RT), to a laterally presented visual matching task to assess the possibility of a callosal transfer deficit in alexithymia. This technique is based on the anatomical evidence which suggest that when the eyes are fixed on a central point, information presented to the left visual field (VF) enters the right cerebral hemisphere and information presented to the right VF, visa versa. It is also based on the anatomical evidence suggesting that the contralateral hemispheres control each hand. Thus, a stimulus presented to the left VF enters the right cerebral hemisphere. When a subject responds to this stimulus with the left hand, the right hemisphere is processing the stimulus and controlling the responding hand. If the subject responds with the right hand to the same stimulus, information about the stimulus must cross the corpus callosum to the left hemisphere before the right hand can initiate a response; see Figure 2.1. Therefore, a differences in RT from the hands that are ipsilateral and contralateral to the hemisphere processing the stimulus gives a measure of callosal transfer interval. RT with the right hand gives a measure of right to left callosal transfer interval. RT with the left hand gives a measure of left to right callosal transfer interval.

Equipment

The following equipment were used in the current study: (1) A three channel projector tachistoscope (Kodak Carousel); (2) An electromechanical timer (Gerbrands G1175); (3) A clock counter (Digitimer TW 7010A); (4) a digital printer (TKK-DP-9A); (5) a response button; (6) a chin rest.(7) a back projection screen.

Measuring Instruments

Japanese version of the MMPI Alexithymia Scale. This is a 20 item self report scale derived from a pool of 556 MMPI items, designed to measure alexithymia.

Japanese version of the Schalling-Sifneos Personality Scale-Revised. The SSPS-R is a 22 item self report scale, based on the Beth Israel Hospital Questionnaire designed to measure alexithymia.

Japanese version of the H. N. Handedness inventory. This is a 10 item questionnaire designed to measure hand preference indicative of cerebral dominance.

Subjects

The subjects who took part in this experiment were

all native speakers of Japanese; undergraduate university students, whose mean age was 19 years. 730 students were screened (472 male) using the SSPS-R and the MMPI alexithymia Scales. 27 students (15 male) scoring the highest points, indicating high alexithymia, and 26 (11 male) students scoring the lowest points, indicating low alexithymia were selected for further testing. All the subjects tested were judged to be strongly right handed according to the H.N. Handedness Inventory. They had normal or corrected vision.

Procedure

There were 24 stimulus slides, half containing linguistic, and half containing non-linguistic, symbolic, stimuli centered in the middle. The slides in the linguistic category contained 3 Japanese Hiragana (phonetic alphabet), 2 letter words. The slides in the non-linguistic, symbolic, category contained line drawings of the same objects.

We back projected the stimulus slide for a randomly variable duration of 3-4 seconds. A warning bell followed. Upon hearing the bell, we instructed the subjects to fixate both eyes on a central fixation point. Then we back projected the second (recognition) slide of the pair; which was of the same category as the stimulus slide.

The recognition slide contained one of the three words or pictures contained in the stimulus slide (positive match), or a different word or a picture (negative match). The stimulus in the recognition slide was centered on the left or the right edge of the slide. When projected the stimulus extended for 4 c.m. When seen from a distance of 45 c.m. the stimulus transcended a visual angle of 6.5 degrees from the fixation point.

Half the recognition slides contained a positive match and the other half a negative match. Half the stimuli on the recognition slides were centered on the left edge of the slide, the other half on the right edge.

A visual masking slide back projected for 50 ms followed the recognition slide. The purpose of this slide was to erase the iconic memory trace of the recognition slide.

The subjects were seated 45 c.m. from the screen with their head resting on a chin rest. They decided if the two slides were a positive match or not and pressed the response button. The Digitimer recorded interval from the presentation of the recognition slide to the button press.

3 different linguistic, and 3 different non-linguistic, stimulus slides were repeated 4 times (3+3=6, 6x4=24) each followed by the second member of the pair. The 24 pairs of slides were repeated 4 times in 4 blocks of trials (24x4=96). The subjects were instructed to respond as fast as possible to a positive match on half

the blocks, and to a negative match on half the blocks. They responded with the right hand on half the blocks, and with the left hand on half the blocks. Presentation order of the slides, and the response blocks were randomized.

Thus each subject saw 96 slides in all and responded to half with each hand. Each generated 48 (24 with the left + 24 with the right hand) RT scores in an error free experiment.

The left and right hand response times for left and right VF presentations were averaged separately for linguistic and non-linguistic stimuli. See Table 5.1- 5.5., We averaged left hand RT to right VF presentations and right hand RT to left VF presentations to get a measure of same hemisphere RT. Similarly, we averaged left hand RT to left VF presentations and right hand RT right VF presentations to get a measure of cross hemisphere RT. See Tables 5.6. and 5.7. All errors and reactions timed over 1000 ms were excluded from further analysis.

Results

A 3 way analysis of variance (high/low alexithymia x left/right hemisphere x linguistic/non linguistic stimulus type) of RT by both the left and the right hands indicated that the interaction between alexithymia, hemispheres and stimulus type was not significant ($F=3.951$, $df=1,51$, $P>0.05$). See appendix 7.1 for the ANOVA, the

averaged data and the raw data of Experiment 2., This result suggests no difference in the way high and low alexithymic subjects process verbal and pictorial information in the left and the right hemispheres.

Right hand RT for linguistic stimuli were analyzed for differences in right to left hemisphere callosal transfer times in the high and low alexithymia groups. A 2x analysis of variance (high/low alexithymia x same/cross hemispheric processing) indicated that cross hemispheric processing takes longer than same hemispheric processing by an average of 36 ms in the low alexithymia, and 32 ms in the high alexithymia groups. These differences were highly significant ($F=12.37$, $df=1,53$, $P<0.01$) However, the interaction between the two groups was not significant ($F=0.015$, $df=1,51$, $P>0.05$) see appendix 7.2 for the ANOVA and the average data. This result indicates that the callosal transfer times of linguistic information from right to the left hemisphere does not differ in the high and low alexithymia groups (See Figure 7.1.).

Right hand RT for non-linguistic, symbolic, stimuli were similarly analyzed using a 2x analysis of variance. The result of this analysis indicated that the interaction cross/same hemisphere processing times x high/low alexithymia was significant ($F=4.952$, $df=1,51$, $P<0.05$) see appendix 7.3., for the ANOVA and the averaged data. A t-test indicated that the difference in same and cross hemispheric processing times for non-linguistic, symbolic

stimuli in the high alexithymia group was highly significant ($t=2.346$, $df=26$, $P<0.02$). This difference was not significant in the low alexithymia group ($t=.6650$, $df=25$, $P>0.05$). These results suggest that the right to left callosal transfer of non-linguistic, symbolic information takes significantly longer in the high alexithymia group but not in the low alexithymia group (See Figure 7.2.).

Left hand responses were analyzed for both linguistic and non linguistic material. Two separate 2x ANOVA suggested that the interaction; same/cross hemispheric processing times x high/low alexithymia for linguistic material ($F=0.170$, $df=1,51$, $P>0.05$) and for non linguistic material ($F=0.092$, $df=1,51$, $P> 0.05$) is insignificant (see appendices 7.4 and 7,5 for the ANOVA). This result suggests no difference in the speed of information transfer from the left to the right hemisphere in high and low alexithymia groups. The possibility remains that this insignificant result is due to the unreliability of left hand reaction times in strongly right handed subjects. For example, it is possible that left hand reaction times are unusually slow, leading to inaccurate measurements. To exclude this possibility we separately analyzed all left and right handed RT to linguistic material presented to the two hemispheres. A series of 4 t-tests indicated that the difference between left and right hand RT in all four conditions were insignificant, suggesting that left hand responses have the same validity as right hand responses.

Figure 7.1. based on reaction times with the right hand show that cross hemispheric processing of linguistic information takes longer for both the groups (F= 12.37, df, 1,53, $p < 0.001$). However, the right to left hemisphere transfer times of the high and low alexithymia groups do not differ significantly for linguistic information (F= 0.015, df, 1,51, $p > 0.05$).

Figure 7.2. based on reaction times with the right hand show that right to left hemisphere transfer times of non linguistic pictorial information of high alexithymia group is significantly different ($t = 2.346$, $df = 26$, $p < 0.02$). This difference was not significant in the low alexithymia group.

These results indicate that the information transfer deficit in high alexithymia is a unidirectional transfer deficit from the right to the left hemisphere which is specific to non linguistic, symbolic information.

Discussion

Our data supported the hypothesis of an association between alexithymia and a right to left hemisphere information transfer deficit specific to nonlinguistic, symbolic information. Interhemispheric transmission time for nonlinguistic, symbolic material in the high alexithymia group is longer in comparison to the low alexithymia group. The difference between same and cross hemispheric processing times in the high alexithymia group was also highly significant.

As can be seen from Figure 7.2, a problem with the results of our study is the non significant difference in the same and cross hemispheric processing times in the low alexithymia group. In this group also, we would expect that the cross hemispheric processing would take significantly longer than same hemispheric processing. This expectation was valid in the case of linguistic information but not in the case of nonlinguistic, symbolic information. This may be because interhemispheric transmission of non-linguistic, symbolic information is the defining characteristic of high and low alexithymia. Since our low

alexithymia subjects were the lowest in the alexithymia continuum, their interhemispheric transmission times of non-linguistic, symbolic information may be the fastest in the general population. Our experimental procedure may have been too insensitive to measure the speed of interhemispheric transfer in this group. Perhaps a further comparison with a group of subjects in the middle of the alexithymia spectrum may resolve this matter.

The data of our experiment does not support the association between hemispheric under activation, or over activation and alexithymia. The right hemisphere deficiency hypothesis would lead us to expect a significant delay in the information processing speed in the right hemisphere in the high alexithymia group; the right hemisphere over activation theory would lead us to expect the opposite. We found no difference in information processing speeds of high and low alexithymia groups in the individual hemispheres. Neither was the speed of processing linguistic and non linguistic information by the two groups significantly different. Thus, we can attribute the differences in same and cross hemispheric processing times to the callosal transfer process independently of the processing times in the individual hemispheres.

Our data is in agreement with the study by Zeitlin, Lane, O'Leary et al. However, in this study the authors found evidence for a bidirectional callosal transfer deficit in alexithymia, while our data indicate a unidi-

rectional transfer deficit. As pointed out by Zeitlin et al., sensorimotor data from the tactile finger location task may not have been appropriate to test the direction of interhemispheric transfer, because there is no evidence that sensorimotor information is lateralized. Since we know that the processing of linguistic and non linguistic information is lateralized, our finding may be more significant to the concept of alexithymia.

In this study we have been able to confirm an association between alexithymia and callosal transfer of symbolic information in subjects judged to be highly alexithymic by two alexithymia scales.

Even more pertinent to alexithymia than symbolic information, is the callosal transfer of emotion laden information, as well as the callosal transfer process of patients suffering from psychosomatic illnesses. The same tachistoscopic technique adopted in the current study can be modified to test the callosal transfer of emotionally charged information as well as the callosal transfer process of psychosomatic patients. We suggest this as the next logical steps in the investigation of neurological processes in alexithymia.

CHAPTER 8

AN EXPERIMENT TO MEASURE AN INTERHEMISPHERIC TRANSFER DEFICIT OF EMOTIONAL INFORMATION IN HIGH ALEXITHYMIA

EXPERIMENT 3

Objective

This study is designed to test the possibility of a callosal transfer deficit in highly alexithymic subjects, specific to the transfer of emotional information from the right to the left hemisphere.

Introduction

Alexithymia is defined as an inability to verbalize emotions. A specific disability to transfer emotions experienced in the right hemisphere to the left for verbalization is hypothesized as a possible cause of alexithymia.

The logic of this experiment is based on the physiological finding that stimuli presented to the left VF enters the right hemisphere. Because language is mediated by the left hemisphere, such stimuli must be transferred to the left hemisphere via the corpus callosum

before a verbal response can be initiated. Stimuli presented to the right VF enters the left hemisphere. Since the left hemisphere mediates verbalization, verbal responses can be initiated directly from this hemisphere. The difference between vocal RT to stimuli presented to the left VF and the right VF gives a measure of callosal transfer speed.

High and low alexithymic subjects were presented with emotionally arousing and emotionally neutral slides. The subjects compared the first (stimulus) slide, with the second (recognition) slide and made a verbal response; "the slides are matching", or "the slides are not matching". On half the trials the two slides were matching and on the other trials they were different. The voice activated a voice switch which stopped a clock counter measuring the interval from the presentation of the second slide of the pair to the initiation of the response.

Equipment

The following equipment were used in the current study: (1) A three channel projector tachistoscope (Kodak Carousel); (2) An electromechanical timer (Gerbrands G1175); (3) A clock counter (Digitimer TW 7010A); (4) a digital printer (TKK-DP-9A); (5) A voice activated switch (6) a chin rest.(7) a back projection screen.

Measuring Instruments

Japanese Version of the Toronto Alexithymia Scale(TAS) (Kamimura 1990).

This is a 26 item self report questionnaire which measures alexithymia on a scale of 26-130. Subjects respond on a 5 point Lickart Scale for each question. It has been established that a score of 65-75 is within the normal range while a score of over 75 indicate alexithymia.

Japanese version of the H. N. Handedness inventory. is a 10 item questionnaire designed to measure hand preference indicative of cerebral dominance.

Subjects

451 native Japanese undergraduate students were screened using the Toronto Alexithymia scale (243 Male). 22 (11 male) with the highest scores and 25 (12 male) with the lowest scores who were right handed as judged by the H.N. handedness inventory were tested further.

Procedure

There were 24 stimulus slides, half containing emotionally laden and half containing neutral stimuli centered in the middle.

We back projected the stimulus slide for a randomly variable duration of 4-5 seconds. A warning bell followed. Upon hearing the bell, we instructed the subjects to fixate both eyes on a central fixation point. Then we back projected the second (recognition) slide of the pair; of the same category as the stimulus slide for the duration of 180 ms.

The recognition slide contained one of the three pictures contained in the stimulus slide (positive match), or a different picture (negative match). The stimulus in the recognition slide was centered on the left or the right edge of the slide. When projected the stimulus extended for 4 c.m. When seen from a distance of 45 c.m., the stimulus transcended a visual angle of 6.5 degrees from the fixation point.

Half the recognition slides contained a positive match and the other half a negative match. Half the stimuli on the recognition slides were centered on the left edge of the slide, the other half on the right edge.

A visual masking slide back projected for 50 ms followed the recognition slide. The purpose of this slide was to erase the iconic memory trace of the recognition slide.

The subjects were seated 45 c.m. from the screen with their head resting on a chin rest. They decided if the two slides were a positive match or not and made the vocal response "the slides are matching" in half the

trials, and "slides are not matching" on the other trials. The onset of the vocal response activating the voice switch which terminated a clock counter. The clock counter measured the time from the presentation of the recognition slide to the initiation of the response.

3 different emotional, and 3 different neutral, stimulus slides were repeated 4 times (3+3=6, 6x4=24) each followed by the second member of the pair. The 24 pairs of slides were repeated 2 times in 2 blocks of trials (24x2=48). The subjects were instructed to respond as fast as possible to a positive match on half the blocks, and to a negative match on half the blocks. Presentation order of the slides, and the response blocks were randomized.

Thus each subject saw 48 slides in all and responded to half. Each generated 24 RT scores in an error free experiment.

The left and right VF presentations were averaged separately for emotional and neutral stimuli. All errors and reactions timed over 1000 ms were excluded from the analysis.

Results

A 3 x analysis of variance (high/low alexithymia x same/cross hemispheric processing x emotional/neutral stimuli indicated that the difference in the processing of emotional and neutral information was highly signifi-

Figure 8.1 shows that the difference in the processing times of emotional and neutral stimuli is highly significant in the high alexithymia group ($F = 34.468$, df, 1,45, $p < 0.001$).

Figure 8.2 shows that the difference in the processing times of emotional and neutral stimuli is highly significant in the low alexithymia group ($F = 9.875$, df, 1,45, $P < 0.001$)

cant ($F = 34.468$, df, 1, 45, $p < 0.001$). The difference in same and cross hemispheric processing was also highly significant ($F = 9.875$, df, 1, 45, $p < 0.001$). See Figures 8.1. and 8.2., However, there was no interaction between alexithymia and same/cross hemispheric processing ($F = 0.680$, df, 1, 45, $p > 0.05$) or alexithymia and the processing of emotional/neutral stimuli ($F = 0.958$, df 1, 45, $p > 0.05$) See Appendix 8.1., for the ANOVA, the averaged and the raw data of Experiment 3., This result indicate that there is no difference in the processing of emotional and neutral information among high and low alexithymic subjects. Our result also suggest that there is no difference in the right to left hemisphere callosal transfer speeds of high and low alexithymia groups.

Discussion

The results of our study does not support the experimental hypothesis that the right to the left hemisphere transfer of emotion laden information takes significantly longer in highly alexithymic subjects. This should lead us to accept the null hypothesis that the two groups do not differ in the right to the left hemisphere transfer of emotion laden information. However, with hind sight, we have been able to identify several procedural and conceptual problems with Experiment 3.

The Japanese version of the TAS that we used was later found to contain several translation errors. In a separate study Kamimura (unpublished) factor analyzed the responses to the Japanese version of the TAS made by our respondents and found that the factor clusters of the Japanese subjects did not match the factor clusters reported by Taylor, Ryan and Bagby (1985) in the original version of the TAS. An alpha reliability analysis by the same worker indicated that the reliability of the Japanese version of the TAS had a standardized alpha reliability coefficient of less than 0.64 which is too low to be acceptable. The original version of the TAS has an acceptable alpha coefficient of 0.79. Furthermore, in our study we did not rely on the cutoff points of high and low alexithymia as suggested by Taylor and Bagby (1988). They suggested that a score of over 74 indicate alexithymia and a score of less than 62 indicate no alexithymia. In our study we designated the 22 highest scoring subjects as high alexithymia and the 25 lowest scoring subjects as low alexithymia. The decision to do this may have been inappropriate.

Because of the reasons outlined above we may have failed to identify a truly high alexithymia group and a truly low alexithymia group. A new Japanese version of the TAS has become available since our study was completed (personal communications; unpublished at the time of writing this thesis) This scale has been validated in

Japan it has been found to have a high degree of validity. The factor cluster of this scale using Japanese subjects has been found to be similar to the original test. It is suggested that a future study should make use of this scale.

In our study we made use of two different types of slides, emotion laden and neutral. The emotion laden category of slides contained more complex photographs than the slides in the neutral category. This may have led to the longer processing times for the emotion laden slides, as indicated by the significantly longer reaction times.

It is suggested that a future study should make use of only one set of slides. The high and low alexithymia groups should be divided into two subgroups. One of each subgroup should be verbally primed by using an emotionally arousing story to describe the content of the slides. While the other sub-group should be primed with a neutral story. Thus emotional arousal should be made a within group difference.

In view of the shortcomings of the current study discussed above factors, it is suggested that a future study should be undertaken to test the right to the left hemisphere transfer deficit of emotional information in alexithymia before the null hypothesis is accepted. The following recommendation are made for as for a future study.

(1) Use of the new Japanese version of the TAS which has been validated in Japan.

(2) Use of cutoff points for low and high alexithymia as suggested by Taylor and Bagby (1988).

(3) Design an experiment making emotional arousal a within group variable.

CHAPTER 9

A PILOT CLINICAL STUDY TO TEST A POSSIBLE INTERHEMISPHERIC TRANSFER DEFICIT IN PSYCHOSOMATIC PATIENTS

CLINICAL STUDY 1

Objective

The purpose of the Clinical Study was to take the topic covered in this thesis to a logical conclusion and investigate callosal transfer times in a clinical population. It is not intended to conclude the clinical study within the scope of this thesis. Rather, it is the intention of the author to carry out a pilot clinical study in preparation to extend the experimental techniques developed in this thesis to a clinical population.

We decided to use lateralized presentations of both linguistic and nonlinguistic, symbolic, stimuli to test the hypothesis that interhemispheric transfer times of certain psychosomatic patients are different from low alexithymic subjects and patients with illnesses other than psychosomatic illnesses. Specifically, we intended to test the hypothesis that right to left hemispheric transfer times in psychosomatic patients will be longer in comparison to subjects who are low alexithymic and patients with illnesses other than psychosomatic illnesses.

Introduction

As predicted by the studies of TenHouten et al., Zeitlin et al., and others, and from the results of Experiment 1., there is evidence of a clear association between alexithymia and an interhemispheric transfer deficiency. As described in the introductory Chapter 1., there is also an association between alexithymia and some psychosomatic illnesses. This clinical study was designed to investigate this possibility that interhemispheric transfer times in a psychosomatic patient population will be longer in comparison to a patient population suffering from non psychosomatic disorders.

The logic of this experiment is based on the physiological finding that stimuli presented to the left VF enters the right hemisphere. Because language is mediated by the left hemisphere, stimuli in the right hemisphere must be transferred to the left hemisphere via the corpus callosum before a verbal response can be initiated. Stimuli presented to the right VF enters the left hemisphere. Since the left hemisphere mediates verbalization, verbal responses can be initiated directly from this hemisphere. The difference between vocal RT to stimuli presented to the left VF and the right VF gives a measure of callosal transfer.

Equipment

The following equipment were used in the current study: (1) A three channel projector tachistoscope (Kodak Carousel); (2) An electromechanical timer (Gerbrands G1175); (3) A clock counter (Digitimer TW 7010A); (4) a digital printer (TKK-DP-9A); (5) a voice activated switch; (6) a chin rest; (7) a back projection screen.

Subjects

The subjects who took part in this study were psychosomatic patients attending the division of psychosomatic medicine at the National Institute of Mental Health in Ichikawa City, Chiba prefecture, Japan. Subject No. 1., was a patient suffering from hypothyroidism. Subject No. 2., was a patient suffering from bronchial asthma. Subject No. 3., was a patient suffering from ischemic heart disease and Subject No. 4., was a patient suffering from torticorllis.

Procedure

There were 24 stimulus slides, half containing linguistic, and half containing non-linguistic, symbolic, stimuli centered in the middle. The slides in the linguistic category contained 3 Japanese Hiragana (phonetic

alphabet), 2 letter words. The slides in the non-linguistic, symbolic, category contained line drawings of the same objects.

We back projected the stimulus slide for a randomly variable duration of 3-4 seconds. A warning bell followed. Upon hearing the bell, we instructed the subjects to fixate both eyes on a central fixation point. Then we back projected the second (recognition) slide of the pair; which was of the same category as the stimulus slide.

The recognition slide contained one of the three words or pictures contained in the stimulus slide (positive match), or a different word or a picture (negative match). The stimulus in the recognition slide was centered on the left or the right edge of the slide. When projected the stimulus extended for 4 c.m. When seen from a distance of 45 c.m. the stimulus transcended a visual angle of 6.5. degrees from the fixation point.

Half the recognition slides contained a positive match and the other half a negative match. Half the stimuli on the recognition slides were centered on the left edge of the slide, the other half on the right edge.

A visual masking slide back projected for 50 ms followed the recognition slide. The purpose of this slide was to erase the iconic memory trace of the recognition slide.

The subjects were seated 45 c.m. from the screen with their head resting on a chin rest. They decided if

the two slides were a positive match or not and verbally stated, "the slides are matching", on half the blocks and "the slides are not matching," on the other half of the blocks. The subjects voice activated a voice operated switch which terminated a digital clock counter. The Digitimer recorded interval from the presentation of the recognition slide to the button press.

3 different linguistic, and 3 different nonlinguistic, stimulus slides were repeated 2 times (3+3=6, 6x4=24) each followed by the second member of the pair. The 24 pairs of slides were repeated 2 times in 2 blocks of trials (24x2=48). The subjects were instructed to respond as fast as possible to a positive match on half the blocks, and to a negative match on half the blocks. Presentation order of the slides and the response blocks were randomized.

Thus each subject saw 48 slides in all and responded to half. Each generated 24 RT scores in an error free experiment.

The positive and negative response times for left and right VF presentations were averaged separately for linguistic and non linguistic stimuli (see table 5.8). We averaged right VF presentations to obtain same hemispheric processing times and left VF presentation to obtain cross hemispheric processing times. All errors and reactions timed over 1000 ms were excluded from further analysis.

The reaction times obtained in the patient popula-

tion were compared with the reaction times in the non-patient, student population scoring high and low points in the MMPI and the SSPS-R alexithymia scales obtained in Experiment 2.

Results

The results of the pilot clinical study are presented in the Tables 9.1. and 9.2. It is clear from the Graphs 9.1.-9.8., that all reaction times in our patient population is longer than those in the non patient population. It is clear from Graphs 9.3. and 9.7., that the differences between same and cross hemispheric processing of linguistic information of patients No.2. and 4 are similar to those of the non patient population. This is indicated by the nearly parallel lines in Graphs 9.3. and 9.7.

It is clear from Graphs 9.4., 9.6. and 9.8., that the pictorial processing scores of patients No. 2, 3 and 4., are similar to those of the high alexithymia group. This is indicated by the near parallel lines between same and cross hemispheric processing times of these two patients and those of the high alexithymia group. However in the case of patient No. 1., the same and cross hemispheric pictorial processing times are similar to those of the low alexithymia group.

VERBAL RT SCORES OF 4 PATIENTS

RT SCORES OF PATIENT NO. 1.

SAME	CROSS
583	511
563	532
532	613
452	487
639	469
521	466
410	588
521	532
638	583
569	417
489	466
457	598
528	574
695	551
478	568
632	563
458	652
592	452
471	623
633	547
456	632
522	574
631	522
511	564
539.043 AVERAGE	545.166 AVERAGE

RT SCORES OF PATIENT NO. 2.

SAME	CROSS
563	549
400	633
456	652
599	410
501	587
406	746
422	697
508	421
692	428
451	569
703	464
546	564
800	741
456	568
562	456
402	451
712	521
445	847
610	326
510	584
523	961
549	754
536	632
571	400
537.391 AVERAGE	581.708 AVERAGE

RT SCORES OF PATIENT NO. 3.

SAME	CROSS
521	523
639	542
648	693
563	654
521	687
531	452
451	478
501	463
568	457
410	800
459	622
897	547
653	574
541	451
523	621
562	547
522	523
458	527
511	563
800	549
406	534
400	564
566	527
621	456
554.391 AVERAGE	556.416 AVERAGE

RT SCORES OF PATIENT NO. 4.

SAME	CROSS
412	552
632	569
698	547
542	846
569	632
547	571
563	478
524	512
578	567
632	745
433	659
529	478
527	659
410	741
451	423
562	632
584	527
554	539
523	554
452	657
574	453
457	578
569	569
452	398
537.478 AVERAGE	578.583 AVERAGE

TABLE (9.1)

PICTORIAL RT SCORES OF FOUR PATIENTS

RT SCORES OF PATIENT NO. 1.

SAME	CROSS
599	442
562	561
541	329
500	641
522	456
589	542
700	856
611	450
563	740
501	761
402	551
523	361
562	424
563	555
571	720
655	610
563	562
554	553
563	563
532	488
453	651
569	400
554	501
445	362
547.739 AVERAGE	544.541 AVERAGE

RT SCORES OF PATIENT NO. 2.

SAME	CROSS
599	650
562	447
541	691
500	451
522	521
589	722
700	501
611	400
563	940
501	563
402	552
523	400
562	600
563	493
571	694
655	841
563	963
554	412
563	554
532	564
453	369
569	451
554	632
445	522
547.739 AVERAGE	580.541 AVERAGE

RT SCORES OF PATIENT NO. 3.

SAME	CROSS
488	553
500	521
410	632
489	489
562	479
532	621
400	654
544	493
410	691
632	488
521	563
440	599
544	411
563	804
451	720
532	610
748	552
542	553
654	568
801	456
481	621
699	541
522	621
300	544
533.782 AVERAGE	574.333 AVERAGE

RT SCORES OF PATIENT NO. 4.

SAME	CROSS
582	552
536	547
774	693
541	632
632	547
554	789
633	589
563	684
524	567
653	785
489	632
478	654
594	559
623	587
740	526
440	632
329	457
666	569
652	458
483	564
487	369
652	451
469	782
487	400
565.173 AVERAGE	584.375 AVERAGE

TABLE (9.2)

Figure 9.1. shows that the difference in same and cross hemispheric verbal processing speed of patient No.1. is similar to that of the high and low alexithymia groups.

Figure 9.2. shows that the difference in same and cross hemispheric pictorial processing speed of patient No.1.is similar to that of the low alexithymia group.

Figure 9.3. shows that the difference in same and cross hemispheric verbal processing speed of patient No.2. is similar to that of the high and low alexithymia groups.

Figure 9.4. shows that the difference in same and cross hemispheric pictorial processing speed of patient No.2. is similar to that of the HIGH alexithymia group.

Figure 9.5. shows that the difference in same and cross hemispheric verbal processing speed of patient No.3. is different from that of the high and low alexithymia groups.

Figure 9.6. shows that the difference in same and cross hemispheric pictorial processing speed of patient No.3. is similar to that of the high alexithymia group.

Figure 9.7. shows that the difference in same and cross hemispheric verbal processing speed of patient No.4. is similar to that of the high and low alexithymia groups.

Figure 9.8. shows that the difference in same and cross hemispheric pictorial processing speed of patient No.4. is similar to that of the high alexithymia group.

Discussion

The most clear observation that can be made from the results presented in the Graphs 9.1.- 9.8. is that the reaction times in the patient population is longer than in the non-patient population. However, this can be explained by the use of two different measurement techniques used with the patient sample in the clinical study and with the non-patient sample of Experiment 2. In the clinical study we used vocal reaction times and in Experiment 2., we used hand reaction times. The vocal reaction times in the patient population is similar to the vocal reaction times for processing nonemotional information obtained in Experiment 3. Since the stimulus material used in the clinical study were also nonemotional the difference in the RT scores of the patient and the non-patient populations is an artifact created by the use of two different measuring techniques. That the data from two different measurement techniques show such a remarkable consistency in the same and cross hemispheric processing times for linguistic and nonlinguistic information as indicated by the Graphs 9.1. - 9.8. adds to the credibility of our data.

Since the number of patients that were used in the pilot clinical study were extremely small, too small for statistical analysis, it is impossible to make any conclusions based on our results. However, it is clear from our data that patient No. 2., with a diagnosis of bronchial

asthma and patient No. 4., with a diagnosis of torticorllis showed an information transfer pattern that was very similar to those of the highly alexithymic subjects. The pictorial information transfer of Patient No. 1., was similar to those of low alexithymic subjects and the verbal information transfer was atypical. In patient No. 3., the cross hemispheric the transfer of pictorial information was typical of the high alexithymia group, but the transfer of verbal information was atypical.

The results of the pilot clinical study, although not conclusive, hints that there is an association between an information transfer deficit for nonlinguistic information and alexithymia. 3 out of 4 patients with a diagnosis of psychosomatic illnesses did show a pictorial information transfer deficit that was associated with high alexithymia as measured by the questionnaires. It is problematic that the patient with a diagnosis of hypothyroidism did not show the typical transfer deficit associated with high alexithymia. However, to the extent that asthma and torticorllis can be considered more typical psychosomatic illnesses, our data is consistent.

PART FOUR

GENERAL DISCUSSION

CHAPTER 10

General Discussion

As discussed in the introductory Chapter 1., alexithymia is a concept developed by Nemiah and Siffneos and later by Sifneos to describe a condition characterized by an inability to express feelings and emotions verbally. Recently alexithymia has been implicated in a variety of conditions. These include psychosomatic illnesses, alcoholism and breast cancer among others. various theories have been developed to explain the alexithymic condition. These theories are based on psychoanalytic, developmental, sociological and physiological explanations.

The physiological theories of alexithymia have proposed a dysfunction of either the left or the right cerebral hemisphere, or a lack of callosal transfer as the cause of alexithymia. As discussed in the introductory Chapter 2., current evidence indicate that emotionally arousing stimuli are processed in the right cerebral hemisphere and that language is a function of the left cerebral hemisphere. A deficiency of callosal transfer will make it difficult to transfer emotions experienced in the right hemisphere over to the left hemisphere for verbalization. On the other hand, a deficiency in the right hemispheric functioning will lead to a deficiency in

experiencing emotions. A deficiency in left hemispheric functioning will lead to a deficiency in the expression of emotional feelings verbally, because linguistic ability is mediated by the left hemisphere.

Our study tested the physiological theories of alexithymia. As discussed in the introductory chapters to the method, Chapters 3 and 4., we used the experimental technique of laterally presenting information to either the left or the right cerebral hemisphere using a tachistoscope. In one experiment we measured the reaction times of the hands that are contralateral and ipsilateral to the hemisphere processing the stimuli. The difference between the contralateral and ipsilateral hand reaction times were taken as an indication of callosal transfer. In another experiment we measured verbal reaction times. In order to issue a vocal response the information has to pass over to the left hemisphere. Thus, linguistic response times for information presented to the right hemisphere takes longer than linguistic response times for information presented to the left hemisphere. The difference in the two RT is an indication of callosal transfer time.

Using this technique we conducted 3 experiments and a pilot Clinical Study. Experiment 1., was a calibration study, Experiments 2 and 3 investigated the main thesis in subjects designated as high and low alexithymia as measured by the MMPI, SSPS-R and the TAS alexithymia scales. In the Clinical Study, we laid the ground work for a study

designed to test the hypothesized correlation between alexithymia and psychosomatic illnesses.

The first experiment that we conducted was a calibration study. The purpose of this study was to establish that the technique we were using was indeed measuring what we set out to measure. We intended to change the presentation times and visual angles until this purpose was achieved. In this experiment, we intended to demonstrate the well established finding that the left hemisphere was more efficient in the processing of verbal information. The positive demonstration of this fact using our procedure and equipment would indicate that the technique we were using was indeed valid. We also wished to establish that cross hemispheric processing, i.e., when the cerebral hemisphere to which the stimuli are presented is different from the hemisphere that is controlling the responding hand, was indeed slower than same hemispheric processing, i.e., when the hemisphere to which the stimuli are presented is the same as the hemisphere that is controlling the responding hand. Since the differences in same and cross hemispheric processing times are central to our thesis we intended to establish that cross hemispheric transmission times are indeed longer. It was indeed possible to demonstrate this using our technique.

By using a presentation time of 4 seconds for the stimulus slide, a presentation time of 150 ms for the recognition slide, 50 ms for the visual masking slide, and

a lateralized visual angle of 6.5 degrees from the central fixation point we were able to demonstrate that the processing times for verbal materials was significant shorter in the left cerebral hemisphere in comparisons to the right cerebral hemisphere. We were also able to demonstrate that same hemispheric processing times of both verbal and pictorial materials were shorter than cross hemispheric processing times. This result indicated that our experimental procedure was sensitive enough to measure interhemispheric transmission times in normal subjects.

After establishing the validity of our procedure we decided to use the same technique in our second experiment. This experiment was designed to measure interhemispheric transmission times in high and low alexithymic subjects as measured by the SSPS-R and the MMPI alexithymia scales. The results of this experiment did confirm that the interhemispheric transmission times in the high alexithymia group was indeed slower in comparison to the low alexithymia group for nonlinguistic, pictorial materials. The interhemispheric transmission times was not different in the two groups for linguistic materials. Our results also indicated that the transmission deficit was limited to the transmission of information from the right to the left hemisphere and not visa versa.

Thus in this experiment we were able to demonstrate a unidirectional information transmission deficit of non linguistic information from the right to the left hemi-

sphere. Such a transmission deficit is of particular relevance to the concept of alexithymia. It has been proposed that highly alexithymic individuals do have a right to the left hemisphere transmission deficit of emotional feelings, which are probably symbolic and non-linguistic. The results of our experiment indicate that this hypothesis is possible correct.

The third experiment in this study was designed to investigate the possibility of a deficit in right to the left hemisphere transmission of emotionally arousing stimuli in comparison to emotionally neutral stimuli. In this experiment we varied the experimental procedure slightly and used a voice activated switch. The reaction time that we measured was the time from the presentation of the recognition slide to the initiation of a verbal re sponse. The logic of using the verbal response was that alexithymia is by definition an inability to verbalize emotions. Thus it was hypothesized that highly alexithymic individuals will take longer to make a verbal response to emotionally arousing stimuli that are presented laterally to the right hemisphere in comparison to non alexithymic subjects and in comparision to information presented directly to the left hemisphere. If we could demonstrate this, it is an indication that there is indeed a callosal transfer deficit specific to emotionally arousing stimuli in highly alexithymic people. Verbal responses were considered directly relevant to the concept of alexithymia.

Unfortunately, in this experiment we were unable to demonstrate the hypothesized hemispheric transfer deficit in highly alexithymic subjects. The failer to demonstrate a callosal transfer deficit should normally cause us to accept the null hypothesis that there is no difference in the transfer of emotional information in high and low alexithymia subjects. However, we have been able to identify several flaws in our experimental procedure which lead us to believe that our experiment should be repeated after correcting the defects in the experiment before the null hypothesis is accepted. Based on our experience in conducting Experiment 3., we have made suggestions for a further experiment.

The pilot clinical study was conducted as a means of establishing a future study which is beyond the scope of this thesis, to investigate interhemispheric transfer in psychosomatic and non psychosomatic patients. The result of measuring four patients with a diagnosis of psychosomatic illness indicated that in three patients the transfer of nonlinguistic information was similar to the transfer of nonlinguistic information in highly alexithymic subjects. In one patient however, it was similar to that of a low alexithymic subjects. It is not possible to make any conclusions based on these findings because of the very small number of subjects that were tested. However, these results indicate the feasibility of a larger study.

Conclusions

In Experiment 1, of this thesis we demonstrated a valid procedure for measuring interhemispheric transfer using reaction times for a laterally presented visual matching task via a tachistoscope.

Based on the results of Experiment 2., of this thesis, it is concluded that a deficit of left to right hemisphere transfer of nonlinguistic information exists in highly alexithymic subjects as measured by the MMPI and the SSPS-R alexithymia scales. This deficit is independent of an over or an under activation of each cerebral hemisphere.

In Experiment 3. of this study, we attempted to demonstrate that the interhemispheric transfer of emotional information was deficient in highly alexithymic subjects as measured by the Toronto Alexithymia Scale. However, we were not able to validate our hypothesis in this experiment. Rather than discarding our hypothesis it is suggested that procedural and conceptual errors in the experiment may have falsified our results. It is concluded that Experiment 3. should be modified as suggested in Chapter 8., and repeated.

We conducted a pilot clinical study to investigate interhemispheric transfer in a psychosomatic population. Based on our data, it is concluded that a larger study using clinical populations and the tachistoscopic tech-

nique developed in this thesis, designed to measure interhemispheric transfer in psychosomatic patients is feasible. It is the authors conclusion that such a study is necessary to clarify the role of interhemispheric transfer in psychosomatic illnesses.

Future studies on this topic should address the basis of the callosal transfer deficit that we have demonstrated in this thesis. This deficit may have a physiological basis or it may be purely functional. If it does have a physiological basis it may be possible to demonstrate this deficit.

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資料 1

Beth Israel Questionaire(BIQ)

Does the patient:

1 (+) Describe endless details, events, or symptoms rather than feelings?
2 (+) Use appropriate words to describe feelings?
3 Have a rich vocabulary?
a) Is affect expressed more in physical terms rather than in thoughts?
4 Is he/she a college graduate?
5 Is je/she ofalow socio-economic group?
6 (+) Have a rich fantasy life? (can daydream for a long time)
7 (+) Use action to express feelings? (Thinking about action and talking about it should not be viewed as daydreaming)
8 (+) Use action to avoid conflicting situations?
9 Cry easily?
10 Is crying associated with joy?
sadness?
frustration?
11 Show inappropriate affect (example: smiles when talking about a sad event)
12 (+) Tend to describe circumstances surrounding an event rather than feelings?
13 (+) Have difficulity communicating with the interviewer?
14 Use any of the following words? Please check several if necessary:
a) anger b) agitation c) anxiety d) annoyance
e) apprehension f) empliness g) fear
h) frustration i) happiness j) helplessness
k) hopelessness l) irritability m) joy
n) nervousness o) resentment p) sadnss
q) tension
15 Dream frequently?
a) Are dreams wish fullfilling ones
b) elaborate ones
16 (+) Is the thought content associated more to external events than to fantasy or feelings?
17 Is of above average intelligence?
18 Does the patient usually assume a rigid posture?
19 Is the patient introverted?
extroverted?

Do you:

1 Like the patient?
2 Have difficulity communicating with the patient?
3 Tend to talk more than the patient?
And offer words for the patient to use?
4 Have any feelings for the patient?
If answer is yes please specofy what they are
5 Find the Patient dull?

APPENDIX 1.1. The Beth Israel Hospital Questionnaire.

資料2

SSPS

1 I find it hard to describe how I feel about people

2 When something unpleasant happens, I feel as if could exprode

3 I often remember the content of dreams very vividly

4 Feelings are what make life worthwhile

5 I prefer movies with action rather than psychological dramas

6 I do not tend to examine my own feelings

7 I think it is not worthwhile discussing how one feels; I prefer to act

8 I find life pretty boring most of the time

9 One may say that I lack imagination

10 I like people tp be precose and to describe details

11 I hardly ever cry except when I'm frustrated

12 It is important to find out how one feels about people

13 I daydream rarely

14 I find it hard to find the right words for my feelings

15 I spend much time daydreaming whenever I have nothing else todo

16 I prefer taking action rather than thinking

17 I don't seem to get really excited about anything

18 It is easy for me to describe in detail events

19 I prefer to use my left hand

20 I like people better than things

APPENDIX 1.2. The Shalling-Sifneos Personality Scale.

資料5　SSPS－R（調査に使用した）

氏名：＿＿＿＿＿　男・女　年齢＿＿歳　検査月日：＿＿年＿月＿日
所属：＿＿＿＿＿　学籍番号：＿＿＿＿住所（電話番号）：＿＿＿＿＿＿＿＿＿＿

以下の項目の　はい　いいえ　のどちらかあてはまるものに○をつけてください。

	はい	いいえ
1感情よりも病状・症状を説明する方が容易である。	＿	＿
2人が他人の事をどう思っているのかを知ることは重要である。	＿	＿
3感情を言葉で説明するのは難しい。	＿	＿
4感情は人生をやりがいのあるものにする。	＿	＿
5想像力に欠ける	＿	＿
6私は空想することが多い。	＿	＿
7興奮すると考えずに行動してしまう。	＿	＿
8心理的なドラマよりもアクションドラマの方が好きだ。	＿	＿
9葛藤状態にあると、それについて考えるよりもむしろすぐに行動する方である。	＿	＿
10悩み（心配）ごとがある時には行動したくない。	＿	＿
11物事を正確に、詳しく話すことを好む。	＿	＿
12細かいことをくどくどと述べることよりは、自分の気持ちを内省することの方を好む。	＿	＿
13人と話し合うのは苦手である。	＿	＿
14人と交わるよりはむしろ一人でいたい。	＿	＿
15私は自分の気持ちに集中するよりもむしろ周りのことに気を配っている。	＿	＿
16夜中に不信な物音が聞こえると自分の気持ちに集中できない。	＿	＿
17人生はたいてい退屈であると思う。	＿	＿
18私を動転させるような状況を思い浮かべることはできない。	＿	＿
19めったに夢を見ない。	＿	＿
20事物よりも人の方が好きです。	＿	＿

以下の病気のどれかにかかったことがありますか。

1)胃潰瘍　または　十二指腸潰瘍	＿	＿
2)高血圧	＿	＿
3)喘息	＿	＿
4)甲状腺機能亢進症	＿	＿
5)神経性皮膚炎	＿	＿
6)慢性関節リューマチ	＿	＿
7)潰瘍性大腸炎	＿	＿
8)その他の身体的症状（　　）	＿	＿
9)アルコール中毒	＿	＿
10)薬物嗜癖	＿	＿
11)精神病	＿	＿
12)その他（　　）	＿	＿

APPENDIX 1.3. The Shalling-Sifneos Personality Scale-Revised.

資料3

MMPI Alexithimia Scale

1.少年時代　ちょっとした盗みをしたことがある。

2.時々　物をたたきつけたくなる。

3.よく　"みぞおち"のあたりに不快感がする。

4.花造りになりたい。

5.病気になるのをあまり気にしない

6.以前は日記をつけていました

7.退屈すると何か騒ぎをひき起こしたくなる。

8.空想にふけることはほとんどない。

9.新聞記者になりたい。

10.科学が好きです。

11.じっとすわっていられないくらい　気持ちがさっぱり落ち着かない時がある。

12.失恋したことがある。

13.時々　理由もなく　物事が旨くもいっていないのに　幸福で有頂天になる。

14.顔形がもっとよければよいのにと　気にしない。

15.新聞記者だったら　スポーツニュースを大いに報道したい。

16時々　たまらなく家出したくなる。

17.お金と仕事のことでくよくよする。

18.時々　眠れなくなるほど興奮する。

19.機会さえあれば　私は非常に世のためになることができる。

20.異性に心がひかれる。

21.嫌いな人がしかられたり　罰をうけたりするといい気味だ。

22.小便の回数は普通ですーーー特に多いほうではない。

反転項目（1，2，4，6，7，9－13，15－24）

APPENDIX 1.4. The Minnesota Multiphasic Personality Inventory-Alexithymia Scale.

1．　以下の１から３２までの項目を読んで、Ａ（まったくあてはまらない）からＥ（とてもよくあてはまる）にマルをつけてください。マルは１つの項目について１箇所だけです。あまり深く考えないで、簡単にマルをつけてください。

	A まったくあてはまらない	B あまりあてはまらない	C どちらともいえない	D わずかにあてはまる	E とてもよくあてはまる
1．泣く時にはいつもその理由がわかっている。					
2．空想にふけるのは時間の無駄であると思う。					
3．こんなに恥ずかしがり屋でなければと思う。					
4．どんな感情の状態にあるのか、しばしば自分でも混乱する。					
5．将来について空想することが多い。					
6．自分は人と同じくらい簡単に友人を作れると思う。					
7．問題の答えが重要であり、その答えの理由を知ることはそれほど重要でない。					
8．自分の感情を表す適切な言葉を見つけるのは難しい。					
9．自分の主張を人に知ってもらいたい。					
10．医師にも理解してもらえないような身体の感覚がある。					
11．ある仕事が片付いただけでは満足できない。その理由と過程を知る必要がある。					
12．自分の感情を述べるのは簡単なことだ。					
13．問題について話すよりも、具体的に分析していくことのほうが好きだ。					
14．動転すると、自分が悲しいのか、怯えているのか、怒っているのかわからない。					
15．頻に心臓を掻く事が非常に多い。					
16．他にすることがないと、空想にふけっていることが多い。					
17．身体に起こる感覚に悩むことが多い。					
18．空想を浮かべることは苦手にない。					

	A	B	C	D	E
19．どうしてそうなったのか理解しようとするよりも、なるがままに任せるほうだ。					
20．人とうちとけられない気がする。					
21．自分の感情を常に把握していることが大切だ。					
22．人をどのように思ったか述べることは難しい。					
23．人からもっと自分の感情を述べるようにと言われる。					
24．人をより深く理解できるよう努めるべきだ。					
25．自分の内部で何が起こっているかわからない。					
26．どうして自分が怒っているのかわからないことが多い。					

2．　以下の病気のどれかにかかったことがありますか。

	はい	いいえ
1．胃潰瘍　又は　十二指腸潰瘍		
2．高血圧		
3．喘息		
4．甲状腺機能亢進症（こうしん）		
5．神経性皮膚炎		
6．慢性関節リュウマチ		
7．潰瘍性大腸炎		
8．その他の身体的症状　（　　）		
9．アルコール中毒		
10．薬物中毒		
11．精神病		
12．その他　（　　）		

どうもありがとうございました。あとで再調査をお願いするかもしれませんが、そのときはよろしく御協力ください。

人間学部３年　伊藤　朝子
泉山　朗子

APPENDIX 1.5. The Toronto Alexithymia Scale.

87/02/28　　22:03:55

ファイル名はB:¥IN2.DATです。タイプはｓＡです。
１要因２水準の計画。被験者数は 12 です。
.....

１要因の分散分析：１要因が被験者内要因

＊＊＊　データ　＊＊＊　　N = 12　　A = 2

被験者	要因A	
1	437.740	426.120
2	504.080	494.060
3	450.330	425.460
4	481.450	467.020
5	756.530	767.650
6	541.460	529.950
7	525.950	513.600
8	544.660	525.580
9	553.770	534.100
10	500.290	478.170
11	515.380	477.220
12	636.930	582.400

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	人数
第 1群	6448.570	537.381	82.668	12
第 2群	6221.330	518.444	86.784	12

☆☆　１要因の分散分析：ＡＮＯＶＡ表

変動因	ＳＳ	ｄｆ	ＭＳ	Ｆ	Ｐ
被験者間	170971.000	11	15542.900	120.149	0.000
被験者内	3569.000	12			
条　件	2146.000	1	2146.000	16.589	0.002
誤　差	1423.000	11	129.364		
全　体	174541.000	23			

LINEGRAPH　WITH THE PROGRAM 'NEWLINE'

DATA OF GROUP 1

No.	X-DATA	Y-DATA	VAR. Y
1	1.0000	537.3800	0.0000
2	2.0000	518.4400	0.0000

APPENDIX 6.1. ANOVA and Raw Data of Experiment 1.

無効標本数　　0

87/02/27　　20:16:12

ファイル名はB:¥EXP.DATです。タイプはｓＡＢです。
２（Ａ）×２（Ｂ）の要因計画。被験者は 12 人です。

２要因の分散分析：２要因とも被験者内要因

＊＊＊　データ　＊＊＊ n = 12　　A = 2　　B = 2

被験者	要因A		要因B	
1	0.491	0.427	0.401	0.409
2	0.504	0.483	0.529	0.482
3	0.444	0.428	0.460	0.428
4	0.527	0.467	0.425	0.479
5	0.857	0.634	0.807	0.743
6	0.518	0.511	0.538	0.574
7	0.528	0.515	0.540	0.497
8	0.553	0.498	0.506	0.583
9	0.592	0.526	0.547	0.508
10	0.561	0.469	0.476	0.454
11	0.494	0.494	0.477	0.509
12	0.605	0.552	0.626	0.597

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	データ数
A(1)-B(1)	6.674	0.556	0.100	12
A(1)-B(2)	6.003	0.500	0.054	12
A(2)-B(1)	6.332	0.528	0.102	12
A(2)-B(2)	6.262	0.522	0.087	12
A(1)	12.677	0.528	0.085	24
A(2)	12.594	0.525	0.095	24
B(1)	13.006	0.542	0.102	24
B(2)	12.265	0.511	0.073	24

☆☆　分散分析表：ｓＡＢ　☆☆

変動因	SS	df	MS	F	P	
Between Sub.						
Er(Ss)	0.329	11	0.030			
Within Sub.						
A	0.000	1	0.000	0.124	0.731	
Er(A)	0.012	11	0.001			
B	0.011	1	0.011	6.073	0.030	*
Er(B)	0.021	11	0.002			
A*B	0.008	1	0.008	7.864	0.016	*
Er(AB)	0.011	11	0.001			
Total	0.392	47	0.008			

◎被験者内の誤差についてのバートレットの等分散の検定◎

MSE= 0.001
χ2= 1.355

RAW DATA OF EXPERIMENT 1

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	483	425	538	340	604	482	417	567
1	372	441	203	433	444	485	484	372
	364	397	603	482	386	457	297	560
	631	410	542	565	561	452	451	572
2	379	475	397	503	542	493	549	440
	459	359	549	521	610	516	635	483
	434	275	476	277	528	331	531	468
3	310	350	518	420	590	250	386	440
	338	479	0	361	318	408	389	569
	434	399	597	540	409	353	479	622
4	457	378	378	395	384	467	484	580
	493	487	447	447	406	574	403	562
	0	626	805	0	0	998	616	0
5	0	544	845	901	0	745	999	898
	572	418	789	0	669	0	805	774
	427	511	597	606	0	503	619	537
6	408	422	619	0	458	591	544	509
	422	374	554	569	598	372	615	604
	330	394	484	436	407	453	454	494
7	854	589	640	554	615	493	681	608
	435	494	582	560	386	710	496	656
	532	529	574	0	477	570	509	483
8	507	578	474	524	0	0	494	530
	398	494	509	537	805	982	445	588
	632	529	524	0	619	631	324	528
9	456	578	318	509	587	656	320	953
	430	494	448	498	422	436	370	467
	0	0	454	477	513	514	446	576
10	405	507	525	545	574	495	484	656
	389	423	0	476	456	494	0	526
	632	464	476	649	600	657	470	656
11	456	513	572	639	596	678	700	606
	430	444	642	735	496	572	809	678
	586	559	392	544	446	417	478	524
12	474	400	709	499	628	437	596	490
	397	530	618	637	479	463	449	555

90/10/24　　21:07:19

ファイル名はb:3wyhlrgt ###です。タイプはＡｓＢＣです。
２（Ａ）×２（Ｂ）×２（Ｃ）の要因計画
Ａ（１）＝ 27 人
Ａ（２）＝ 26 人

３要因の分散分析：２要因が被験者内要因

＊＊＊　データ　＊＊＊　　Ａ＝２　Ｂ＝２　Ｃ＝２

要因Ａ	被験者			要因Ｂ	要因Ｃ
1	1	390.000	356.000	429.000	405.000
1	2	493.000	549.000	584.000	605.000
1	3	652.000	614.000	635.000	655.000
1	4	468.000	456.000	561.000	555.000
1	5	603.000	535.000	556.000	460.000
1	6	514.000	518.000	503.000	482.000
1	7	568.000	602.000	620.000	667.000
1	8	457.000	472.000	468.000	598.000
1	9	645.000	792.000	653.000	725.000
1	10	707.000	757.000	791.000	782.000
1	11	386.000	447.000	407.000	439.000
1	12	733.000	779.000	718.000	693.000
1	13	460.000	564.000	508.000	474.000
1	14	437.000	436.000	436.000	422.000
1	15	446.000	481.000	462.000	502.000
1	16	433.000	462.000	584.000	550.000
1	17	371.000	457.000	426.000	500.000
1	18	495.000	440.000	462.000	452.000
1	19	600.000	635.000	764.000	827.000
1	20	416.000	487.000	435.000	458.000
1	21	459.000	513.000	601.000	639.000
1	22	353.000	335.000	430.000	418.000
1	23	530.000	568.000	553.000	590.000
1	24	529.000	629.000	533.000	645.000
1	25	393.000	352.000	420.000	572.000
1	26	543.000	521.000	512.000	560.000
1	27	359.000	383.000	399.000	436.000
2	1	397.000	364.000	434.000	515.000
2	2	513.000	573.000	492.000	583.000
2	3	376.000	425.000	431.000	477.000
2	4	440.000	449.000	451.000	494.000
2	5	469.000	590.000	541.000	690.000
2	6	682.000	681.000	599.000	710.000
2	7	484.000	563.000	502.000	569.000
2	8	591.000	550.000	582.000	508.000
2	9	521.000	560.000	545.000	555.000
2	10	424.000	379.000	425.000	546.000
2	11	479.000	404.000	451.000	495.000
2	12	403.000	420.000	463.000	516.000
2	13	613.000	630.000	616.000	579.000
2	14	616.000	650.000	669.000	605.000
2	15	767.000	812.000	679.000	823.000
2	16	404.000	385.000	413.000	440.000
2	17	389.000	528.000	421.000	422.000
2	18	705.000	571.000	619.000	683.000

APPENDIX 7.1. ANOVA (1) of Experiment 2.

2	19	532.000	389.000	461.000	427.000
2	20	349.000	411.000	382.000	459.000
2	21	445.000	429.000	454.000	451.000
2	22	478.000	404.000	407.000	474.000
2	23	735.000	648.000	578.000	643.000
2	24	495.000	484.000	461.000	486.000
2	25	590.000	576.000	601.000	590.000
2	26	654.000	745.000	688.000	718.000

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	データ
A(1)-B(1)-C(1)	13440.000	497.778	103.546	27
A(1)-B(1)-C(2)	14140.000	523.704	119.587	27
A(1)-B(2)-C(1)	14450.000	535.185	107.616	27
A(1)-B(2)-C(2)	15111.000	559.667	113.827	27
A(2)-B(1)-C(1)	13551.000	521.192	116.395	26
A(2)-B(1)-C(2)	13620.000	523.846	120.370	26
A(2)-B(2)-C(1)	13365.000	514.038	91.458	26
A(2)-B(2)-C(2)	14458.000	556.077	101.430	26
A(1)-B(1)	27580.000	510.741	112.603	54
A(1)-B(2)	29561.000	547.426	111.440	54
A(2)-B(1)	27171.000	522.519	118.407	52
A(2)-B(2)	27823.000	535.058	98.835	52
B(1)-C(1)	26991.000	509.264	110.657	53
B(1)-C(2)	27760.000	523.774	119.971	53
B(2)-C(1)	27815.000	524.811	100.573	53
B(2)-C(2)	29569.000	557.906	107.938	53
A(1)-C(1)	27890.000	516.482	107.243	54
A(1)-C(2)	29251.000	541.685	118.118	54
A(2)-C(1)	26916.000	517.615	104.733	52
A(2)-C(2)	28078.000	539.962	112.464	52
A(1)	57141.000	529.083	113.515	108
A(2)	54994.000	528.788	109.240	104
B(1)	54751.000	516.519	115.637	106
B(2)	57384.000	541.359	105.625	106
C(1)	54806.000	517.038	106.021	106
C(2)	57329.000	540.840	115.383	106

☆★☆　被験者内誤差項についてのＢａｒｔｌｅｔｔの等分散の検定　☆★☆

SS	MS	df
136132.0000	2669.2500	51
109352.0000	2144.1600	51
70520.0000	1382.7500	51

CHI-SQUARE　5.4268　　DF=2

＊＊＊　分散分析表　＊＊＊

source	SS	df	MS	F
B.subjects		52		
A	-33.113	1	-33.113	-0.001
subj.w.group	2236020.000	51	43843.500	
W.subjects		159		
B	32053.600	1	32053.600	12.008
A x B	7768.360	1	7768.360	2.910
Bxsubj.w.group	136132.000	51	2669.250	
C	29921.100	1	29921.100	13.955
A x C	158.943	1	158.943	0.074
Cxsubj.w.group	109352.000	51	2144.160	
B x C	4801.410	1	4801.410	3.472
A x B x C	5463.680	1	5463.680	3.951
BCxsubj.w.group	70520.000	51	1382.750	

＊＊＊　分散分析表　（誤差項をプール）＊＊＊

source	SS	df	MS	F
B.subjects		52		
A	-33.113	1	-33.113	-0.001
subj.w.group	2236020.000	51	43843.500	
W.subjects		159		
B	32053.600	1	32053.600	15.519
A x B	7768.360	1	7768.360	3.761
C	29921.100	1	29921.100	14.487
A x C	158.943	1	158.943	0.077
B x C	4801.410	1	4801.410	2.325
A x B x C	5463.680	1	5463.680	2.645
pooled error	316004.000	153	2065.390	

Main effect A　ﾃｭｰｷｰ = 105.96200
Main effect B　ﾃｭｰｷｰ = 105.96200
Main effect C　ﾃｭｰｷｰ = 105.96200

90/10/24　　22:07:27

ファイル名はb:12rgtwdです。タイプはＡｓＢです。
２（Ａ）×２（Ｂ）の要因計画
Ａ（１）＝ 26 人
Ａ（２）＝ 27 人

２要因の分散分析：１要因が被験者内要因

＊＊＊　データ　＊＊＊　　Ａ＝２　Ｂ＝２

要因Ａ	被験者	要因Ｂ	
1	1	571.000	759.000
1	2	389.000	427.000
1	3	411.000	459.000
1	4	429.000	451.000
1	5	404.000	474.000
1	6	648.000	643.000
1	7	484.000	486.000
1	8	576.000	590.000
1	9	745.000	718.000
1	10	364.000	515.000
1	11	573.000	583.000
1	12	425.000	477.000
1	13	449.000	494.000
1	14	590.000	690.000
1	15	681.000	710.000
1	16	563.000	569.000
1	17	550.000	508.000
1	18	560.000	555.000
1	19	379.000	546.000
1	20	404.000	495.000
1	21	420.000	516.000
1	22	630.000	579.000
1	23	650.000	605.000
1	24	812.000	823.000
1	25	385.000	440.000
1	26	528.000	422.000
2	1	462.000	550.000
2	2	457.000	500.000
2	3	440.000	452.000
2	4	863.000	967.000
2	5	487.000	458.000
2	6	513.000	639.000
2	7	335.000	418.000
2	8	568.000	590.000
2	9	629.000	645.000
2	10	352.000	572.000
2	11	521.000	560.000
2	12	383.000	436.000
2	13	356.000	405.000
2	14	549.000	605.000
2	15	614.000	655.000
2	16	456.000	555.000
2	17	535.000	460.000
2	18	518.000	482.000

APPENDIX 7.2. ANOVA (2) and Raw Data of Experiment 2.

2	19	602.000	667.000
2	20	472.000	598.000
2	21	792.000	723.000
2	22	757.000	782.000
2	23	447.000	439.000
2	24	778.000	693.000
2	25	564.000	474.000
2	26	436.000	422.000
2	27	481.000	502.000

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	データ数
A(1)-B(1)	13620.000	523.846	120.370	26
A(1)-B(2)	14534.000	559.000	106.037	26
A(2)-B(1)	14367.000	532.111	134.226	27
A(2)-B(2)	15249.000	564.778	128.079	27
A(1)	28154.000	541.423	114.783	52
A(2)	29616.000	548.444	132.202	54
B(1)	27987.000	528.057	127.684	53
B(2)	29783.000	561.943	117.819	53

＊＊＊　分散分析表　＊＊＊

source	SS	df	MS	F
B.subjects		52		
A	1307.970	1	1307.970	0.045
subj.w.group	1472270.000	51	28868.100	
W.subjects		53		
B	30464.100	1	30464.100	12.317
A x B	36.425	1	36.425	0.015
Bxsubj.w.group	126136.000	51	2473.250	

Main Effect A　ﾃｭｰｷｰ =　52.98110
Main Effect B　ﾃｭｰｷｰ =　52.98110

90/10/24　　22:10:41

ファイル名はb:12rgtpicです。タイプはＡｓＢです。
2（Ａ）×2（Ｂ）の要因計画
Ａ（1）＝ 26 人
Ａ（2）＝ 27 人

2要因の分散分析：1要因が被験者内要因

＊＊＊　データ　＊＊＊　　Ａ＝ 2　Ｂ＝ 2

要因Ａ	被験者	要因Ｂ	
1	1	705.000	619.000
1	2	532.000	461.000
1	3	349.000	382.000
1	4	445.000	454.000
1	5	478.000	407.000
1	6	735.000	578.000
1	7	495.000	461.000
1	8	590.000	601.000
1	9	654.000	688.000
1	10	397.000	434.000
1	11	513.000	492.000
1	12	376.000	431.000
1	13	440.000	451.000
1	14	468.000	541.000
1	15	682.000	599.000
1	16	484.000	502.000
1	17	591.000	582.000
1	18	521.000	545.000
1	19	424.000	425.000
1	20	479.000	451.000
1	21	403.000	463.000
1	22	613.000	616.000
1	23	616.000	669.000
1	24	767.000	679.000
1	25	409.000	413.000
1	26	389.000	421.000
2	1	433.000	584.000
2	2	371.000	426.000
2	3	495.000	462.000
2	4	600.000	764.000
2	5	416.000	435.000
2	6	459.000	601.000
2	7	353.000	430.000
2	8	530.000	553.000
2	9	529.000	533.000
2	10	593.000	420.000
2	11	543.000	512.000
2	12	359.000	436.000
2	13	390.000	429.000
2	14	494.000	584.000
2	15	652.000	635.000
2	16	468.000	561.000
2	17	603.000	556.000
2	18	514.000	503.000

APPENDIX 7.3. ANOVA (3) of Experiment 2.

2	19	568.000	620.000
2	20	457.000	468.000
2	21	645.000	653.000
2	22	707.000	791.000
2	23	386.000	407.000
2	24	733.000	718.000
2	25	460.000	508.000
2	26	437.000	436.000
2	27	446.000	462.000

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	データ数
A(1)-B(1)	13555.000	521.346	116.223	26
A(1)-B(2)	13365.000	514.038	91.458	26
A(2)-B(1)	13641.000	505.222	102.934	27
A(2)-B(2)	14487.000	536.556	106.098	27
A(1)	26920.000	517.692	104.640	52
A(2)	28128.000	520.889	105.695	54
B(1)	27196.000	513.132	109.950	53
B(2)	27852.000	525.509	99.823	53

＊＊＊　分散分析表　＊＊＊

source	SS	df	MS	F
B.subjects		52		
A	268.217	1	268.217	0.013
subj.w.group	1056850.000	51	20722.500	
W.subjects		53		
B	3817.950	1	3817.950	1.912
A x B	9887.600	1	9887.600	4.952
Bxsubj.w.group	101838.000	51	1996.820	

Main Effect A　ﾃｭｰｷｰ =　52.98110
Main Effect B　ﾃｭｰｷｰ =　52.98110

2（A）× 2（B）の要因計画
A（1）＝ 26 人
A（2）＝ 27 人

2要因の分散分析：1要因が被験者内要因

＊＊＊ データ ＊＊＊ A＝ 2 B＝ 2

要因A	被験者		要因B
1	1	696.000	610.000
1	2	541.000	512.000
1	3	505.000	471.000
1	4	417.000	493.000
1	5	450.000	433.000
1	6	568.000	591.000
1	7	455.000	502.000
1	8	503.000	557.000
1	9	670.000	720.000
1	10	411.000	504.000
1	11	690.000	654.000
1	12	439.000	373.000
1	13	457.000	457.000
1	14	534.000	466.000
1	15	620.000	663.000
1	16	665.000	622.000
1	17	558.000	543.000
1	18	500.000	509.000
1	19	503.000	413.000
1	20	430.000	414.000
1	21	536.000	468.000
1	22	654.000	619.000
1	23	722.000	590.000
1	24	648.000	534.000
1	25	463.000	391.000
1	26	337.000	374.000
2	1	493.000	421.000
2	2	548.000	474.000
2	3	455.000	488.000
2	4	836.000	963.000
2	5	443.000	426.000
2	6	498.000	632.000
2	7	421.000	335.000
2	8	536.000	587.000
2	9	457.000	431.000
2	10	426.000	428.000
2	11	471.000	564.000
2	12	335.000	300.000
2	13	448.000	446.000
2	14	633.000	554.000
2	15	592.000	653.000
2	16	443.000	394.000
2	17	585.000	576.000
2	18	463.000	451.000
2	19	596.000	591.000
2	20	498.000	471.000
2	21	730.000	617.000
2	22	700.000	665.000
2	23	494.000	496.000
2	24	693.000	638.000

APPENDIX 7.4. ANOVA (4) of Experiment 2.

2	25	476.000	482.000
2	26	563.000	454.000
2	27	503.000	482.000

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	データ数
A(1)-B(1)	13972.000	537.385	102.567	26
A(1)-B(2)	13483.000	518.577	92.402	26
A(2)-B(1)	14336.000	530.963	109.245	27
A(2)-B(2)	14019.000	519.222	128.193	27
A(1)	27455.000	527.981	98.069	52
A(2)	28355.000	525.093	119.242	54
B(1)	28308.000	534.113	106.070	53
B(2)	27502.000	518.906	112.076	53

＊＊＊　分散分析表　＊＊＊

source	SS	df	MS	F
B.subjects		52		
A	221.858	1	221.858	0.010
subj.w.group	1164340.000	51	22830.200	
W.subjects		53		
B	6185.550	1	6185.550	3.249
A x B	324.509	1	324.509	0.170
Bxsubj.w.group	97106.000	51	1904.040	

Main Effect A　ﾃｭｰｷｰ =　52.98110
Main Effect B　ﾃｭｰｷｰ =　52.98110

* * * データ * * * A = 2

要因A	被験者		要因B
1	1	396.000	403.000
1	2	457.000	529.000
1	3	504.000	457.000
1	4	374.000	359.000
1	5	597.000	667.000
1	6	455.000	423.000
1	7	604.000	624.000
1	8	467.000	490.000
1	9	644.000	771.000
1	10	657.000	702.000
1	11	465.000	438.000
1	12	645.000	
1	13	509.000	483.000
1	14	467.000	420.000
1	15	446.000	462.000
1	16	483.000	500.000
1	17	417.000	407.000
1	18	516.000	489.000
1	19	766.000	500.000
1	20	677.000	464.000
1	21	496.000	561.000
1	22	328.000	440.000
1	23	409.000	556.000
1	24	463.000	400.000
1	25	402.000	412.000
1	26	531.000	477.000
1	27	420.000	340.000
2	1	483.000	390.000
2	2	629.000	629.000
2	3	338.000	404.000
2	4	427.000	443.000
2	5	414.000	412.000
2	6	530.000	555.000
2	7	656.000	596.000
2	8	582.000	544.000
2	9	536.000	488.000
2	10	444.000	472.000
2	11	417.000	488.000
2	12	434.000	413.000
2	13	619.000	626.000
2	14	654.000	640.000
2	15	579.000	584.000
2	16	399.000	428.000
2	17	337.000	337.000
2	18	677.000	628.000
2	19	493.000	484.000
2	20	475.000	456.000
2	21	424.000	441.000
2	22	487.000	443.000
2	23	526.000	574.000
2	24	444.000	449.000
2	25	514.000	559.000
2	26	780.000	710.000

* * * 平均とS．D * * *

	合計	平均	S．D．	データ数
A(1)-B(1)	13595.000	503.519	103.462	27
A(1)-B(2)	13327.000	493.593	100.663	27
A(2)-B(1)	13298.000	511.462	107.661	26
A(2)-B(2)	13193.000	507.423	93.147	26
A(1)	26922.000	498.556	102.192	54
A(2)	26491.000	509.442	100.689	52
B(1)	26893.000	507.415	105.618	53
B(2)	26520.000	500.377	97.294	53

＊＊＊　分散分析表　＊＊＊

source	SS	df	MS	F
B.subjects		52		
A	3139.130	1	3139.130	0.166
subj.w.group	962622.000	51	18874.900	
W.subjects		53		
B	1289.760	1	1289.760	0.518
A x B	230.137	1	230.137	0.092
Bxsubj.w.group	126938.000	51	2488.980	

Main Effect A　テューキー ＝　52.98110
Main Effect B　テューキー ＝　52.98110

RAW DATA OF EXPERIMENT 2

RIGHT HAND REACTION TIMES OF HIGHLY ALEXITHYMIC SUBJECTS

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	368	341	423	289	390	381	340	487
1	354	372	368	465	344	339	358	899
	328	401	500	270	485	369	658	456
	392	578	711	425	601	421	669	774
2	401	799	571	669	371	545	747	635
	408	402	477	469	431	740	688	518
	0	499	710	567	577	552	646	927
3	651	961	787	0	748	473	812	684
	478	546	636	614	507	643	520	651
	314	404	637	386	431	570	900	625
4	0	460	628	471	693	573	400	597
	322	493	442	525	360	408	584	562
	0	455	703	525	411	455	685	533
5	599	764	705	521	384	458	713	437
	487	398	524	551	434	371	711	511
	582	491	456	485	542	491	504	548
6	533	419	527	649	441	484	555	475
	375	623	611	446	385	426	595	636
	583	0	726	0	624	531	727	614
7	450	442	0	745	514	622	629	793
	434	486	647	736	492	440	737	707
	407	570	485	464	0	531	578	721
8	453	483	551	520	449	512	404	0
	366	363	482	434	444	322	0	762
	548	633	425	776	635	863	550	648
9	651	768	579	938	639	663	618	544
	754	622	916	0	740	691	739	938
	765	866	0	0	630	513	926	0
10	430	864	0	0	478	0	975	0
	637	456	999	787	950	615	0	813

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	332	414	387	462	350	524	386	366
11	424	362	349	502	434	470	0	0
	376	493	450	451	0	376	460	479
	771	701	752	890	0	603	727	0
12	0	713	761	738	706	633	800	678
	651	711	0	926	600	0	757	858
	333	384	434	623	966	382	472	462
13	307	798	628	623	289	573	514	491
	537	333	520	0	374	371	433	619
	571	451	459	452	0	304	479	503
14	273	449	616	394	307	294	467	506
	355	381	348	490	394	581	535	393
	454	463	475	439	373	503	436	547
15	415	491	407	443	449	559	524	492
	358	0	572	578	390	374	603	543
	377	523	500	467	666	619	490	545
16	417	426	365	503	652	559	544	446
	475	426	467	429	452	669	705	464
	353	349	313	782	460	571	277	772
17	375	462	417	320	526	395	339	599
	334	0	439	376	566	308	390	562
	405	387	362	367	400	406	488	363
18	439	374	828	698	391	464	451	508
	447	400	493	418	399	518	647	453
	657	719	999	999	559	974	999	999
19	461	633	999	968	999	697	984	999
	684	554	0	923	749	734	999	903
	360	414	470	692	406	369	545	502
20	327	403	532	451	393	470	490	578
	0	533	395	432	344	446	0	0
	344	326	426	616	938	773	533	517
21	0	0	540	503	724	635	482	541
	599	312	390	508	521	842	412	531

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	338	335	284	319	426	417	307	475
22	391	413	368	268	405	454	403	397
	380	343	361	332	309	337	653	433
	530	598	517	690	0	647	499	600
23	521	606	564	491	644	641	535	472
	483	469	567	559	521	0	569	590
	0	0	425	675	0	766	514	595
24	0	789	569	590	781	784	442	503
	508	0	616	465	493	653	439	571
	371	236	478	361	327	672	563	529
25	294	357	545	481	540	562	345	416
	306	326	366	0	359	338	383	920
	427	414	557	554	0	451	615	569
26	553	415	582	677	496	531	571	434
	554	601	588	470	383	389	499	987
	0	336	285	400	397	467	302	582
27	0	511	327	472	470	255	408	380
	415	289	387	290	451	454	376	480

RAW DATA OF EXPERIMENT 2

RIGHT HAND RESPONSES OF LOW ALEXITHYMIC SUBJECTS

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	255	581	514	376	394	399	464	604
1	438	299	335	264	402	382	419	570
	323	371	519	348	492	312	0	566
	460	707	791	593	469	675	579	538
2	429	655	503	492	529	529	445	591
	383	505	528	491	442	554	492	613
	377	446	340	320	404	415	394	507
3	410	568	392	354	510	390	338	520
	316	495	423	369	322	473	623	450
	403	508	534	495	642	474	351	468
4	424	427	410	409	439	740	406	487
	312	423	560	436	364	419	508	377
	0	425	514	770	0	645	582	833
5	461	869	415	443	503	843	380	784
	473	481	483	558	580	586	455	558
	996	635	634	777	724	689	690	811
6	656	555	750	793	625	845	569	756
	341	585	717	743	390	525	0	638
	420	799	610	608	462	438	485	637
7	505	420	412	543	443	843	389	428
	445	510	517	500	672	494	624	580
	465	442	875	767	647	386	597	544
8	517	458	0	629	492	461	555	535
	421	432	680	577	424	504	778	634
	486	501	549	726	653	518	547	628
9	584	600	533	550	512	601	584	550
	475	384	499	602	424	481	553	553
	563	479	548	365	412	771	475	756
10	348	568	347	394	442	391	328	383
	278	353	465	440	378	446	517	531
	486	342	444	330	392	450	547	623
11	355	387	852	494	552	649	414	410
	325	335	415	541	429	422	376	418

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	391	357	447	407	340	563	443	710
12	374	448	524	384	469	481	574	467
	289	466	394	463	433	404	520	473
	456	453	684	430	601	560	472	609
13	494	606	0	699	560	525	616	639
	481	901	951	697	608	521	843	0
	770	809	678	517	0	715	635	632
14	596	680	0	479	846	581	555	558
	518	764	522	652	624	594	0	551
	814	780	852	707	0	727	710	989
15	989	984	519	609	788	642	579	873
	860	886	571	881	661	787	661	0
	329	345	423	314	466	368	361	561
16	413	429	443	421	458	391	436	401
	353	356	461	452	417	541	344	384
	401	578	395	976	587	488	304	403
17	480	529	330	364	402	832	461	350
	367	367	362	358	449	458	324	305
	770	429	614	564	424	610	674	826
18	617	501	934	589	999	720	715	611
	619	738	677	605	666	651	0	999
	508	395	515	432	463	363	450	550
19	558	372	696	363	410	367	442	403
	346	349	573	424	483	375	481	500
	336	428	360	311	487	509	376	575
20	316	416	376	526	349	408	307	458
	359	336	0	449	0	429	391	378
	337	410	524	364	498	505	414	439
21	368	469	661	538	512	471	392	484
	364	373	416	424	532	456	377	352
	478	396	399	366	379	420	385	564
22	380	392	700	476	410	431	479	487
	396	376	515	418	386	425	407	557
	977	734	634	838	531	704	741	682
23	595	557	735	665	514	684	527	604
	0	523	0	571	0	562	0	625

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	348	307	413	547	360	478	325	453
24	534	404	702	393	651	362	464	655
	389	536	588	474	369	462	597	546
	494	427	611	671	521	622	635	582
25	459	480	890	538	524	546	639	720
	0	399	499	944	0	464	775	610
	392	850	644	850	777	747	605	695
26	578	857	785	558	0	735	585	732
	654	671	876	684	444	648	900	756

RAW DATA OF EXPERIMENT 2

LEFT HAND RESPONSES OF LOW ALEXITHYMIA SUBJECTS

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	789	625	403	632	198	373	429	534
1	368	358	410	509	416	428	492	367
	417	317	512	582	433	294	376	471
	739	707	471	552	615	803	507	508
2	696	832	633	424	831	828	464	550
	683	756	554	0	672	906	685	545
	251	521	335	398	351	292	433	463
3	299	408	418	317	345	425	453	545
	336	247	393	359	439	469	405	445
	378	404	660	616	319	437	505	636
4	364	437	405	487	518	348	508	0
	318	348	440	450	359	375	453	455
	354	339	490	500	317	471	405	827
5	371	492	484	463	361	432	466	0
	287	390	498	612	345	380	579	563
	516	509	684	635	554	0	728	734
6	450	948	609	707	374	446	651	662
	392	507	0	676	472	495	0	765
	427	584	955	0	449	579	654	831
7	521	700	773	628	704	0	643	644
	445	580	815	621	558	622	570	649
	715	555	586	692	0	420	638	440
8	586	562	601	519	519	777	504	496
	450	468	552	466	425	385	637	833
	430	413	519	587	382	491	518	631
9	735	518	573	625	494	465	475	507
	437	441	522	472	406	434	654	477
	571	433	413	405	356	536	531	797
10	352	359	493	407	550	397	435	457
	433	458	403	390	495	373	466	460

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	639	417	316	430	636	628	339	330
11	389	298	375	397	522	355	433	571
	550	512	435	430	526	341	477	360
	343	396	503	529	352	557	480	515
12	381	391	478	502	366	830	442	421
	389	570	513	423	379	430	460	463
	389	789	601	483	640	619	0	753
13	518	629	834	719	497	579	782	781
	499	448	876	656	585	542	0	599
	669	600	815	478	858	695	553	722
14	633	767	0	454	675	671	512	962
	640	590	514	654	517	717	0	566
	605	561	543	510	760	593	541	834
15	734	512	457	537	632	696	399	353
	643	514	497	604	588	555	0	663
	430	381	404	351	0	500	458	458
16	286	423	465	357	387	497	533	533
	394	464	420	371	372	361	391	432
	342	396	346	277	357	336	499	373
17	371	490	326	305	308	311	338	286
	314	342	324	437	250	324	273	394
	382	503	717	627	473	549	698	820
18	819	499	834	745	602	600	575	817
	636	613	999	675	701	0	720	0
	479	386	504	999	400	496	424	685
19	383	335	652	406	355	370	602	557
	374	360	573	339	531	535	597	605
	288	367	373	427	490	446	477	533
20	545	489	599	498	445	398	319	585
	373	403	0	643	413	513	559	557
	438	852	523	391	414	422	530	604
21	436	388	328	403	426	417	438	522
	390	431	432	0	386	330	457	507
	410	441	455	472	426	423	409	497
22	480	390	659	442	493	507	445	417
	396	0	524	421	423	384	465	477

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	625	400	596	817	525	544	617	640
23	412	470	642	634	537	463	538	619
	359	0	0	635	656	0	0	577
	428	445	437	728	394	553	995	368
24	354	374	510	485	399	471	510	509
	342	396	560	584	0	378	445	462
	315	407	558	457	434	423	516	520
25	573	919	395	444	785	448	566	583
	413	511	533	605	492	455	561	592
	718	822	645	832	836	747	590	634
26	892	665	853	602	704	633	765	702
	702	888	870	511	736	747	629	557

RAW DATA OF EXPERIMENT 2

LEFT HANDED RESPONSES OF HIGH ALEXITHYMIA SUBJECTS

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	354	374	444	476	392	410	304	440
1	527	446	312	413	518	496	403	424
	370	487	372	481	425	524	378	396
	442	529	465	350	504	438	672	752
2	422	689	386	593	386	445	583	640
	455	479	576	685	508	0	542	891
	451	437	515	804	328	653	475	626
3	0	0	530	674	0	676	861	494
	515	841	510	512	651	558	430	546
	345	323	410	348	318	311	439	614
4	349	382	371	431	330	307	358	442
	296	432	431	443	338	400	375	588
	489	474	806	670	577	378	703	777
5	567	502	0	667	402	537	712	740
	420	484	708	660	630	402	979	678
	431	483	429	459	339	511	415	518
6	569	357	415	542	424	368	464	453
	474	351	415	519	343	401	555	532
	583	501	678	720	506	569	652	736
7	616	629	0	707	508	630	593	584
	517	470	630	521	650	470	835	592
	425	555	645	431	418	435	823	538
8	404	420	424	523	449	423	340	583
	456	435	448	476	385	440	528	570
	394	516	584	0	775	0	830	0
9	734	465	905	701	780	741	633	772
	595	723	652	681	865	709	742	699
	600	787	754	635	638	726	628	569
10	712	734	965	636	806	696	911	754
	525	603	0	596	579	525	655	935

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	402	574	461	474	472	499	405	494
11	552	509	524	478	561	473	381	472
	385	471	467	471	429	505	381	524
	629	561	778	645	502	514	655	749
12	452	614	789	742	559	588	586	541
	513	559	714	726	579	514	442	655
	402	519	662	652	408	414	438	529
13	608	446	536	522	678	445	427	507
	278	559	570	395	464	455	483	507
	545	281	536	353	287	362	556	531
14	490	712	449	505	407	529	402	601
	327	417	457	459	543	562	326	795
	454	463	475	439	373	503	436	547
15	415	491	407	443	449	559	524	492
	358	0	572	578	390	374	603	543
	354	362	528	466	526	602	480	474
16	606	436	425	397	504	380	616	479
	433	325	554	543	406	526	472	501
	325	374	640	542	500	396	346	648
17	321	546	486	480	438	525	403	706
	368	388	362	514	0	468	352	0
	880	588	389	634	692	589	415	411
18	373	459	427	361	528	572	386	353
	373	489	657	395	477	378	441	427
	837	932	633	999	999	999	501	862
19	999	999	999	435	999	989	611	810
	0	999	829	430	0	992	389	0
	395	533	353	353	563	414	340	421
20	378	423	722	401	445	421	390	666
	327	402	437	442	401	433	645	504
	502	520	479	626	729	422	431	416
21	493	0	458	455	577	552	530	493
	493	999	552	487	607	613	495	496
	355	369	288	306	263	403	287	384
22	255	287	0	376	312	412	960	457
	355	368	388	308	277	431	543	440

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	589	619	513	611	548	496	581	592
23	366	617	670	658	548	477	519	543
	385	560	559	460	439	444	706	665
	0	547	434	283	0	636	355	388
24	999	600	626	354	522	910	334	347
	347	430	448	376	326	403	464	375
	370	444	464	421	412	313	466	543
25	631	378	283	404	414	376	445	357
	346	429	323	492	388	437	352	535
	523	435	574	594	537	488	406	450
26	584	556	560	633	458	500	481	451
	442	520	508	646	509	466	473	0
	279	275	329	0	399	241	447	308
27	326	0	348	333	238	399	283	355
	414	289	628	303	268	231	593	477

A (1) = 22 人
A (2) = 25 人

3 要因の分散分析：2 要因が被験者内要因

＊＊＊ データ ＊＊＊ A = 2 B = 2 C = 2

要因A	被験者			要因B	要因C
1	1	633.000	513.000	809.000	659.000
1	2	668.000	527.000	593.000	608.000
1	3	642.000	665.000	608.000	726.000
1	4	482.000	456.000	487.000	436.000
1	5	531.000	489.000	473.000	452.000
1	6	559.000	549.000	577.000	589.000
1	7	708.000	532.000	744.000	614.000
1	8	780.000	668.000	651.000	592.000
1	9	626.000	545.000	624.000	578.000
1	10	606.000	503.000	519.000	517.000
1	11	668.000	605.000	724.000	618.000
1	12	674.000	511.000	903.000	503.000
1	13	619.000	509.000	602.000	515.000
1	14	556.000	557.000	606.000	660.000
1	15	500.000	465.000	575.000	534.000
1	16	633.000	553.000	653.000	703.000
1	17	709.000	642.000	762.000	627.000
1	18	602.000	447.000	539.000	608.000
1	19	505.000	528.000	567.000	503.000
1	20	719.000	544.000	698.000	642.000
1	21	805.000	585.000	683.000	756.000
1	22	642.000	527.000	593.000	608.000
2	1	580.000	605.000	567.000	613.000
2	2	566.000	482.000	591.000	486.000
2	3	577.000	486.000	543.000	611.000
2	4	549.000	660.000	558.000	635.000
2	5	504.000	408.000	521.000	417.000
2	6	496.000	478.000	474.000	500.000
2	7	745.000	735.000	775.000	718.000
2	8	795.000	666.000	708.000	661.000
2	9	603.000	545.000	592.000	521.000
2	10	727.000	616.000	706.000	722.000
2	11	594.000	553.000	682.000	520.000
2	12	476.000	422.000	445.000	461.000
2	13	816.000	645.000	767.000	702.000
2	14	837.000	693.000	794.000	672.000
2	15	549.000	577.000	602.000	572.000
2	16	433.000	435.000	500.000	458.000
2	17	554.000	568.000	525.000	646.000
2	18	723.000	642.000	632.000	570.000
2	19	609.000	579.000	727.000	551.000
2	20	706.000	638.000	785.000	686.000
2	21	518.000	481.000	679.000	583.000
2	22	636.000	653.000	648.000	699.000
2	23	797.000	707.000	840.000	782.000
2	24	716.000	668.000	772.000	721.000
2	25	727.000	561.000	652.000	568.000

Appendix 8.1, ANOVA and Raw Dta of Exp.4

＊＊＊　平均とＳ．Ｄ　＊＊＊

	合計	平均	Ｓ．Ｄ．	データ
A(1)-B(1)-C(1)	13867.000	630.318	83.868	22
A(1)-B(1)-C(2)	11920.000	541.818	59.371	22
A(1)-B(2)-C(1)	13990.000	635.909	103.042	22
A(1)-B(2)-C(2)	13048.000	593.091	81.691	22
A(2)-B(1)-C(1)	15833.000	633.320	114.166	25
A(2)-B(1)-C(2)	14503.000	580.120	91.616	25
A(2)-B(2)-C(1)	16085.000	643.400	108.907	25
A(2)-B(2)-C(2)	15075.000	603.000	96.019	25
A(1)-B(1)	25787.000	586.068	85.074	44
A(1)-B(2)	27038.000	614.500	95.413	44
A(2)-B(1)	30336.000	606.720	106.870	50
A(2)-B(2)	31160.000	623.200	104.634	50
B(1)-C(1)	29700.000	631.915	101.133	47
B(1)-C(2)	26423.000	562.191	80.499	47
B(2)-C(1)	30075.000	639.894	106.266	47
B(2)-C(2)	28123.000	598.362	89.736	47
A(1)-C(1)	27857.000	633.114	93.985	44
A(1)-C(2)	24968.000	567.455	75.870	44
A(2)-C(1)	31918.000	638.360	111.681	50
A(2)-C(2)	29578.000	591.560	94.538	50
A(1)	52825.000	600.284	91.503	88
A(2)	61496.000	614.960	106.078	100
B(1)	56123.000	597.053	97.821	94
B(2)	58198.000	619.128	100.518	94
C(1)	59775.000	635.904	103.808	94
C(2)	54546.000	580.277	87.137	94

☆★☆　被験者内誤差項についてのＢａｒｔｌｅｔｔの等分散の検定　☆★☆

SS	MS	df
107688.0000	2393.0700	45
193296.0000	4295.4700	45
99216.0000	2204.8000	45

CHI-SQUARE=　6.2071　　DF=2

＊＊＊　分散分析表　＊＊＊

source	SS	df	MS	F
B.subjects		46		
A	10110.600	1	10110.600	0.357
subj.w.group	1275140.000	45	28336.400	
W.subjects		141		
B	23632.400	1	23632.400	9.875

A x B	1626.600	1	1626.600	0.680
Bxsubj.w.group	107688.000	45	2393.070	
C	148055.000	1	148055.000	34.468
A x C	4113.300	1	4113.300	0.958
Cxsubj.w.group	193296.000	45	4295.470	
B x C	9929.250	1	9929.250	4.503
A x B x C	3212.230	1	3212.230	1.457
BCxsubj.w.group	99216.000	45	2204.800	

＊＊＊　分散分析表　（誤差項をプール）＊＊＊

source	SS	df	MS	F
B.subjects		46		
A	10110.600	1	10110.600	0.357
subj.w.group	1275140.000	45	28336.400	
W.subjects		141		
B	23632.400	1	23632.400	7.972
A x B	1626.600	1	1626.600	0.549
C	148055.000	1	148055.000	49.944
A x C	4113.300	1	4113.300	1.388
B x C	9929.250	1	9929.250	3.349
A x B x C	3212.230	1	3212.230	1.084
pooled error	400200.000	135	2964.440	

Main effect A　ﾃｭｰｷｰ =　93.61700
Main effect B　ﾃｭｰｷｰ =　93.61700
Main effect C　ﾃｭｰｷｰ =　93.61700

RAW DATA FROM EXPERIMENT 3

RESPONSES OF HIGHLY ALEXITHYMIC SUBJECTS

	CROSS				SAME			
SS	+E	-E	+N	-N	+E	-E	+N	-N
	558	497	0	881	1	757	992	655
1	938	573	428	633	988	0	506	568
	677	558	554	571	592	901	681	554
	928	620	473	583	498	0	441	839
2	449	0	491	537	0	726	472	809
	0	677	472	609	507	644	457	630
	667	710	793	522	644	582	911	546
3	0	582	0	668	659	555	906	610
	0	612	924	420	0	567	891	494
	507	504	501	441	412	541	454	437
4	488	454	492	474	570	440	412	443
	459	0	362	467	517	447	446	425
	452	566	454	528	447	413	447	726
5	537	570	420	556	365	0	392	417
	0	0	357	624	0	668	401	330
	660	0	629	701	622	849	697	897
6	579	0	609	938	682	0	0	969
	641	0	586	854	743	0	580	0
	569	561	530	486	510	621	470	531
7	430	656	490	536	516	729	542	0
	488	655	564	689	450	639	565	837
	794	627	380	540	697	0	628	587
8	537	822	428	587	674	876	635	772
	594	875	684	575	691	513	550	514
	910	846	629	796	674	620	0	619
9	738	735	624	612	732	0	718	558
	0	672	687	562	628	603	630	438
	634	550	547	561	603	635	476	580
10	589	600	589	584	0	700	587	708
	686	702	503	488	666	520	578	541
	689	477	482	563	506	0	525	635
11	490	0	489	521	472	594	524	410
	634	742	506	460	417	610	504	506

	CROSS				SAME			
SS	+E	-E	+N	-N	+E	-E	+N	-N
	777	650	576	743	0	680	559	681
12	597	697	544	583	685	804	780	620
	619	0	522	663	696	758	437	631
	0	543	620	460	973	807	430	546
13	894	629	445	487	0	949	474	469
	662	645	486	568	0	886	0	596
	633	725	517	501	495	0	0	527
14	539	0	426	577	609	464	590	441
	544	654	568	468	872	574	500	517
	0	533	513	667	709	627	914	612
15	558	646	489	629	542	612	754	566
	487	0	482	567	568	581	508	606
	417	600	357	625	812	0	393	547
16	474	488	439	597	504	615	559	513
	509	514	381	394	455	489	594	599
	640	623	592	0	619	0	852	618
17	592	0	532	648	553	0	844	724
	0	677	451	544	718	723	481	701
	890	586	754	480	0	833	0	625
18	831	634	733	629	829	751	794	587
	0	605	794	467	761	637	694	482
	687	538	397	494	498	657	765	578
19	654	584	437	426	682	495	754	532
	0	547	451	480	459	447	556	464
	483	0	484	456	497	695	480	554
20	0	0	457	714	0	0	431	575
	527	0	581	477	496	582	549	533
	771	829	635	509	797	806	0	698
21	748	0	570	466	606	715	829	571
	778	471	492	595	603	666	582	534
	775	832	616	487	667	936	734	984
22	856	720	592	577	609	784	743	621
	0	845	627	612	589	513	0	701

RAW DATA OF EXPERIMENT 3

RESPONSES OF LOW ALEXITHYMIA SUBJECTS

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	0	566	569	632	666	512	712	581
1	658	518	607	399	0	596	465	576
	611	547	502	898	523	542	556	792
	502	634	498	600	510	658	589	517
2	451	803	409	493	442	0	418	436
	441	0	415	479	0	755	447	511
	652	619	449	519	468	568	700	686
3	442	598	401	648	0	610	712	497
	0	0	424	479	547	526	490	583
	559	565	586	821	514	601	411	571
4	495	732	367	580	444	0	531	975
	419	528	348	600	595	639	581	742
	512	411	415	444	407	504	422	380
5	413	471	396	471	532	648	407	443
	401	820	372	353	550	490	441	414
	433	449	456	524	415	479	380	574
6	490	449	0	526	423	0	630	434
	0	660	395	489	581	0	549	434
	699	778	694	743	753	0	765	720
7	721	0	816	782	825	0	875	696
	785	0	649	731	821	703	644	608
	916	847	609	715	734	759	658	630
8	557	0	701	683	513	0	725	667
	863	0	539	753	0	826	619	672
	715	507	508	619	531	598	441	585
9	512	667	431	558	362	778	524	571
	614	0	538	618	606	680	495	573
	764	765	516	683	703	0	969	626
10	602	770	574	0	0	0	725	712
	802	661	690	621	710	0	671	632
	0	595	454	447	859	526	525	608
11	560	610	591	872	0	601	449	543
	0	611	509	448	782	646	503	435

	CROSS				SAME			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	597	477	442	370	362	0	592	401
12	429	569	368	497	397	643	579	439
	417	368	392	465	406	420	404	356
	736	984	550	785	861	818	730	401
13	733	975	607	708	740	747	602	439
	656	0	586	638	789	648	630	356
	0	817	566	585	692	713	0	719
14	883	0	634	814	0	0	628	731
	692	958	724	836	681	911	715	803
	586	522	528	616	580	585	394	774
15	588	565	549	627	783	555	723	620
	488	0	627	517	459	615	531	624
	506	0	385	403	414	706	445	729
16	372	491	373	640	467	0	530	538
	365	0	377	437	416	0	413	520
	691	338	719	516	795	397	723	566
17	662	477	579	452	0	456	753	391
	0	0	658	488	0	455	666	404
	884	867	565	622	602	0	608	522
18	593	0	539	852	0	0	646	671
	627	648	561	716	518	777	418	545
	794	631	516	653	615	818	598	654
19	433	664	525	572	0	782	404	573
	496	638	542	668	695	726	488	526
	673	0	737	626	891	962	811	619
20	763	724	562	700	0	685	721	715
	0	664	599	607	636	751	688	567
	636	473	438	497	834	0	534	862
21	469	0	431	598	464	0	682	479
	497	0	401	521	739	0	393	552
	653	617	555	779	801	723	780	719
22	579	700	537	732	0	605	534	619
	0	631	0	663	532	553	895	652
	870	992	821	701	724	973	931	898
23	715	613	714	568	880	0	768	738
	796	0	786	657	786	0	688	674

	SAME				CROSS			
SS	+PR	+WR	-PR	-WR	+PL	+WL	-PL	-WL
	0	0	969	586	0	0	0	727
24	0	0	678	568	672	0	0	619
	716	0	574	633	863	781	933	607
	758	810	468	616	688	567	0	602
25	669	613	590	572	0	496	591	528
	808	705	583	538	742	771	578	543

ANTIQUITY IN MODERNITY

inches
cm
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Cyan
Green
Yellow
Red
Magenta
White
3/Color
Black
C
Y
M
Kodak Gray Scale
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A 1 2 3 4 5 6 M 8 9 10 11 12 13 14 15 B 17 18 19