ESTABLISHING NORMS ON THE AUDITORY COMPREHENSION TEST AMONG A SAMPLE OF FIRST YEAR UNIVERSITY STUDENTS

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TO JODI,

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ABSTRACT

This study seeks to establish a wider normative sample base for the Auditory Comprehension Test (ACT) (Green and Krammer, 1983). The ACT is effective in differentiating between individuals who have a binaural deficit in speech comprehension and those who do not.

One hundred and three first year University students were tested on the ACT (seventy- three females and thirty males). Three out of this number (2.91%) were found to have binaural deficits.

No significant differences were found to exist between males and females on Left, Right, and Both ear scores of the ACT.

Significant differences were found to exist between performance on each ear condition for this current study in comparison with an earlier study (Green & Kramer, 1984) with a smaller sample. This indicates a need for more exhaustive methods of standardising the administration and scoring of the ACT, as well as testing with larger and more varied population groups.

Ear plug testing with one of the three subjects found to have binaural deficits indicated a 27 point improvement (21.78%) when the ear plug was fitted in

the weaker ear as compared to the open field binaural no-ear plug condition.

An interview conducted with the same subject revealed a preference for visual or audio-visual modes of assimilating environmental stimuli in comparison to auditory inputs alone.

This subject showed extreme elevations on the Hypomania scale of the MMPI.

The Emotional Perception Test (Green & Severson, 1986) did not reveal any differences in the same subject's ability to discriminate emotions in comparison to the test norms, although there was a relatively more frequent overestimation of the sadness emotion by this subject in comparison to the normative sample.

The promise of the ACT both as a diagnostic and therapeutic tool is emphasized. The need for a comprehensive scoring manual is emphatically indicated.

INTRODUCTION

Recent advances in medical technology have led to a better understanding of the physiological and anatomical substrates of psychological functioning. New knowledge obtained from innovative brain scanning methods such as the Positron Emission Tomography (PET scans), which yields metabolic images of the brain, has helped discover the strong relationship between depression and the rate of glucose metabolism (Kupfer, 1986); advances in molecular biology have prompted the search for a specific gene in the transmission of schizophrenia (Walker & McGuire, 1982); computed brain electrical activity mapping (BEAM), among numerous other technological inventions have enabled a better understanding of human behaviour (Weinberger & Salzman, 1984). These advances have been paralleled in many respects by the rapid development of psychological testing in clinical neurology. The areas of dichotic listening, binaural interference, and speech comprehension are a few such examples where the development and use of innovative psychological testing methods have provided valuable supplemental data to further our knowledge of the way we as human beings function.

The present study is designed to investigate the recently documented phenomenon of a "Binaural Deficit" in auditory speech comprehension among a small number of apparently well-adjusted normal individuals. The two main purposes of this research were to expand the normative base for the Auditory Comprehension Test (Green and Krammer, 1983) by testing 100 adults recruited from a university population; as well as to study in some detail, the adjustment capabilities of individuals who have Binaural Deficits but have been able to make it to University. Further, some clinical implications of living with Binaural Deficits would be studied.

The Binaural Deficit phenomenon

It is a widely held notion that hearing with both ears is always better than hearing with one or the other ear. This is true in auditory localization of sound, where the juxtaposition of the ears helps the individual in many cases to determine the location of the sound source (Morais & Bertelson, 1975).

However, it is also interesting to note that listening with both ears does not necessarily guarantee a more accurate comprehension of speech than with either ear alone (Green & Josey, 1988). A rather curious phenomenon which has come to be known as a Binaural Deficit involves the reduction or total absence of this normally co-operative and integrative link between the hemispheres. In these cases one of the auditory pathways seems to interfere with the performance of the other at the hemispheric level. In many people the relatively longer left ear pathway tends to be the culprit (Green, 1983). A Binaural Deficit therefore manifests itself in poorer language comprehension abilities with both ears than with one ear alone. A number of hypotheses have been proposed to explain the Binaural Deficit problem. The most popular seems to be that of abnormalites in interhemispheric integration (Green, Glass, & O'Callaghan, 1979) which points to the dysfunction in the structures that link both cerebral hemispheres, specifically the corpus callosum.

Some likely problems for people with Binaural Deficits

The Binaural Deficit problem could result in a number of undesirable consequences. People with such deficits would likely have problems in school, considering the fact that the primary mode of instruction is verbal presentation of information. Some spill-over effects include an underestimation of the intellectual abilities of an individual with this deficit (Ogle, 1991).

Difficulties in accurate comprehension of spoken instruction could initiate difficulties in interaction with authority figures. If the real problem is not addressed, such difficulties in understanding and following through with a teacher's instruction, for example, could affect the individual in many ways. Further problems would obviously develop as the individual makes his or her way through life.

One could speculate further about the cumulative effects of this problem, creating a "Binaural Deficit personality type" of individual (who might be introverted, have a low self-esteem, have very few friends, and an unsatisfactory social life). One could even picture an individual who might be thought of as having no sense of humour, simply because of his/her difficulty of comprehending jokes as fast as others would expect. There is a possibility that people with this problem might be misclassified as either having conduct disorders, or being of subnormal intelligence.

This is an exciting area of research because of the obvious practical importance of being able to identify the proportion of normal adults with this deficit as well as their likely personality characteristics, in addition to helping analyse their strategies for coping with their deficits. The Auditory Comprehension Test (ACT), which is used to test for the existence of Binaural Deficits, would definitely benefit from an expansion of its current normative sampling base, which, as mentioned above, forms a major part of the objectives of the current study. Although not within the scope of this work, implications of this study would be of some psychometric value in assessing such tests as the Wechsler Memory Scale-Revised (Wechsler, 1981). The Logical memory passages subtest of the latter has a less exhaustive scope (both in number of stories and details to be recalled) in comparison to the ACT. The ACT could be used in conjunction with the logical memory passages subscale when more detailed information is being sought.

Remedial interventions for people with Binaural Deficits

A significant contribution of this work would be to find out what proportion of first year University students suffer from a Binaural Deficit in auditory speech comprehension. Green (1987) found 5% of his normal subjects to have this deficit. An in-depth study of these normals with Binaural Deficits should help immensely in the direction and type of therapeutic intervention to be used with such people in helping improve their quality of life. It is only logical in cases of Binaural Deficits (that is, one ear comprehends speech more accurately than two) for the "bad" ear to be occluded in order to improve speech comprehension. The use of an earplug as a therapeutic device has been used in this way to increase speech comprehension in learning disabled children (Green & Josey, 1988), reduce the frequency and severity of voices in severely hallucinating schizophrenic patients (Birchwood, 1986; Levick & Peselow, 1986; Done, Frith, & Owens, 1986); and reduce illusory auditory perceptions (Jacobs, Feldman, Diamond, & Bender, 1973).

The use of this earplug is carefully determined by the ACT test results. The inferior single ear is then occluded. Upon a physician's recommendation, a custom-made earplug is fitted by an Audiologist. In order to "qualify" for the earplug treatment, the individual must show consistently inferior story recall on the ACT under binaural listening in comparison to monaural recall accuracy.

In attempting to explain the effectiveness of using an earplug in these deficit problems, Green and Josey (1988) indicate the possibility that introduction of the earplug "produces a relative decrease in metabolic activity in the contralateral temporal lobe and that such a change underlies the earplug effect" (p 25).

This proposed explanation is based on Mazziota and Phelp's (1985) discovery using the positron emission tomography to show that when subjects listen to stories with both ears, both temporal lobes increase their glucose uptake in normal subjects. However, monaural stimulation results in relatively higher metabolic activity in the temporal lobe contralateral to that ear which was stimulated. This is consistent with the notion that use of an earplug reduces unwanted inhibition of one temporal lobe by the other and hence reduces contalateral cortical stimulation.

Dichotic listening tests and Cerebral Laterality

In terms of our current state of knowledge about cerebral laterality, we know that both hemispheres normally receive projections from each eye, and the auditory system is no exception (Kimura, 1967). Substantial work using dichotic listening tasks have taught us, however, that the contralateral connections in auditory information processing actually do have preferred access to the cortex (Hiscock & Bergstrom,1982). A dichotic listening task involves the presentation of auditory stimuli to a specific hemisphere through the simultaneous stimulation of the two ears with different stimuli. During a dichotic listening task, therefore, the stimulus presented to the left ear must go to the right hemisphere and then move across the cerebral commissures to the left hemisphere. This route puts stimuli from the left ear at a disadvantage relative to the right ear (which primarily makes its way directly to the left hemisphere where receptive speech is processed), with words presented to the latter being recalled more accurately.

Not all subjects however show the expected ear advantages in dichotic studies; and in attempting to account for these differences, some researchers have noted that dichotic listening results are apparently affected by various contextual and practice effects. Other individual variations in cerebral asymmetry have been attributed to such factors as gender, or handedness, both of which have strong implications for speech comprehension and interhemispheric interaction.

The two hemispheres of the human brain are known to be anatomically and functionally different. The right and left hemispheres differ in their processing strategies and their capacities for performing various linguistic, affective, and visuospatial tasks (Moscovitch, 1979). It has long been known, for instance, that one cerebral hemisphere is more instrumental in language function than the other, and most people who suffer permanent linguistic disorders caused by brain damage tend to have left hemispheric injury. Although many factors (such as gender and handedness which have been mentioned above) mediate this compartmentalization of hemispheric dominance, the picture is still not totally clear. For example, researchers report that only 15 to 30% of left-handed aphasics have unilateral right hemisphere damage (Hecaen & Sauget, 1971).

It is common knowledge following the works of Paul Broca and Carl Wernicke, that damage to an area now known as Broca's area in the frontal convexity of the left hemisphere inhibits one's capacity to produce speech. People with such expressive aphasias are capable of understanding language, and may even be able to sing words that they cannot say. On the other hand, if the damage is located more posteriorly along the superior temporal lobe, understanding spoken or written language becomes impossible.

Green (1988) noted, contrary to the prevailing view, that not all speech comprehension deficits can be attributed to Wernicke's aphasia. This is supported by the existence of binaural interference.

Effects of different testing procedures

It may be appropriate to point out here that many of the apparent differences in comprehension and other linguistic abilities or deficits that have been found by various researches in this area are perhaps due to different testing procedures. Broadbent's (1954) description of the dichotic listening technique is a popular method that has many variants, and involves the simultaneous presentation of different words to the two ears. Currently there are tasks that entail dichotic digits with free recall (Lerner, Nachson, & Carmon, 1977); dichotic consonant-vowel syllables (Moscovitch, Strauss, & Olds, 1981); and dichotic digits with both directed and free recall (Gruzelier & Hammond, 1980); among others. The point here is that dichotic tasks which vary across meaningfulness, information load needed for recall, and the way the response is required may tap different aspects of perceptual processes and laterality in the brain (Berlin & McNeil, 1976). These significantly different tasks and the apparently diverse results that emanate from them call for more serious attempts at integration towards a coherent set of models and theories of interhemispheric interaction and speech comprehension.

There are a variety of comprehension tasks which aim at different objectives. The most common seems to be that of differentiating organically impaired individuals from non-impaired ones in functions such as speech production, accurate enunciation of auditorily presented words, and recall of complex stories. As E. Green (1985) has posited based on her work with acute schizophrenics, the possibility of attentional and other cognitive biases do play an important role in the determination of ear asymmetry. She also points to the often forgotten fact that listening to material presented in laboratory settings where such things as headphones are used, is an unusual task which bears little similarity with what happens in everyday life. This is not to say, however, that the use of headphones and other laboratory settings are to be jettisoned altogether, but rather other additional factors need to be taken into account in researches of this nature.

THE AUDITORY COMPREHENSION TEST (ACT)

The ACT (Green & Krammer, 1984) is a test used to measure story recall and is obviously heavily based on speech comprehension abilities. The principal architect of this test has pointed out that not all speech comprehension deficits can be attributed to Wernicke's aphasia (Green, 1988), hence finding evidence to support the existence of superior monaural over binaural speech comprehension in certain people.

A brief historical basis of the ACT

This test was originally standardized on 52 staff workers at Alberta Hospital, Edmonton, of which 8 were males and 44 were females. The mean age of the sample was 31.4 years. Overall mean verbal IQ, estimated from the vocabulary subtest of the revised edition of the Weschler Adult Intelligence Scale (WAIS-R) for these subjects was 101.6. The mean ACT scores for this original normative sample were:

Left ear recall = 100.21 (s.d.=16.17);

Right ear recall = 101.23 (s.d.=13.83); and

Binaural recall = 101.52 (s.d.=13.31).

These scores are obtained out of a total possible score of 160 for each of the three conditions.

The performance of these subjects follows a normal distribution with a mean of 100.9 and standard deviation of 13.31. Eighteen (34.62%) of the normative sample scored within one standard deviation above the mean, while 19 subjects (36.54%) fell within one standard deviation below the mean. Seven subjects (13.46%) fell within two standard deviations above the mean, while 6 (11.54%) occupied the position below the mean. The two other subjects (3.85%) could be accounted for as scoring more than two standard deviations above the mean.

Current applications of the ACT

The ACT has been found to be effective in discriminating between normals and schizophrenics, brain-lesioned patients, and psychotics (Green, 1987). As was found in Green, Hewko, & Astner's (1988) work, the ACT has a lower misclassification rate in all respects than the Logical Memory Passages subscale of the Wechsler Memory Scale (Wechsler, 1945).

There is a constantly growing body of research on the ACT (Maclean, 1990). So far the ACT appears to have some value in shedding light on the current difficulty of accurately pinpointing the association between left and right cerebral hemisphere damage and schizophrenia (Luchins, 1983; Ingvar & Franzen, 1974). Current research on the extent to which high risk children of schizophrenics have problems with interhemispheric integration similar to those found among schizophrenic patients has also been picked up by the ACT (Green, Hallett & Hunter, 1983).

Green and Josey (1988) have demonstrated that there is some value in using the ACT to uncover the problem of binaural interference among some learning disabled (LD) children. They found a significant deficit in binaural relative to monaural recall of the stories on the ACT among the latter, while normal control subjects showed a significant binaural advantage relative to monaural recall. (Initial testing with the LD children showed at least a 20% monaural advantage over binaural performance). Even among the learning disabled group of children, those who were selected as having prominent auditory processing difficulties had monaural scores similar to the normal control group of children (although their binaural scores were significantly lower than normals). The remaining LD children were found to be impaired in all conditions. A replication of this study by Maclean (1990) yielded similar results. He found that 41% of his learning disabled subjects (average age of 12 years and 2 months) had binaural deficits.

In the wake of these modest but increasingly significant findings on the relationship between the ACT (or language comprehension abilities in general) and interhemispheric abnormality, it becomes necessary to assure oneself that the psychometric properties of this test will stand the test of time. Since Green's initial work with normal subjects in 1983, further work with normal adult populations has not been forthcoming. This is one contribution the present study hopes to produce.

METHOD

Subjects

One hundred and three first year University students took part in the study. Out of that number, seventy-three were females and thirty were males.

The youngest participant was seventeen years and eleven months old, while the oldest was sixty-nine years old.

Subjects were included in the study on condition that they were right-handed, had normal hearing abilities, had not been treated by a physician or audiologist for any hearing problems in the last twelve months (see Appendix 3), and had English as their first language.

Apparatus

'. The Auditory Comprehension Test kit, which comprises a cassette tape recorder, an audio tape with the test stories recorded on it, a switchbox, two sets of headphones, and a set of standardized record forms.

The ACT in its current form comprises thirty short stories divided into five subtests. Attempts were made to ensure that the length of each story in each subtest, the number of items to be recalled, and the difficulty level of the stories themselves do not vary markedly among the six stories in each subtest. The subtests increase in difficulty from subtest A to subtest E.

The structured instructions for the administration of the ACT are:

> On this tape there is a woman reading some short stories. I want you to listen to each story and as soon as it is finished, I want you to tell me as much as you can remember about the story in your own words. Sometimes the story will be in this ear (pointing to the headphones), sometimes in the other, and sometimes in both ears. Don't worry if you can't remember it all. Nobody can remember all of a story. Just listen carefully and try your best. Is that clear? (Explain further if not).

The stories have been recorded on audio cassette tape, and are presented to the subjects by way of headphones. The experimenter is able to switch the incoming story to one or both ears in the following fashion: For every subtest, two stories are presented to the left ear, two stories to the right ear, and two stories to both ears. This is repeated so that at the end of the whole session, the subject will have heard a total of thirty stories (10 in the left ear, 10 in the right ear, and 10 in both ears).

Scoring uses the free recall method where at the end of each story, the subject is asked to recall as much of what was said as possible. Points are given for certain target words or phrases within the story that are recalled correctly. A total of 160 points for each ear is possible. This enables one to calculate a score for the left ear, for the right ear, and for both ears, and hence to determine the presence or absence of a Binaural Deficit. Further, one can tally intrusions, that is, the frequency of misinterpretations or additional information in each auditory presentation.

Reliability

Test-retest reliability of the ACT was assessed by Green (1983), who tested twenty subjects twice, with approximately 21 days as the interval period between sessions. The mean scores he arrived at for these subjects were:

Initial test: 98.79 (s.d.=10.19)

Re-test: 109.26 (s.d.=12.24).

The test retest correlation coefficient of 0.86 (standard error of measure= 5.19) is very high.

Inter-rater reliability of trained testers is also very high, due to the relative objectivity in scoring the test. Although there is no scoring manual for the ACT at this present time, all the individuals currently using the test have been personally trained by the author of the test (Dr. P. Green) or Dr. S. Sellick.

Validity

Face and content validity of the ACT is appreciably high, since it aims at measuring speech comprehension and recall of spoken material. Criterion-oriented validity of the test is remarkably enhanced by the practical use of improved speech comprehension as well as recall through the use of earplug treatments of those found to have Binaural Deficits. The proliferation of researches that support the binaural interference model (Green, 1988) also adds to the empirical validity of the ACT.

Earplug form of the ACT

This form of the ACT is basically focused on individuals found to have Binaural Deficits. Such individuals are re-tested in an open field without headphones, but instead, a wax earplug is fitted in the ear found to be inferior on the initial test. The ACT stories are played at a comfortable volume and distance (about six feet) from the subject. In total, fifteen stories are presented to the testee with the plug fitted, and fifteen stories without the earplug (the latter being akin to everday normal listening activity). Scoring follows the same procedure as the headphone technique, except that, having only two conditions, the totals for each of the 'plug-noplug' condition are out of 240 instead of 160 in the headphone condition. Subjects who score consistently higher in the monaural condition may then agree to have earplugs customized for wear in their everyday lives.

2. The Weschler Adult Intelligence Scale-Revised (WAIS-R) test kit.

The WAIS-R is an intelligence test which aims at "assessing an individual's potential for purposeful and useful behaviour" (Weschler, 1981. p 7). It is perhaps the most widely used test of intellectual ability in North America, and the current revision was originally standardized on 1880 Americans.

Split-half reliability correlation coefficients of 0.97 on the Full Scale IQ indicates extremely high consistency of this test. The validity of the WAIS-R Full Scale IQ when compared with the Standford-Binet IQ is a high 0.85.

3. Cottonwax ear stopples.

4. Beck Depression Inventory (BDI).

This is a 21-item self-report measure that assesses the severity of cognitive, affective, somatic, and motivational depressive symptoms. Items are composed of 4 alternative statements rated in severity on a scale of 0 to 3. Total scores may range from 0 to 60.

The BDI still maintains good validity and reliability (Reynolds & Coats, 1982).

5. Minnesota Multiphasic Personality Inventory (MMPI).

The MMPI is the world's most referenced Personality Inventory, and although it was originally standardized on psychiatric populations (Hathaway & McKinley, 1967), the plethora of researches indicate a variety of uses and applications with many varied populations.

6. Emotional Perception Test (EPT).

This test aims at assessing an individual's ability to correctly discriminate emotions in another person's voice (Green & Severson, 1986).

The EPT comprises forty-five tape-recorded items, involving three sentences spoken by a woman in five different emotions: Happy, Frightened, Neutral, and Sad. The three sentences are:

"The store is crowded with people".

2. "Would you take the door on the left, please?"
3. "Why didn't you call me at work this afternoon?"

Scoring this test is done in a variety of ways. The total errors can be analysed, where wrongly identifying the emotions for each item is counted and added up. The cut-off for impairment (normal versus psychiatric patients) for this test is nineteen or more errors out of a possible forty-five.

The test is divided into three groups of fifteen items each. This division enables us to find out whether the subject benefits from past exposure in improving his/her accuracy as the test progresses.

The EPT further enables us to analyze errors per emotion in order to find out whether subjects tend to make more errors in discriminating certain emotions rather than others.

Preliminary norms using forty-one normal adult staff of Alberta Hospital Edmonton have been established. Subsequent testing by Severson (1988) with 34 psychiatric patients indicated an overall impairment in judgement of emotion compared to normal controls.

Psychometric and Empirical properties of the EPT.

The short form of the EPT, which involves administering just the first 30 items, correlates very well with the full test ($\underline{r}$= .94) with normals.

The EPT is effective in discriminating between normals and psychiatric patients. The mean total error score for the normative sample was 11.1 out of 45 (s.d.= 4.8). Psychiatric patients' mean error score was 19.5 (s.d.=8.5). At a criterion for impairment cut-off of 19 or more errors, none of the 41 normal subjects (as compared to 18 of psychiatric patients) met this criterion. More empirical work related to the EPT is in progress.

Procedure

Each subject was given a cover letter to read, a consent form and a preliminary screening questionnaire to fill out (see Appendices 2, 3, and 5).

After rapport was established and the participant was found to be sufficiently ready for the study, the ACT instructions were given, followed by the test itself. This took between thirty to forty-five minutes to go through. Following the assurance that the instructions were understood, the tape was played story by story through a randomly predetermined ear sequence throughout the whole session (for example, Left- Right- Both; or Right- Both- Left; etc). After each story ended, the tape was stopped and the subject had to recall in as much detail as possible what was just said. Every so often, subjects were encouraged to provide more responses by being asked "Do you remember anything else ?". The switchbox was used to change the story receiving ear, based on the randomly selected order of presentation. At the end of the test, each individual had provided ten blocks of responses on the Left, Right, and Both ears, hence accounting for the thirty stories in all.

The randomization without replacement procedure was used to determine which starting ear and sequence was to be followed in switching from ear to ear. There were six different possible starting and sequencing orders (Both-Right-Left; Left-Right-Both; Left-Both-Right; Right-Left-Both; Right-Both-Left; and Both-Left-Right).

The instructions for the two subtest short-form of the WAIS-R were as follows:

> **We are going to do some more tasks. One will involve answering questions and the other will not involve words at all. Most of the tasks begin easily and become progressively more difficult.**
> **Do you have any questions before we begin?**

The Vocabulary and Block Design subtests of the WAIS-R were then administered respectively (for a good exploration of the issues surrounding the use of the two- subtest short form of the WAIS-R, see Silverstein, 1982; Thompson, 1987; and Thompson, Howard, & Anderson, 1986).

Participants who were found to have binaural deficits were invited back for re-testing after at least two weeks since their last testing. Only one individual accepted the invitation, and she was simply told that one ear would have to be plugged for some stories and not for others, because she had the unique ability to recall much better with one ear compared to both. She however was not told which ear it was until after the test session. The ABBA sequencing procedure was used, hence the first three stories on subtest A were administered with no ear plug fitted, while the next three were presented with an ear plug fitted. On story B, the first three stories were played with an ear plug fitted while the last three were without an ear plug and so on, throughout the test. The experimenter demonstrated the appropriate use of the ear plug and assisted the subject where she was found to have problems fitting it properly. After the ear plug testing was done, a brief interview (up to an hour) was conducted (see Appendix 4).

RESULTS

Out of the one hundred and three people who took part in the study, thirty (28.57%) were males and seventy-three (70.87%) were females.

Participants' ages varied from 17 years 11 months to 69 years 5 months. Average age was 23.98 years. As many as forty (38.1%) of them were 19 years old. Further, thirty-nine subjects (37.86%) were over 21; while sixty-four (62.14%) were less than 21 years old.

Three out of the one hundred and three participants (2.91%) were found to have clear-cut Binaural Deficits which warranted ear plug testing. One person out of the three was male. The ages for these three subjects were 35, 34, and 19 years respectively (mean age= 29.33).

Scoring of the ACT.

Points were awarded for certain words or phrases in each story that were correctly recalled. A maximum overall score of 160 could therefore be obtained for each ear condition. A look at the ACT scoring sheet (Appendix 1) shows the various score-attracting phrases.

Intrusions (defined as producing material not presented in the story, or rearranging the format to give a different meaning) were calculated as well, with a maximum of one intrusion per story.

Table 1 shows the means and standard deviations for all the subjects on the ACT.

Table 1

Mean scores and standard deviations for the various ear conditions (N=103) compared to Norms (Green & Kramer, 1984).

	Left ear		Right ear		Both ears	
	Current Study	Norms	Current Study	Norms	Current Study	Norms
Mean	91.96	100.1	92.59	100.2	93.39	101.2
SD	15.96	15.7	16.37	14.1	16.11	13.9

Three different t-tests were calculated, aimed at comparing the means obtained in this present study with Green's normative data. There was a significant difference between the mean Left ear score in the present study, and the mean norm $t(153) = -3.02$, $p < .05$. Similarly, there was a significant difference between the mean Right ear scores obtained in the present study and the norm $t(153) = -2.86$, $p < .05$. A significant difference between the Both ear mean scores for the present study and the norm was also found, $t(153) = -2.98$, $p < .05$.

Table 2

Means and standard deviations for Intrusions on the various ear conditions (N=103).

	Left ear	Right ear	Both ears
Mean	4.854	4.874	4.777
SD	1.927	1.813	1.804

The Pearson Product Moment correlation was used to determine whether any relationship exists between the mean recall score over all ear conditions on the one hand, and mean intrusion score on the other. It was the author's expectation that a higher mean recall score would be associated with a lower mean intrusion score. This is because those individuals who have high mean recall scores may have a more accurate idea of the stories, and hence be less prone to generating intrusions as compared to low scorers who may probably feel pressured to fill in the story they just heard with additional information. A correlation of $\underline{r}$ (103) = -.079, p = .336 was found. This shows a non-significant linear relationship between the above-mentioned variables.

Table 3 shows the mean score on each story of the ACT, broken down by gender.

Table 3

Mean score on each Story of the ACT for Males and Females.

	Story					
Subtest	1	2	3	4	5	6
Male subjects (n=30)						
A	7.69	7.93	8.52	9.45	7.93	6.83
B	6.31	7.90	8.66	8.79	7.45	7.45
C	9.04	9.59	10.59	10.62	9.93	8.72
D	10.07	11.72	10.55	10.93	12.17	9.24
E	10.83	11.66	13.38	12.35	11.59	11.52
Female subjects (n=73)						
	7.41	7.37	8.87	8.68	8.53	6.59
B	6.87	7.67	9.01	8.36	7.97	7.09
C	7.71	9.36	10.47	9.99	9.42	8.39
D	9.04	11.16	11.43	10.07	11.56	7.51
E	9.15	10.58	12.57	11.09	10.63	11.56

In order to find out the role of gender on the subjects' performance on the ACT, the mean ear score for each participant was calculated (Left + Right +

Both/3) and the two-tailed t-test was used to compare the difference between the means for males and females. There was no significant difference in mean performance on the ACT between males and females, $\underline{t}(101)= 1.22$, $p=.225$.

Similarly, no significant difference was found to exist between the sexes on the mean ear intrusion score (ie. Left +Right +Both /3), $\underline{t}\ (101) = 1.11$, $p = .271$.

The procedure for calculating the proportion of Ear Difference across the right and left ears on the ACT is the quotient of the difference between total right and total left score on all the subtests and the sum of the total right and left ear score on all the subtests:

$$\frac{R-L}{R+L} \times 100$$ where R= Sum of right ear scores, and L= Sum of left ear scores.

The Binaural Quotient score is calculated by finding the quotient of the difference between the highest monaural condition score from the binaural score and the binaural score:

$$\frac{B-HS}{B} \times 100$$ where B=Sum of binaural scores, and HS= The highest monaural sum score condition value.

Table 4 shows the mean Ear difference and Binaural

Quotient score for all the participants of the study.

Table 4

Mean and Standard deviation of Ear Difference and Binaural Quotient (B.Q) Score (N=103) compared to Norms (Green & Kramer, 1984).

	Ear Difference	Binaural Quotient	
	Current Study	Current Study	Norms
Mean	0.342	-3.299	2.7
SD	5.48	10.235	9.0

The Ear Difference (or Laterality Quotient) score as the name suggests, gives us an idea of the discrepancy between performance on the two ears when considered singularly. The mean of approximately zero (0.342 in Table 4) for the entire group indicates that on average, recall in the Left and Right ear conditions are equivalent. However, while as a group, there appears to be little difference between Left and Right ear scores, individuals may have a difference between one ear and the other. Whatever ear differences do exist is averaged out when all the subjects are considered together.

In comparing the mean Binaural Quotient for this study with that of the Norms, significant differences were found to exist when the t-test was used, $\underline{t}(153) = -3.586$, $p < .01$.

Subjects with Binaural Deficits

As has been stated above, three of 103 subjects, or 2.91% of all the participants had Binaural Deficits (20% or more difference between monaural recall outputs) which warranted ear plug testing. The table below shows the raw scores of these subjects on the first administration of the entire ACT.

Table 5

Raw scores on ACT for subjects with Binaural Deficits (N=3).

	Recall	Scores		Intrusion	Scores		Ear	
Sample	Left	Right	Both	Left	Right	Both	Diff.	B.Q.
#1	112	94	90	2	3	2	-8.74	-24.4
#2	102	114	95	2			5.56	-20.0
#3	75	96	80	3	6	5	12.28	-20.0

Table 6 shows the means and standard deviations for the various ear conditions of these three subjects found to have Binaural Deficits.

Table 6

Means and Standard deviations for the various ear conditions of subjects with Binaural Deficits (N=3).

	Left	Right	Both
Mean	96.3	101.3	88.3
S.D	19.14	11.02	7.64

It must be noted here that three more individuals provided responses on the ACT that would indicate the existence of a significant Binaural Deficit (-20% or more).However, because there was no significant Ear Difference between monaural conditions, they were excluded from classification as having a Binaural Deficit. One individual was however re-tested, because although her performance on the first administration of the ACT showed her to have a Binaural Deficit, there was no large difference between her left and right ears (Left ear raw score=105; Both=81; Right= 106). When re-tested 21 days later, her general performance improved, as well as not indicating the existence of a Binaural Deficit (Re-test scores were: Left=125; Right=121; Both=118). The other two subjects were not available for re-testing, but their first and only ACT scores are: Subject #6, Left ear raw score=104; Right=101; Both=85. Subject #76's Left ear score=92; Right=93; and Both ears= 77.

The Z test of the difference between the mean binaural score of subjects with Binaural Deficits (shown in table 6 as 88.3) and the mean binaural score for all the subjects (shown in table 1 as 93.39) revealed no significant difference, z=-.547, p=.291.

The difference between the mean Right ear score for subjects with Binaural Deficits and the mean Right ear score for all the subjects in the study was not significant (z= .922, p=.179). Similarly, the difference between the mean Left ear score for subjects with Binaural Deficits and the mean Left ear score for all the subjects was not significant (z=.471, p=.319). Table 7 below shows the mean intrusion scores for the three subjects who had Binaural Deficits.

Table 7

Means and Standard Deviations for Intrusions on the various ear conditions of subjects with Binaural Deficits (N=3).

	Left	Right	Both
Mean	2.3	3.67	2.67
SD	0.58	2.08	2.08

The mean Left ear intrusion score for subjects with Binaural Deficits was found to be significantly lower than mean left ear intrusion score for all the subjects (*z*=-2.295, p=.011). However, mean Right ear intrusion score did not yield any significant differences when subjects with Binaural Deficits were compared with all the subjects (*z*=-1.150, p=.125). In comparing both ear intrusion scores for subjects with Binaural Deficits and the total sample, results showed a significantly lower binaural intrusion score among subjects with Binaural Deficits (*z*=-2.022, p=.022).

Table 8 shows the Mean Ear Difference and Binaural Quotient score for these three subjects:

Table 8

Means and Standard Deviations of Ear Difference and Binaural Quotient Score of subjects with Binaural Deficits (N=3).

	Ear Difference	Binaural Quotient
Mean	3.03	- 21.47
SD	10.74	2.54

When the mean scores shown here are compared to that of the sample group as a whole (see Table 4), one finds no significant difference between mean Ear difference score for subjects with Binaural Deficits as compared to the total sample ($\underline{z}$=.85, p=.198).

On the other hand, there was a highly significant difference ($\underline{z}$= -3.08, p=.001) between the mean Binaural Quotient score for subjects with Binaural Deficits as compared to the total sample.

WAIS-R Results.

The mean two-subtest short form IQ (SF2 IQ, as estimated from Silverstein, 1982) for the total sample was 114.6 (s.d.=14.45). Mean SFIQ for the three subjects with Binaural Deficits was 127.33 (s.d.=11.59).

The Pearson Correlation analysis was applied to find out the relationship between ACT scores and IQ of the subjects in the study. Green (1983) has found the ACT as a good predictor of intelligence among normals. A correlation of $\underline{r}(103)=.511$, $p<.01$. was found, indicating a significant linear relationship between performance on the ACT and intelligence as measured by the short form WAIS-R.

Further, the Pearson correlation analysis yielded a statistical relationship between mean ear score on the ACT and the vocabulary subtest of the WAIS-R ($r(103)=.47$, $p<.01$). A significant linear relationship can therefore be said to exist between these two variables.

Subsequent to the identification of these individuals with Binaural Deficits, attempts were made to get the latter back for re-testing on the ACT with ear plugs in an open field (no headphones). Only one subject agreed to be re-tested. The subject's "weaker" ear (identified by her performance in either monaural condition) was then occluded with a cottonwax ear plug for half of the test stories. On the other half, however, she was allowed to listen freely with both ears. Table 9 shows her scores for both conditions:

Table 9

Scores for subject #3 on Earplug testing and Short Form IQ on the WAIS-R.

	EARPLUG CONDITION		NOPLUG CONDITION		SF2 IQ
Subject	Recall	Intrusion	Recall	Intrusion	(WAIS-R)
#3	151	8	124	10	129

As can be seen from the above table, subject #3 showed a 27 point increase in number of target phrases recalled when her weaker ear was plugged. Her intrusion score also showed a concomitant reduction by two points when the ear plug was fitted. It must be borne in mind that the scores for each of the two conditions (plug and no plug) are calculated out of a total possible score of 240 points respectively. The intrusion scores are also obtained out of a total possible score of 15 for each of the two conditions.

Subject #3 showed a 21.78% improvement in performance on the ACT when the ear plug treatment was administered. This is in keeping with the minimum expected monaural advantage of 20% when the ACT was administered for the first time.

Interview Results

Only one of the three participants with binaural deficits agreed to be interviewed. The reason for the interview was to arrive at some understanding with regard to the subject's lifestyle, and how she has tried to cope with the "deficit" (see Appendix 4).

Subject #3 indicated that she has a very close familial relationship, with both parents still living together. This subject did not think that there was anything peculiarly different about her that makes it harder to understand what others say, compared to her close associates.

She reported that her academic performance is, and has always been above average, and she even won an academic bursary during the current school year.

She indicated a preference for doing private study in a quiet environment, although she could tolerate a low level of noise or music in the background. She also stated her preference for visual or audio-visual media rather than just the auditory medium of instruction in school, which the present author finds interesting albeit unverifiable. She preferred to read out aloud when studying her texts, because she felt it yields better results than reading silently. This she thinks is probably due to the fact that she finds herself easily distracted, and is convinced that she has a lower level of concentration ability as compared to others in her class.

This subject has many friends, hobbies, and a very healthy social life. She likes going to parties, esspecially small ones where her close friends and acquaintances are in attendance.

One regret that this subject has was that, she felt she worked too hard in High school, and if she had the chance to live her life all over again she would not have worked quite as hard. Her career goal is to be a teacher.

The Emotional Perception Test (EPT).

Green and Severson (1986) devised the Emotional Perception Test to measure the extent to which one can accurately discriminate emotions in another person's voice.

This test was administered to subject #3 in order to ascertain whether she had any peculiarities in the perception of emotion. Her total errors was 12 out of a possible 45 (26.67%), which puts her safely in the category of normal, non-impaired subjects with regard to the perception of emotion (cut-off for impairment is 19 or more errors).

A break down of the errors the subject made on the three parts of the test (5, 4, and 3 respectively) indicated a normal tendency to learn from her previous experience and to use it in improving her subsequent performance.

The EPT further enables us to analyse errors per emotion in order to find out whether subjects tend to make more errors in discriminating certain emotions rather than others. The current subject's scores followed the pattern noted by Green and Severson (1986) quite closely where normal subjects tend to find Happy emotions the hardest to discriminate, followed by Anger, Fright, Neutral, and then Sadness, in that order. For subject #3, Neutral emotions were the hardest to discriminate (5 errors) followed by Happy emotions (4 errors), Anger (3 errors), Fright (no error), and finally Sadness (no error).

With regard to response bias, which analyzes the frequency of an individual detecting each emotion irrespective of the actual tone or emotion expressed by the testor on the audio tape, one finds the subject reporting Sadness the most times (13), followed by Fright (11), and then Happiness, Anger, and Neutral emotions equally (7 each).

The Beck Depression Inventory

The single subject (#3) with Binaural Deficits who agreed to be tested on the BDI did not respond to the test in any way indicative of any depressive tendencies. (Her score was 5 out of 21). Her score on this inventory was therefore in the normal range.

MMPI Results

Subject #3 was once again the only individual tested on the MMPI. Her responses on this inventory yielded a valid profile.

She produced an extreme elevation on one Clinical scale (Scale 9, Hypomania), with a T of 98. High (normal) scorers on this scale tend to be outgoing, frank, sociable, and gregarious people who like to create good first impressions. They seem poised, at ease around others, not reserved or shy, but self-confident. They are also likely to show initiative and ingenuity, as well as being efficient and responsible; although not particularly characterised as conscientious. They tend to describe themselves as enterprising and sociable, and quite idealistic (Dahlstrom & Welsh, 1960). The rest of the other

Clinical scales were all in the expected normal range compared to the normative sample on which the MMPI was based.

DISCUSSION

This study has some value in expanding the normative sample base for the ACT. It also provides a basis for identifying the proportion of a sample of apparently well-adjusted normal individuals who have Binaural Deficits. An insight into some of the behaviours of those found to have Binaural Deficits through the use of interviews (and a battery of Psychological tests) would be of immense practical significance to the clinician in providing adequate and beneficial therapeutic interventions for such individuals.

This research was however limited to only right-handed first year university students, who are not the most accurate representation of the general population. Except for one woman who was 69 years old, most of the subjects were young adults (62.14% were less than 21 years old). Further, while it would have been desirable to have tested as many males as females, only a third of the total sample was male, and just one person out of the three individuals found to have Binaural Deficits was male.

The mean recall scores for all the subjects on the

ACT were found to be significantly different from those of the earlier sample (see Table 1). This could be due to the different backgrounds and composition of the samples used in the two studies (the present study used university students, and the earlier norm was based on staff of Alberta Hospital, Edmonton); and the effects of test anxiety and motivation levels on their performance. With regard to test anxiety, if the university student population in this current study was highly anxious, being a group of high achievers, such anxiety may have affected their scores by lowering it. Conversely, the original hospital staff may have been a high anxious group (because they knew the investigator, and were aware that their performance would be compared to that of their colleagues), and improved their performance. In other words, we do not know exactly what role anxiety plays in one's performance on the ACT. Additionally, the university sample, in spite of being found to have a relatively higher average IQ, may have been poorly motivated to perform at a potentially (and probably more usual) higher level. A more important factor lies in the extent to which the scoring criteria of the ACT can be said to be objective. This calls for a scoring manual that would indicate which synonyms of the target phrases are acceptable, and hence eliminate different scoring styles of other raters. For instance, if a subject were to say "vacationers" instead of "holidaymakers" on story 6 of Subtest C, s/he should be given credit for that response. If that individual were to call a baby carriage (story 15.2, Subtest C) a "perambulator"or a "pram", credit should likewise be awarded. If however a subject were to say the woman in story 25.3, Subtest E lit a candle instead of a cigarette, that would obvously not be correct.

No significant differences were found in mean recall scores on the ACT between males and females. Similarly, no significant differences were found between the sexes on mean intrusion scores. These results do not seem congruent with some of the studies conducted on cerebral asymetry, which find the existence of gender-related differences in cognitive functioning based on tasks that rely on certain sensory modalties and perceptual abilities (Bleir, Houston, & Byne, 1986; Breathnach, 1991). However, these differences could in all likelihood be due to the different testing methods employed in the various researches (see Green, 1985), thereby obscuring or even accentuating gender differences. Following from the results obtained from this study, and barring any subsequent evidence to the contrary, one may be safe in comparing individual scores to the norms obtained from this study equally to either sexes.

Ear Difference score analysis.

The need for more utilization of the Ear Difference scores cannot be overemphasized. It may be recalled that three subjects were found to have Binaural Deficits even though there was very little difference between their Left and Right ear recall performance. To the extent that the whole idea of Binaural Deficits and Ear plug intervention relies heavily on identifying (and subsequently occluding) an "inferior" ear in order to enhance auditory speech comprehension, care must be taken to ensure that foolproof methods of determining such Difference are in place. At this point in time, it may be expedient to advice (although 'a priori') that the larger the Ear Difference, the more comfortable one can be in assuming the existence of a Binaural Deficit. Clinicians may therefore consider an absolute difference between Left and Right ear recall score in excess of 10 points as indicators requiring further scrutiny. More research is however need to show how much Ear Difference Clinicians should use as a convenient cut-off for impairment.

Three out of the 103 subjects tested (2.91%) were found to have Binaural Deficits. Each of these three subjects had their best recall score on a monaural condition rather than the binaural condition on the initial administration of the ACT. Although these three subjects scored consistently poorly in the binaural condition, their performance was not found to be significantly different from that of the rest of the sample ($\underline{z}$=.922, p=.29). Curiously, however, in considering the binaural intrusion scores, a significantly lower mean binaural intrusion score was found for subjects with Binaural Deficits, in comparison to the rest of the sample ($\underline{z}$=-2.022, p=.022). A likely explanation for this could be that subjects with Binaural Deficits tended to be conservative in the volume of responses produced in the both ear condition, simply because they may have "missed" some portions of the stories altogether. This is consistent with the profile of a young child who had a binaural deficit in auditory comprehension, and was convinced that people spoke in incomplete sentences (Ogle, 1991).

Performance on the ACT in either monaural ear condition for subjects with Binaural Deficits was not found to be significantly different from the rest of the sample, nor was performance in the binaural condition. Only the mean Binaural Quotient score for subjects with Binaural Deficits was found to be significantly different from the mean Binaural Quotient score for all the subjects. This is indicative of the accuracy with which the Binaural Quotient criterion differentiates between those who do and those who do not have any such Binaural Deficits. However this accuracy is compromised by the experience of the three individuals mentioned above who had Binaural Quotient scores indicative of Binaural Deficits, but no significant Ear Difference. The attention of Clinicians who employ this test should be drawn to this possibility. One would therefore strongly urge that dignosis of any deficit be made only after careful scrutny of both Binaural Quotient and Ear Difference scores.

A noteworthy phenomenon is the higher mean IQ for subjects with Binaural Deficits (127.33) as compared to that for the overall sample (114.6). There is a strong possibility that only those individuals with Binaural Deficits who have been effective in their adjustment capabilities and who have higher intellectual ability are able to make it to university. Perhaps the very bright individuals succeed in findings ways to compensate for their deficit, for example by working extraordinarily hard throughout school, and by becoming very disciplined in their study habits. It would have been interesting and would have contributed to the current body of knowledge in a significant way, had a larger sample of university students with Binaural Deficits been studied in greater depth.

The significant relationship found to exist between the performance of all the subjects on the ACT and short form WAIS-R ($\underline{r}(103)=.511$, $p<.01$) supports Green's (1983) finding of the ACT as a good predictor of intelligence among normals. In addition, the statistical relationship found to exist between mean ear score on the ACT and the vocabulary subtest of the WAIS-R ($\underline{r}(103)=.47$, $p<.01$) was expected due to the importance of the vocabulary subtest as a very sensitive measure of verbal ability.

Ear plug intervention

Although just one individual out of the three who were found to have Binaural Deficits agreed to be tested on the earplug form of the ACT, the results obtained are still interesting. This particular individual (subject #3) showed a 27 point increase in the earplug (monaural) condition over the no plug condition, which is what approximates her everyday life encounters. Also, there were less intrusions in her earplug performance compared to the no plug performance (2 point difference). The 21.78% improvement in her performance on the ACT when the earplug was in place was found to be in conformity with the minimum expected monaural advantage of 20% when she was given the ACT for the first time. This improvement is of great significance in its ramifications. It could mean an even fuller life for such an individual with less ambiguities in interpersonal communications with a broad spectrum of people in various roles (whether at school, home or work).

The interview that was conducted with subject #3 convinced the present author that she has been able to adjust very well with some of the vagaries of the academic and social pressures of University life. Her academic activities could however be more efficiently managed and enjoyed better by her should she improve her listening comprehension as well as she did with the earplug administration of the ACT. This subject's remorse for working too hard in Secondary school may not have occured if the benefits of earplug intervention had been realised and made widely available just a few years ago.

With regard to her performance on the Emotional Perception Test, her ability to benefit from previous experience in improving her performance as the test progressed indicated a good capacity in this individual to assimilate material encountered in the recent past, and relate them to the present. However, the subject's difficulty in discriminating Neutral emotions more than what one would expect in comparison to the norms, may be explained as an inherent overexpectation for some positive or negative emotion in whatever is heard.

This, coupled with her response bias in reporting sadness the most times (regardless of whether it was right or wrong) implies some tendency towards seeing melancholy in the stimuli more than would be expected. These behavioural manifestations, coupled with subject #3's elevated score on scale 9 (Hypomania) of the MMPI must be carefully interpreted at this point in time, but she seems to be a person who, by and large, tends to fit the profile pertaining to individuals with elevations on the Hypomania scale. Nonetheless, any generalization from this individual to cover all individuals with Binaural Deficits would be completely premature.

CONCLUSIONS

The ACT is just one example of the utility that psychological testing in clinical neurology can have in helping us understand human behaviour, as well as to provide simple and potentially easily accessible therapeutic avenues for the amelioration of the likely consequences of suffering and pain that people with Binaural Deficits need not endure.

The two main objectives of the present study, which were to expand the normative base for the ACT and to attempt an understanding of some adjustment capabilities of individuals with Binaural Deficits have been discussed above.

The ACT has at least disputed the notion that everyone should be able to understand spoken language better with both ears instead of one. This is an important discovery, and points directly to a simple and dramatically helpful recommendation: the wearing of an ear plug in the inferior or "interfering" ear.

There is however the urgent need for a scoring and test intepretation manual for the ACT. This should improve the objectivity of test scoring and improve upon its validity.

The fact that Binaural Deficits can emerge even when there are no real differences between monaural conditions points to the need for caution in administering, scoring, and most importantly, interpreting the ACT. There is therefore the need for a more careful and in-depth evaluation of the Ear Difference scores of individuals who are given the ACT in order to enhance the validity of the latter in identifying people with true Binaural Deficits. Additional sources of information such as personal interviews with the individual in question (as well as close associates if possible), can be useful adjuncts in lowering possible misclassifications of individuals as having Binaural Deficits.

Nonetheless, the overall experience that the present author has had with the ACT is convincing in terms of the promise it holds for making life for some people a lot easier and satisfying, be it at home, in the classroom, or in the company of friends.

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APPENDICES

A.C.T. Scores:	Left	(Intrusions)	Right	(Intrusions)	Binaural	(Intrusions)	Plug	(Intrusions)	No Plug	(Intrusions)
Subtest A		( )		( )		( )		( )		( )
Subtest B		( )		( )		( )		( )		( )
Subtest C		( )		( )		( )		( )		( )
Subtest D		( )		( )		( )		( )		( )
Subtest E		( )		( )		( )		( )		( )
TOTAL		( )		( )		( )		( )		( )

SUBTEST A 22 Word Stories BEFORE TEST - CHECK HEADSET DIRECTION

10.1 L R B **Kitten**
The children O were watching O a policeman O climbing O up a tree. O He was rescuing O a white O kitten O that was sitting O on a branch. O

10.2 L R B **Channel**
A 12 year old O boy O from Washington O broke O a world record O on Saturday. O He swam across O the English Channel O in four O hours. O

10.3 L R B **Birthday**
Kathy's O father O gave her O a present O for her birthday. O She had expected O some chocolates O but in the box O there was O a dress. O

10.4 L R B **Arrest**
A 15 year old O girl O stole O some jewelry O from a department O store. O A detective O followed her O into the street O and arrested her. O

10.5 L R B **Zoo**
The children O spent an hour O looking at O animals O in the Zoo. O One gorilla O reached out O of his cage O and touched O the teacher. O

10.6 L R B **Charity**
Twenty-seven O Canadian O children O collected O over $1000.00 O for charity. O The money was sent O to a school O for the blind O and the handicapped. O

SUBTEST B 26 Word Stories

10.1 L R B **Christmas**
The presents O were opened O on Christmas day. O Peter O got a bicycle O from his father O and Annie O got a video game O from her great-uncle O in Scotland. O

10.2 L R B **Holiday**
John O and Mary O went on holiday O with their parents. O In the aeroplane O they sat O near a window O and looked down O at the ships O in the sea. O

10.3 L R B **Classroom**
Michael O was sitting O at the back O of the classroom. O When the teacher O turned around O and wrote O on the blackboard O he took a bite O from his sandwich. O

10.4 L R B **Dog Show**
Janet O entered O her terrier O in a dog show. O The first prize O went to a bull dog O with no tail O but Janet's dog O won O the second prize. O

10.5 L R B **Squirrel**
A squirrel O came down O from an oak tree O into the garden O and found O some peanuts. O Now the grey squirrel O comes back O every day O for more food. O

10.6 L R B **Circus**
Roger O went to the circus O with his mother O and his sister O on Sunday. O They saw a monkey O on a trapeze O and a dog O riding O a horse. O

SUBTEST C 33 Word Stories

15.1 L R B **Wolves**
Young O animals O play games O in order to practice O skills O which they will need O to survive. O Packs O of young wolves O sometimes capture O a deer, O but instead of O killing it O they allow it O to escape. O

15.2 L R B **Baby**
Jack O was going O to school O when he saw O a baby carriage O rolling O toward the road. O Dropping O his bag, O he ran O to save the baby O from rolling O into the path O of a speeding O truck. O

15.3 L R B **Puppies**
When Roy O came home O he found O a basket O full O of clothes O on the porch. O When he took it O into the house O he heard O a squeak. O Inside the clothes O there were two O black O puppies. O

15.4 L R B **Camping**
Carol O and Doug O were camping O near a river. O While they were cooking O their supper, O they heard O a splash. O A fisherman O had fallen O out of his boat. O Doug O waded out O and pulled him O ashore. O

15.5 L R B **Bears**
Car drivers O and motorcyclists O had stopped O on the roadside O in the park. O They were watching O a mother O bear O and three O cubs O which had come O from the forest O to eat O berries O in the ditch. O

15.6 L R B **Strike**
Many O holidaymakers O were disappointed O when they arrived O at the airport O this weekend. O Passengers O on flights O to Florida O and Spain O were told O that the air traffic O controllers O had gone on strike O for higher pay. O

SUBTEST D: 45 Word Stories

20.1 Fishermen

L R B

Three O fishermen O were stranded O when their engine O broke down O in the Atlantic. O Air Force O Helicopters O searched O for a week O but were unable to find them. O After 90 days, O two O survivors O were washed ashore O in their boat. O They had been living on O fish, O rain O and seawater. O

20.2 Kidnap

L R B

A month ago O a German O businessman, O who was staying O at an hotel O in Rome O was kidnapped. O This week O his wife O flew to O Italy O and announced O in a television O interview O that she would pay O the million dollar O ransom O if her husband O was returned to her O unharmed. O

20.3 Caffeine

L R B

The drug O caffeine O which is present O in coffee O can lead to O loss of sleep, O headaches O and depression. O These symptoms O can last O up to 2 days O after the last drink O of coffee. O Caffeine O is also found O in chocolate, O some cola drinks, O headache tablets O and frozen O puddings. O

20.4 Racquetball

L R B

Scientists O at the University of O Toronto O have been studying O hundreds O of eye O injuries O in racquetball players. O In 70 cases O the ball, O travelling O at 100 mph O had hit the eye directly, O causing damage O requiring a week O in hospital. O The players O had not been wearing O protective O glasses. O

20.5 Prime Minister

L R B

An Austrian O man O was arrested O when he was banging O on the Prime Minister's O door O with a rock O on Thursday. O He was protesting O about being unemployed O and homeless. O The judge O found him O guilty O of causing O a public O nuisance O and sentenced him O to one month O in prison. O

20.6 Pope

L R B

While escaping O from detectives O a guerilla O suspect O was hit O by a car. O He told O security O forces O that there was a plot O to kill O the Pope O on his tour O of El Salvador. O Then he handed over O the passports O of 18 O sharpshooters O who had entered O the country. O

SUBTEST E: 56 Word Stories

25.1 Hijack

L R B

The pilot O of a hijacked O Libyan O D.C.10 O airliner O was told O to fly O to Malta. O When the plane landed O in Paris O to refuel, O a blizzard O grounded the aircraft O for 24 hours. O Eleven O children O and one woman O were allowed to leave O the plane. O Minutes later, O the hijackers O surrendered O after a surprise O assault O by an anti-terrorist squad. O

25.2 Railway

L R B

A murder O suspect O drove a O stolen O red O convertible O at high speeds O after escaping O from police O on Saturday. O It sped toward a railway crossing O at the same time O as an express O train. O The engineer O braked O but the track O was icy. O The car O was thrown O across the road O and stopped O in the flower bed O of a children's O hospital. O

25.3 Fire

L R B

Many people O watched O the Fire Department O using ladders O for the rescue of O office O workers O from a burning O building O on McDonald Street. O As the fire chief O helped O an injured O man O into an ambulance O an explosion O threw him O to the ground. O A woman O who lit O a cigarette O near a damaged O gas pump O was accused O of starting the fire. O

25.4 Airbrakes

L R B

The co-pilot O of a medium-sized O plane O caught sight O of the airfield O when he noticed O that he was flying O too low. O He had to act quickly O to avoid O collision O with a skycraper. O He banked O right O sharply, O then circled O the airport. O Sighing O with relief, O he pulled O a lever O to lower O the wheels O and touched down O safely. O

25.5 Bank

L R B

Mary Robinson O of south O Calgary, O a bank O manager, O arrived first O on Friday O morning. O In the entrance O there were three O men O wearing masks O and carrying O shotguns. O They forced her O to open the safe O and then they tied O her hands. O At the rear exit O the police O stopped O the bank robbers O while questioning O the driver O of the getaway car. O

25.6 Storm

L R B

Expecting O the sunny O weather O to last all day, O a group O of inexperienced O climbers O proceeded O to the top O of the mountain. O Though they sheltered O behind a wall, O they were cold O and frightened O when a storm O arose. O For two O hours O they suffered O wind O and rain O and they came very close O to being struck O by lightning O near the peak. O

AUDITORY COMPREHENSION TESTS LTD.

GREEN AND KRAMAR 1983 ©

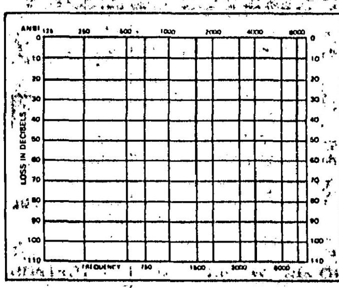
Date ____________ No. ____________

Name ____________

Age ______ Sex ______ Birth Date ______

Address ____________

Phone ____________



Physician's Diagnosis: ____________

R — L [ ] $\frac{R - L}{R + L} \times 100\%$ [ ]

B — HS [ ] $\frac{B - HS}{B} \times 100\%$ [ ]

APPENDIX 2

CONSENT FORM

MY SIGNATURE ON THIS FORM INDICATES THAT I WILL PARTICIPATE IN A STUDY BY ANTHONY DUGBARTEY ON ESTABLISHING NORMS FOR THE AUDITORY COMPREHENSION TEST, AND INDICATES THAT I UNDERSTAND THE FOLLOWING:

. I AM A VOLUNTEER AND CAN WITHDRAW AT ANY TIME FROM THE STUDY.

2. I HAVE RECEIVED EXPLANATIONS ABOUT THE NATURE OF THE STUDY, ITS PURPOSES, AND PROCEDURES.

3. THERE IS NO RISK OR PSYCHOLOGICAL HARM ANTICIPATED IN THIS STUDY.

4. THE DATA I PROVIDE WILL BE CONFIDENTIAL

5. I WILL RECEIVE A SUMMARY OF THE PROJECT, UPON REQUEST, FOLLOWING THE COMPLETION OF THE PROJECT.

------------------------ --------------

SIGNATURE OF PARTICIPANT DATE

APPENDIX 3

INTERVIEW GUIDE FOR SCREENING SUITABLE PARTICIPANTS

NAME ______________________________

. AGE __________ DATE OF BIRTH________________

2. SEX ___________

3. ARE YOU: RIGHT HANDED _______ (CHECK WHICH APPLIES

LEFT HANDED______ TO YOU).

AMBIDEXTROUS __________

4. SELF-REPORT ON HEARING LOSS: Have you been treated by an audiologist for any hearing difficulties?

YES _____

NO _____

APPENDIX 4.

IN-DEPTH INTERVIEW GUIDE FOR SUBJECTS WITH BINAURAL DEFICITS.

A. ACADEMIC PERFORMANCE.

. Can you tell me about some significant experiences you have had in school? . ...

2. Which environment do you find conducive when doing private study?

3. Which teaching method do you prefer most? (eg audio; audio-visual; etc)

B. DOMESTIC SITUATION

. How would you describe your family?

2. How is your relationship with them?

C. PEER RELATIONS

. Do they have a lot of friends?

2. How much do you value your friendship with them?..

3. How often do you initiate friendships with strangers?

3b. Why?..

OTHER ASPECTS OF SOCIAL LIFE

. Do you have any hobbies? .

1b. Please specify .

2. Do you enjoy going to parties?

2b. Which kinds of parties do you enjoy most? (Probe to find if they enjoy big, small, quiet, or noisy parties)

.. ..

3. What do you see yourself doing 10 years from now?

....

3b. Any other ambitions?

4. Which sporting/recreational activities (in addition to your hobbies) do you enjoy:

'. Watching .

ii. Participating in

5. How would you describe your sense of humour?

6. How do you feel when people make fun of you?

7. Why?.........................

8. If you had the chance to live your life all over again, how different would you like to be?

....

9. Briefly, how would you generally describe yourself?

THANK YOU VERY MUCH.

APPENDIX 5 (COVER LETTER)

Dear Participant:

I am interested in establishing norms for the Auditory Comprehension Test. This test is effective in differentiating between individuals who understand speech better with only one ear and those who understand speech better with both ears.

In order to assess your auditory comprehension abilities, you will be required to listen to a series of short stories through a pair of headphones, and to recall as best you can, all you heard of each story. You might be re-contacted for a short interview and debriefing session at a later date depending on your performance on the test.

The assessment also involves your answering some general intelligence questions.

The whole procedure will take about 40 minutes and will be held at the Department of Psychology's interview room. All information gathered will remain confidential. However, your test scores will be made available to you upon request.

Thank you for your co-operation.

Yours respectfully,
Anthony T. Dugbartey.

APPENDIX 6

LIST OF SHORT FORM IQ SCORES (N=103).

135	111	119	95	129
115*	108	129	125	129
77	94	132	119	115
98	81	138	107	119
129	123	110	91	115
102	118	122	109	115
113	101	132	101	111
116	112	125	101	125
94	109	142	109	129*
88	109	125	105	115
84	139	108	115	135
101	114	91	145	130
100	101	125	115	110
150	128	123	129	119
106	112	102	112	115
138	135	104	85	117
88	122	106	117	115
111	112	125	125	114
108	135	120*	101	109
110	129	102	115	
123	115	115	132	

Note:'*' indicates subjects with Binaural Deficits.