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Title

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Permalink

Journal

ISSN

Authors

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Publication Date

DOI

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Peer reviewed

Computerized Neuropsychiatric Assessment of Geriatric Subjects by Content Analysis of Brief Samples of Their Speech

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The life expectancy of people living in the United States is increasing. Are very elderly individuals compromised mentally and physically in comparison to much younger persons? The purpose of this study was to test the efficacy of a computerized program applicable to the content analysis of 5-minute speech samples obtained from a group of individuals 90 years of age and older and to compare the results with those previously obtained in younger people with respect to their mental capacities in terms of a set of diverse neuropsychiatric dimensions. After obtaining informed consent from 26 elderly people, recorded verbal samples were elicited from each individual in response to purposely ambiguous instructions to talk for 5 minutes about any interesting or dramatic personal life experiences. The transcripts of their speech samples were digitized on a computer diskette and processed on the computer program. The computer program compared the scores obtained on each verbal sample with norms obtained on 15 previously validated content-analysis scales from individuals ranging in age from 5 to 80. The norms on these content-analysis scales are different for children (aged 5–10) and adults (aged 11–80). The computerized content-analysis scores obtained from this elderly cohort reveal plausible deviations from the norms for younger people.

K E Y W O R D S

Computerized content analysis of speech •
Very elderly geriatric cohort

BACKGROUND

The extremely elderly are the fastest growing segment of our population. By 2020, more than 3 million Americans will be 90 years of age or older, doubling the current number of people in that age range (Figure 1). Because little is known about those who achieve this milestone, the remarkable increase in the number of the oldest old presents a public health challenge in promoting the quality of life as well as the quantity of such persons. As we approach this challenge, many important questions about our oldest citizens need to be answered.

An opportunity to assess the neuropsychiatric status, including the quality of life, of a cohort of elderly subjects, 90 years of age and older, presented itself through an ongoing National Institute on Aging–supported study awarded to one of us, namely, Professor Claudia Kawas, MD.

An extension and modification of this study involved using a computerized program capable of easily and rapidly measuring, from small samples of speech
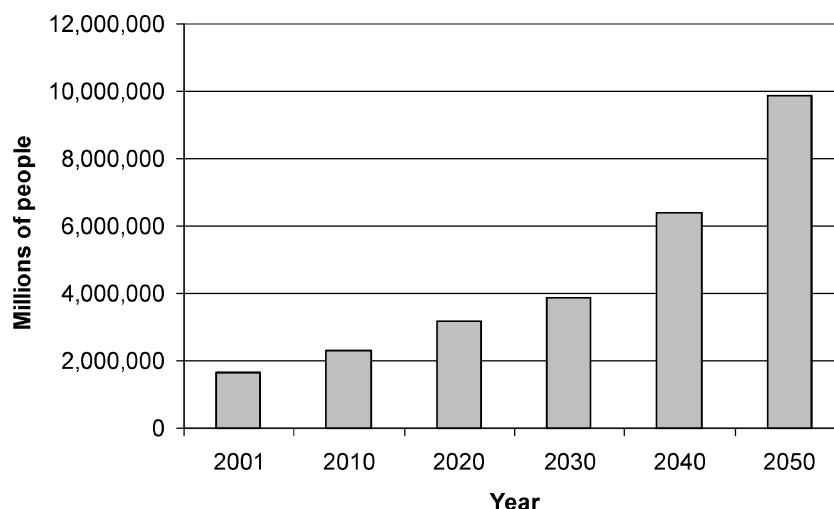
FIGURE 1. US projected population growth among those older than 90 years of age. From Population Projections Program.[1]

METHODS

obtained from these individuals, their current mental status in terms of the magnitude of a large set of neuropsychiatric dimensions.

These neuropsychiatric dimensions were measured by a computerized content-analysis method that used scales designed by Gottschalk and coworkers. The scales include Total Anxiety (and six subscales), Hostility Outward (Overt and Covert), Hostility Inward, Ambivalent Hostility (hostility perceived as originating from outside oneself), Social Alienation–Personal Disorganization, Cognitive Impairment, Total Depression (and seven subscales), Achievement Strivings, Hope, Human Relations, Dependency and Dependency Frustration, Health/Sickness, and Quality of Life.[2–6]

Norms for these content-analysis scales have been derived through years of extensive research and data collection,[2–6] and are based on scores of medically and psychiatrically healthy individuals aged 18–80. Norms were obtained for each content-analysis scale at different occasions when reliability and construct validity studies were being carried out for that content-analysis scale. Data involving normative scores for the Human Relations Scale were initially reported[7] in 1968, for the Hope Scale[8] in 1974, for the Social Alienation–Personal Disorganization Scale[9] in 1961, and for the Depression Scale[10] in 1986. These norms were further described and established with subsequent studies.[2,6] To summarize these studies, the norms (in terms of mean scores and standard deviations) for each scale were obtained from the verbal content-analysis score of well over 100 normal individuals for each content-analysis scale. These subjects had no medical or psychiatric disorder, were balanced

for sex distribution, ranged in age from 18 to 80 for adults and from 4 to 17 for children, and they were well distributed in educational level from some grade school to graduate or professional school. Initially, norms were derived from Caucasian subjects[2,6] and later from African American[6,11] and Hispanic[12] subjects. No significant differences have been found in the normative scores with respect to race and ethnicity,[11,12] nationality[11,13,14] (specifically, German, Chilean, and Australian), and educational level or gender. However, the Cognitive Impairment scores derived from verbal samples are influenced by educational level and age. That is, normal children between the ages of 4 and 8 as compared to older children or adults have higher average cognitive impairment scores[15] than children 9 to 17.

Norms for the Health-Sickness Scale were first published by Gottschalk and Gleser,[2,3] and these initial studies were amplified later by further data.[6] These norms were also obtained from content-analysis scores obtained from more than 100 medically and psychiatrically healthy adults.

A computerized version of the content-analysis methodology[16–21] has been useful in providing neuropsychiatric diagnostic evaluations and in serving as a guideline for therapeutic intervention,[22–24] and was used in this study.

The computer software operates on a PC-class computer using Microsoft Windows. The software system relies on a very large dictionary (>300,000 words) containing part-of-speech information and a large collection of (mostly American) English idiomatic and slang expressions. Some of the words and all of the idioms are identified as possible indicators of semantic content pertinent to one or more of the content-analysis scales. Syntactic information about the words in the input, such as part of speech and number (ie, singular or plural), is extracted from the dictionary and used by a

software parser, which outputs an analysis of the structure of each input clause. When a word or phrase from the dictionary is noted as a possible marker of an item from a content-analysis scale, it is added to a listing of scoring candidates. This list of candidates is then examined by a set of scale-dependent procedures that consider the clause structure as well as the score marking to decide the validity of each candidate's scoring. Candidate scores approved by the process are emitted as content-analysis scores applicable to the input clause.

The dictionary is predefined for any specific content-analysis scoring session. But it can be changed or terms added through the use of a set of interactive dictionary manipulation tools.

The software system generates four distinct classes of output, the last three of which are optional. The first and most basic output is an interlinear listing of each grammatical clause and the scores assigned to it. This is printed out as clause per line, with each clause followed by a line of scores (one or more per scale, but more lines may be used if the clause or score tokens are lengthy).

The second class of outputs is a scoring summary for each scale being used. The summary gives tallies of the number of occurrences of the various scores/codes and a word count of the total verbal sample. It derives a single number from the score/code that is used to characterize the verbal sample on each scale. The summaries indicate to what extent the verbal sample scores deviate from the norms that have been already obtained for each scale, in terms of standard deviations.

The third class of outputs is an analysis or interpretation, in textual forms, of the scale scores. It is directed to the clinician's making diagnostic use of the scoring output, and it suggests areas for further examination and areas in which significant deviation from the norms have been found.

The fourth class of outputs suggests possible neuropsychiatric diagnoses that the user might consider in evaluation of the subject. The suggested diagnoses are taken from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*).[25]

The current study was a preliminary one to assess the mental status of these elderly people by means of computerized content-analysis of a cohort of 26 of these randomly selected elderly individuals, aged 90 or more, who voluntarily gave informed consent to participate. The focus of interest was the extent of deviation of scores on these content-analysis scales from the established norms for younger adults.

Setting

The sites for these geriatric studies were (1) the Center for Aging Research and Education Clinic in Laguna Woods, CA, and (2) the homes of the subjects. Approximately 50% of the speech samples were obtained at the Clinic in Laguna Woods, CA, and 50% were obtained in the homes of the subjects.

Subjects

The subjects were invited to participate voluntarily in this study of speech patterns, and they were informed regarding its goals and methods, with the assurance that their verbal samples would be kept confidential. The subjects were randomly selected; that is, no discrimination was made with respect to gender, racial status, educational level, ethnicity, or setting of interviews in selecting the participants. The subjects ($N = 26$) ranged in age from 90 to 100. Twice as many females ($n = 17$) as males ($n = 9$) participated in this study. All subjects were English-speaking, and none were excluded on the basis of medical illnesses or previous diagnoses of mental disorders.

Procedure

The subjects were requested to give a 5-minute verbal sample in response to the following standard, purposely ambiguous instructions: "This is a procedure to study speaking and conversational habits. I have here a recorder and a video camera to record your speech. I would like you to talk for 5 minutes about any interesting or dramatic personal life experiences you have ever had. If you finish talking about one experience, you can continue to talk about another experience until the 5 minutes are over. I will tell you when to start and stop. While you are talking, I would prefer not to answer any questions until the 5 minutes have passed. However, I will certainly answer any questions you may have before we start. Do you have any questions now? Are you ready to begin?"

The 5-minute verbal sample was recorded on both a cassette recorder and a digital camcorder. The audible recordings were transcribed and saved as a text document using Microsoft Word 2002. A single investigator (Ann Hoang) carried out all interviews, recordings, and transcriptions.

A computer software program, the Psychiatric Content Analysis and Diagnosis 2000 (PCAD 2000),[16] was employed to analyze the content of transcribed speech samples. The program measures emotional and neuropsychiatric states and traits, including hostility, hope, depression, and cognitive impairment through analysis of grammatical clauses in the speech samples. Possible diagnoses generated by the software are drawn from the *DSM-IV*.[25]

RESULTS

The computerized program automatically compares the content-analysis–scale scores obtained from each subject's verbal sample with the norm for each content-analysis scale in terms of (1) no difference from the norm, (2) mild difference (one standard deviation) from the norm, (3) moderate difference (two standard deviations) from the norm, and (4) serious difference (three standard deviations) from the norm. Table 1 summarizes our findings.

DISCUSSION

For a randomly selected sample of 26 quite elderly people, it is somewhat surprising that 18 had quality-of-life scores within normal limits, that is, from the perspective of the norms for these content-analysis scales, which are derived from physically and mentally healthy, much younger people (ranging in age from 11 to 80). It was not unexpected that a sizable portion ($n = 15$) had complaints and preoccupations with sickness and the state of their health, and that 12 of them were anxious about death and had fears about physical injuries (mutilation anxiety) ($n = 3$) and separation ($n = 3$). On the other hand, why eight of them had elevated guilt anxiety scores was not self-evident.

It is noteworthy that nine of the 26 subjects show evidence of various degrees of cognitive impairment on the basis of this measure. The incidence of dementias with aging secondary to Alzheimer's and similar diseases, cerebral vascular disorders, physical injuries, and Parkinsonism accounts for some of this evidence of cognitive impairment. The way the detection of cognitive impairment derived from this computerized verbal-behavior content-analysis measure compares to findings obtained from other neuropsychological measures used in this research needs further scrutiny.

Only one subject had an elevated total depression score. This is a low number for a random sample of aged individuals of this sort. Some of these subjects were being administered psychoactive drugs, including antidepressant and antianxiety agents, which most likely influenced these findings. And the finding that 12 of the subjects had significantly decreased human relations scores indicates that the life situations and/or the social circumstances and settings in which these subjects were living, in addition to aging and sickness, possibly contributed to these phenomena.

To obtain accurate norms on our content-analysis scales for people of age 90 and more, a subgroup of such individuals who are evaluated as medically and mentally healthy needs to be selected for further study rather than a sampling of these very elderly subjects regardless of whether or not they have a diagnosable medical or mental illness.

In any event, the ease of administration, speed of assessment, and the utility of this computerized verbal

Table 1

Number of Subjects With Elevated Scores

Scale	Normal	Mildly Elevated	Moderately Elevated	Seriously Elevated
Total anxiety	25	1	0	0
Death anxiety	14	6	6	0
Mutilation anxiety	23	3	0	0
Separation anxiety	23	3	0	0
Guilt anxiety	18	8	0	0
Shame anxiety	23	3	0	0
Diffuse anxiety	25	1	0	0
Total hostility outward	26	0	0	0
Hostility inward	17	9	0	0
Ambivalent hostility	26	0	0	0
Social alienation–personal disorganization	22	2	2	0
Cognitive impairment	17	4	0	5
Hope	24	2	0	0
Depression	25	1	0	0
Health/sickness	11	4	0	11
Human relations*	14	10	2	0
Quality of life*	19[†]	5	1	1

*Human relations and quality of life are measured below the norm, rather than above.
[†]One subject exhibited a Quality of Life score moderately elevated above the normal range.

content-analysis measure used with these elderly subjects is illustrated by our findings.

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