

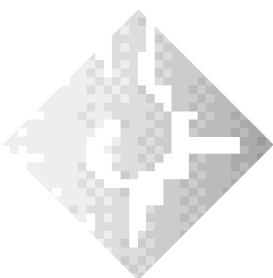
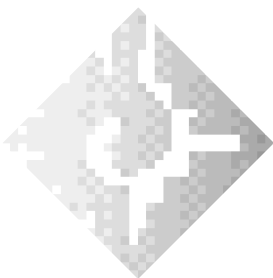
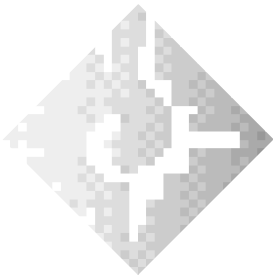
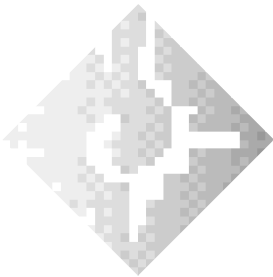
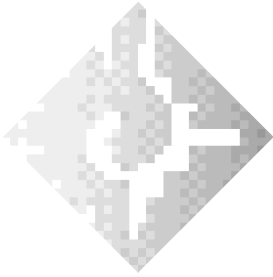
# JSRI

**Occasional Paper No. 39**  
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## **Bilingual Computer-Assisted Psychological Assessment: An Innovative Approach for Screening Depression in Chicanos/Latinos**

by *Gerardo M. González*  
*California State University, San Marcos*

**Occasional Paper No. 39**  
*February 1999*



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**Abstract:** Literature suggests that clinical depression is a major public health problem. Latinos are significantly at high risk for depression and in need of culturally-responsive mental health services. Conventional self-report depression assessment methods display limited predictive power. Fortunately, computer-assisted assessment methods offer alternatives to overcome the psychometric and cultural limitations of self-report measures. Most importantly, computerized speech recognition promises to enhance the early and accurate detection of depressed mood and symptoms. The author developed, tested, and evaluated several bilingual computerized speech recognition (voice-interactive) depression screening programs that verbally interviewed English and Spanish speakers using the Center for Epidemiological Studies - Depression scale (CES-D). The bilingual computer programs were evaluated for psychometric properties and the relationship of depression levels to demographics, acculturation, and speech behavior. The studies provided evidence that the bilingual voice-interactive speech recognition applications were generally feasible to administer, reliable, valid, and equivalent (means and variabilities) to standard interview (face-to-face and paper-and-pencil) methods. The English and Spanish-speaking samples positively rated the automated interviews. The findings suggested that the applications were culturally and linguistically viable tools for screening depression. The potential of the analysis of speech behavior and voice characteristics for accurately detecting depression among Chicanos/Latinos is discussed.

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# Bilingual Computer-Assisted Psychological Assessment: An Innovative Approach for Screening Depression in Chicanos/Latinos

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- *Transmission of research findings to academic institutions, government officials, community leaders, and private sector executives through publications, public policy seminars, workshops, and consultations.*
- *Provision of technical expertise and support to Latino communities in an effort to develop policy responses to local problems.*
- *Development of Latino faculty, including support for the development of curriculum and scholarship for Chicano/Latino Studies.*

# Bilingual Computer-Assisted Psychological Assessment: An Innovative Approach for Screening Depression in Chicanos/Latinos

Clinical depression poses a major public health concern in the United States. According to the Diagnostic and Statistical Manual-IV, major depression is a mood disorder displaying persistent sad/anxious moods or loss of pleasure/interest in usual activities. Symptoms include problems sleeping, significant change in eating habits or weight, fatigue or loss of energy, psychomotor change (agitation or retardation), difficulty with thinking or making decisions, feelings of worthlessness, or recurrent thoughts of death (American Psychiatric Association, 1994). Depressive disorders afflict 6-7% of the general population (Robins et al., 1985; Smith and Weissmann, 1992). Twenty-five percent of women and 11% of men experience depression in their lifetime (Kendler, et al., 1993).

Depression severely reduces quality of life. A Medical Outcomes Study found that depressed persons experienced worse social functioning, lower physical functioning, and more frequent hospitalization than patients with other major chronic medical problems, such as diabetes, hypertension, and arthritis (Wells et al., 1989). The multi-site World Health Organization (W.H.O.) study on the effects of depression on social functioning discovered that after 10 years, one-fourth of depressed patients showed poor functioning and about 40% exhibited moderate impairment (Thorncroft and Sartorius, 1993). Depression has been implicated in 40 to 60% of suicide attempts (Clark and Fawcett, 1992) and two-thirds of completed suicides (Strickland, 1992). The NIMH Collaborative Health Program on the Psychobiology of Depression revealed that in the course of five years, depressed persons had lower educational achievement, income levels, and occupational status, as well as fewer periods of employment than non-depressed persons matched for age and gender (Coryell et al., 1990). Direct and indirect annual cost estimates of clinical depression, based on diminished occupational productivity and related treatment expenses, increased from \$16 billion to \$43 billion during the last decade (Stoudemire et al., 1987; Greenberg et al., 1993). Clearly, the health, social, and economic consequences of clinical depression are very serious.

Persons not meeting the criteria for clinical depression (i.e. subclinical), but displaying elevated depression symptom levels are at risk for poor health and mental health. Between 10 to 26% of the general population report significant depressive symptoms at any one time (Boyd and Weissman, 1982; Roberts, 1987). High subclinical depressive symptoms predicted the future onset of psychiatric disorders and eventual psychiatric hospitalization (Zonderman et al., 1993). Horwath et al. (1992) found that 50% of new depression cases were associated with subclinical symptoms. Moreover, subclinical cases were 4.4 times more likely to develop major depression than those without symptoms. Johnson et al. (1992) indicated that persons with mild depression symptoms showed higher rates of negative medical outcomes including poor physical health and higher use of emergency services. Recently, a Medical Outcomes Study revealed that mild subclinical cases reported more impaired functioning than non-depressed medical patients (Hays et al., 1995). Subclinical and high-risk cases *need* early detection and intervention to reduce the severity of depressive symptoms, thereby decreasing the chances for an occurrence of clinical depression.

## Depression in Latinos

Latinos in the U.S. constitute a large and growing population that is significantly at risk for depression. Latinos are approximately 9% of the national population and are expected to comprise 12% by the year 2003 (U.S. Census, 1996). A substantial segment of U.S. Latinos are Spanish-speaking as well. Community studies found that 47-83% of Latinos preferred interviews in Spanish (Burnam et al., 1987; Lang et al., 1982; Marín, Pérez-Stable et al., 1989). Research suggests that Latinos are at higher risk for depression than non-Hispanics. Kessler et al. (1994) found that Latinos displayed an 8.1% prevalence rate for current affective disorders. The high rate of depression among Latinos, especially females, may be related to problematic acculturative, social support, and socioeconomic factors (Blazer et al., 1994). For example, recently arrived Latino immigrants may experience high stress from the lack of resources, isolation, and

limited English proficiency (Rogler et al., 1991). Low income is related to increased risk for depression because of severe financial pressures and stressors (Bruce et al., 1991). Latinos are substantially impacted because they make up 25% of families in poverty (U.S. Census, 1996). Thus, affordable Spanish language mental health services would help decrease the risk for depression among Latinos.

However, Spanish-speaking populations face numerous barriers to mental health services. Latinos reportedly underutilize mental health services because of cultural, financial, and service delivery issues (Wells et al., 1987; Woodward et al., 1992). An Epidemiological Catchment Area (ECA) study indicated that only 11% of Mexican Americans (compared to 22% of non-Hispanic Whites), who met the criteria for clinical depression, sought a mental health care provider for treatment (Hough et al., 1987). Access to services for Spanish-speaking respondents is also impeded by linguistic incompatibility, cultural miscommunications, and patient suspicions of exploitation (Marín and Marín, 1991). Fortunately, Rogler (1989) found that culturally and linguistically-relevant mental health services increased the utilization and effectiveness of treatment for Latinos. Among Mexican American patients whose primary language was not English, ethnic match with therapists was related to greater treatment participation and positive outcome (Sue et al., 1991). Unfortunately, Latinos generally lack accessibility to culturally-responsive and linguistically-compatible mental health services (González, 1997; Organista, Muñoz, and González, 1994).

For instance, over 350,000 Latinos in the mainland U.S. are estimated to be clinically depressed and about 200,000 need Spanish-speaking mental health services in any 6-month period. The estimated 500 to 600 Spanish-speaking therapists in the U.S. represent an insufficient number to feasibly meet the present mental health needs of U.S. monolingual Spanish-speaking populations (Muñoz and Ying, 1993). Obviously, more appropriately trained culturally-sensitive bilingual mental health professionals are needed. Yet the growing disparity between the Latino population (estimated to increase over 50% between 1990 and 2000) and Latino clinical psychol-

ogy doctoral students in the training pipeline (static levels since 1980), makes it unlikely that ample Spanish-speaking professionals will be available to provide necessary services (Bernal and Castro, 1994). An alternative strategy for delivering culturally-responsive mental health services for the detection and treatment of depression in Spanish-speaking communities is imperative.

## The Underdetection of Depression

Depression remains largely undetected and untreated in the general population. The inadequacies of current screening methods contribute to the underdetection. Most depression screening scales use a metric system that quantifies and interprets self-report responses along a continuum of symptom severity (Muñoz, 1993). However, many persons who are reportedly “symptomatic” are not depressed at all. Self-report assessment is limited by respondent biases, such as memory distortions, inhibitions, and reactivity (Plutchik, 1994). Self-report depression screening instruments demonstrate moderate predictive value resulting in poor discrimination between depression, general distress, and other psychiatric disorders (Santor et al., 1995), and display limited psychometric specificity, yielding 25-40% false positive depression cases (Coulehan et al., 1989; Fechner-Bates et al., 1994). Depression is also severely underidentified due to the fact that only 20-25% of clinically depressed persons actually see a mental health professional. People with depression most often visit non-psychiatric medical care providers for relief of their depressive symptoms (Shapiro et al., 1984). Many depressed individuals are seen at primary care settings, where up to 30% of the patients may be clinically depressed (Broadhead et al., 1989). Primary health care settings, however, suffer from the deficiencies of screening methods, high patient volume, insufficient bilingual mental health staff, and enormous time constraints that hinder the adequate assessment of depression. Pérez-Stable et al. (1990) found that depression was accurately detected in only 36% of primary care medical patients. Thus, the shortcomings of depression screening practices contribute to insufficient evaluations and inappropriate treatment resulting in unnecessary health care costs.



## Technology as an Alternative

Computers serve as useful tools to facilitate and enhance mental health services through computer-assisted psychological assessment and test interpretation (Fowler, 1985). Computer-assisted psychological assessment represents several major advantages in the structure, flexibility, and ease of test administration (Kobak, 1996). Structured computerized interviewing improves the quality, quantity, and integrity of clinical data by accurately transcribing, scoring and storing patient responses, standardizing administration procedures, and minimizing errors attributable to human oversight (Erdman, 1985). For example, a clinician may inadvertently omit up to 35% of clinically meaningful inquiries during an open-ended face-to-face interview (Climent et al., 1975; Simmons and Miller, 1971). Also, computer-assisted assessment produces cost savings through more efficient use of clinician time to conduct assessment batteries and treatment (Butcher, 1987). Thus, computerized screening can reduce the costs associated with misdiagnosis and inappropriate treatment through early identification of high symptom subclinical cases and by facilitating low intensity prevention interventions that make more effective use of clinicians.

The literature reflects abundant evidence to support the viability of computer-assisted depression assessment. In consumer acceptability, client users reported positive ratings and evaluations of computer-assisted assessment techniques (Lukin et al., 1985; Rozensky et al., 1986). Many depressed patients preferred computer interactive interviews over face-to-face interviews, even when patients knew the clinician (Lucas et al., 1977; Carr et al., 1983). One explanation is that computer-assisted interviewing may increase respondent self-disclosure because of discomfort with revealing sensitive issues (e.g. suicidal ideation) to a clinician (Moore et al., 1984). Past research also suggested that computer-assisted assessment methods displayed strong psychometric properties for personality assessment (Honaker et al., 1988; Wilson et al., 1985), psychiatric histories (Johnson and Williams, 1980), mental status examinations (Donnelly et al., 1970; Slack, 1971), behavioral assessment (Angle et al., 1977), and psychiatric diagnosis (Helzer et al., 1981). Computer-assisted depression assessment methods demonstrated high reliability and validity in clinical and nonclinical populations (Greist and Klein, 1980; Kobak et al., 1990; Steer, et al., 1994).

Recent advances in computerized technology afford alternative screening methods for individuals not reliably assessed with standard English language based techniques, such as the disabled (Noyes et al., 1989), persons who cannot read nor write, or non-English speakers (Starkweather and Muñoz, 1989). These populations are less likely to utilize mental services because of paper-and-pencil assessment or language barriers. A promising state-of-the-art technology for presenting an automated structured clinical interview is computerized speech recognition (Bloom et al., 1978). A computerized speech recognition system verbally administers a discrete choice questionnaire by presenting pre-recorded prompts, recognizing spoken responses, scoring the responses, and storing the data. The advantages of speech recognition technology include hands-free interaction, realistic voice presentation, and availability in multiple languages. Among the disadvantages of computerized speech recognition are less than perfect recognition accuracy, depersonalization, loss of observational data, and the possibility of respondent experiencing computer anxiety. In busy health care settings, speech recognition technology offers avenues to increase accessibility to mental health services by conducting brief clinical interviews and generating interpretative reports to inform health care staff. Thus, innovative technology can reduce obstacles that contribute to the underidentification of depression.

## Research Aims

The research objectives are to improve accuracy in both detecting depression and enhancing the early screening of depression symptoms, to increase access to mental health services that promote the prevention of depression, to generate alternative assessment methods such as cross-cultural and multilingual applications, and to employ technology as a tool, not as a substitute for mental health professionals. Among the research aims of this line of programmatic research are:

- (a) To develop and test bilingual speech responsive screening tools to accurately identify high depression symptom cases.
- (b) To increase the accessibility of mental health services for individuals not likely to be evaluated for depression.

- (c) To extend the capabilities of mental health professionals by evaluating and treating more persons who would otherwise continue to suffer debilitating depressive disorders.

## Research Hypotheses

Among the research questions to be addressed by the research are:

- (a) Is automated voice-interactive screening feasible to administer?
- (b) Is automated voice-interactive screening acceptable for the Chicano/Latino population?
- (c) Is automated voice-interactive screening a reliable and valid tool for detecting high depression symptom cases?
- (d) Is automated voice-interactive screening equivalent to face-to-face screening?
- (e) Is speech behavior related to depression symptoms levels?

The data analyses included examining the feasibility of administration of computerized screening, acceptability ratings and preferences for interview method, the reliability (consistency) of responses, the equivalence of methods (means and standard deviations), the correlation of independent depression scales to the automated voice-interactive depression screener, and the relationship of depression levels to demographics, acculturation, and speech behavior.

## Preliminary Studies

Based on the potential of computer technology and the imminent need for alternative assessment methods in Chicano/Latino communities, the author and colleagues developed several bilingual computerized speech recognition prototypes for screening clinical depression. Essentially, the prototypes administered a depression questionnaire by presenting prompts, recognizing the individuals verbal responses, and scoring the results. The following pilot studies summarize the findings on the feasibility and psychometric characteristics of the computer-

ized speech recognition prototypes for screening depression in English and Spanish-speaking samples.

The author and colleagues at the University of California, San Francisco (UCSF) developed and evaluated a bilingual speaker-dependent speech recognition prototype to screen depression symptoms in English and Spanish-speaking adults. The speaker-dependent speech recognition system required each participant to complete template training. That is, each respondent had to train the computer to recognize his or her voice patterns for each possible choice of the questionnaire. A counterbalanced experimental design randomly ordered both paper-and-pencil and computerized forms of the Center for Epidemiological Depression scale (CES-D). The CES-D is a 20-item, self-report screening measure for assessing the frequency of depressive mood and symptoms during the past week (Radloff, 1977). The participants were public sector primary care patients referred to a depression clinic. Nineteen English-speaking and 19 Spanish-speaking patients completed the CES-D in an immediate test-retest sequence during a single session. The study found that the means and variabilities of the two CES-D methods were not significantly different for both language groups. Strong psychometric properties were evident for both methods. In both groups, ranked-order correlations between methods and coefficient alpha reliability estimates for the methods were all above .90. The total time to administer the computerized method took significantly longer than the paper-and-pencil form, because template training added at least three minutes to the entire interview. Although a majority of the patients were computer novices, both methods were rated highly. The Spanish-speakers did not display a preference for either method, however the English-speakers preferred the computerized method. The participants' reasons for preferring the computer method included perceptions that it was easier to use, captivating, and presented a feeling of personal interaction (Muñoz, González, and Starkweather, 1995).

González (1993a) developed an English language speaker-dependent speech recognition CES-D prototype. A total of 68 adult participants completed both paper-and-pencil and computerized forms of the CES-D in a single-session counterbalanced design. Since computerized testing could elicit anxiety and invalidate the results, participants also completed a



computer anxiety scale as a validity criterion. The results suggested that the prototype displayed strong psychometric properties. There were no significant differences between the means and variabilities of the two CES-D methods. The reliability and internal consistency estimates of alternate forms of the two CES-D forms were above .90 and .80, respectively. Both versions of the CES-D correlated equivalently with the computer anxiety scale ( $> .30$ ). The total time to administer the computerized CES-D took significantly longer than paper-and-pencil because of template-training. Both methods were rated positively, but there were no significant differences in preference rates between the two methods (González, Spiteri et al., 1995).

Research was directed toward telephone-enabled computer-assisted screening. The rationale for using telephone-assisted interviews was to *increase access* for populations not likely to visit health care settings (Lavrakas, 1987). Marín, Pérez-Stable, and Marín (1989) found that telephone interviewing generated lower refusal rates among Latino research participants than in non-Hispanic Whites. Latino respondents also perceived telephone interviews as person-friendly and displayed more willingness over telephone, rather than face-to-face, to answer highly sensitive items on drug use and sexual behavior (Marín and Marín, 1989).

González (1993b) developed a bilingual speaker-dependent telephone-assisted speech recognition CES-D. The exploratory field study evaluated computerized speech recognition integrated with cellular telephone technology. Thirty Spanish and 22 English-speakers completed both computer-telephone and face-to-face versions of the CES-D in immediate test-retest counterbalanced order. To ease the presentation of the all-audio, all-verbal computer-telephone program, the CES-D response format was modified from the standard four responses (less than one day, one to two days, three to four days, and five to seven days) to the actual number of days (0 to 7) in one week. Participants also completed a face-to-face depression checklist as a validity criterion. The results suggested that both language groups reported significantly elevated scores on the modified computer-telephone method, but follow-up data using equivalent response formats (0 to 7 days) revealed no differences between both methods. Regardless of CES-D response format, total score variances did not

differ for either language group. In both samples, the CES-D methods yielded high internal consistency estimates (.80), high alternate forms reliability coefficients (.75 to .90), and similarly high correlations to the depression checklist ( $> .60$ ). Total time to complete the computerized method took significantly longer than the face-to-face interview because of template-training. However, the actual time for the computer to administer the CES-D items was comparable to face-to-face administration. Both groups reported positive ratings for the two methods, but the English sample preferred the computer-telephone method because it seemed more “person-friendly” (González, Costello et al., 1995).

The focus of research was directed toward investigating elements of speech behavior to enhance the detection of depression. UCSF colleagues pioneered the research on the analyses of voice characteristics for assessing emotion in speech (Hargreaves and Starkweather, 1964). As cited earlier, exciting new research revealed strong promise for the analysis of voice properties for detecting depressed affect. The author’s research began to explore speech behavior, such as verbal response latency (reaction time to answer a presented item) and speech recognition accuracy (computer accuracy level for recognizing a participant’s utterances). The hypotheses were that longer response latency and lower recognition accuracy would be related to depressed mood.

González, et al. (1997) evaluated a bilingual speaker-dependent cellular telephone-assisted computerized speech recognition CES-D that evaluated verbal response latency and speech recognition accuracy. A brief acculturation scale was also administered to investigate the relationship between acculturation and depression for Latinos. In a single session counterbalanced experimental design, 32 English and 23 Spanish-speakers completed randomly ordered computer-telephone and face-to-face CES-D methods, the Beck Depression Inventory (BDI) (Beck and Steer, 1987), and the Short Acculturation Scale (Marín, Sabogal et al., 1989). The results suggested that the two CES-D methods displayed strong internal consistency estimates ( $> .85$ ), good test-retest reliabilities ( $> .85$ ), and high correlations to the BDI ( $> .80$ ) for both language groups. The two groups rated both methods equally high, but English-speakers preferred the face-to-face mode because it was more person-friendly. Among Lati-

nos, the correlation between depression and acculturation was not significant. For the computer method, depression scores directly correlated with verbal response latencies (.45) and inversely related to speech recognition accuracy (-.37) across both language groups. Thus, longer response latency served as a general index of depression. Also, respondents who had higher depression symptoms levels had lower speech recognition accuracy (more recognition complications during the computer interview). The analyses of speech behavior demonstrated good potential as a method for screening depression in both languages.

The National Institutes of Health (NIH) funded a two-year grant to extend the author's research on bilingual telephone-assisted speech recognition screening for depression. The author is conducting rigorous experimental studies with larger and more representative Spanish and English-speaking samples from a wider range of field sites. The author has enhanced the research design by collecting retest data on participants in a second, separate session. The author is assessing the equivalency of similar computerized and face-to-face versions of the CES-D for English and Spanish-speakers, analyzing the effects

of acculturation, and exploring the relationship between speech behavior and depression. The purpose of the first year study was to develop, test, and evaluate an English and Spanish continuous speaker-independent speech recognition CES-D application for screening depression symptoms by digital cellular telephone. A continuous speaker-independent system is designed to recognize natural continuous speech and independent multiple users without requiring template training, thus significantly reducing overall interview time. Also, the computer conducted the interview using a pre-recorded female or male voice selected by the participant. In previous prototypes, only a pre-recorded male voice was presented.

The procedures for a cellular telephone-assisted prototype are briefly presented. The interviewer presents the participant with instructions for completing the automated interview in his or her primary language and the opportunity to select the gender of the automated interviewer. The participant calls a computer (located at a secured university facility) and enters identifying information (participant ID, session, and automated interviewer gender). Over the telephone, the program instructs the participant to answer the questionnaire verbally. The program

**Table 1 Summary of the Telephone-Assisted Voice-Interactive Interview Sequence**

**1. Introduction**

- a. Interviewer briefs participant on completing the automated interview
- b. Participant selects the preference for the gender of the automated interviewer (male or female)
- c. Interviewer calls the program of participant's primary language (English or Spanish)
- d. Interviewer enters identifying information (participant ID and session)
- e. Interviewer hands telephone to participant

**2. CES-D Items**

- a. The program greets the participant and presents brief instructions for completing the CES-D items verbally
- b. The program begins by presenting an item and waiting for the participant's response
- c. Participant verbally responds to the item
- d. The program registers the participant's recognized response and records voice characteristics
- e. The program continues to the next item until the CES-D is completed

**3. Closing**

- a. The program thanks the participant, requests that the interviewer be advised, and hangs up
- b. The program scores and analyzes the responses
- c. The program generates a brief interpretative report file
- d. The program saves the results in a database

administers the CES-D items, obtains the participant's spoken responses (e.g. yes, no, digits, help!, or what?), and records the voice characteristics. Once the interview is concluded, the program hangs up, scores the responses, analyzes the data, generates a brief interpretive report, and stores the results. Table 1 is a comprehensive summary of the interview sequence.

In the first NIH study, a Language x Method (x Time) experimental design was employed. The CES-D was randomly administered to 82 English-speakers (ES) and 85 Spanish-speakers (SS) in either computer-telephone (CT) or face-to-face (FF) form in two separate sessions. Additional measures included a structured demographic interview, the Bidimensional Acculturation Scale (BAS) (Marín and Gamba, 1996), and the BDI. The CT program also recorded speech behavior variables including verbal response latency, item presentations and repetitions, and administration time. The results suggested that both methods displayed strong psychometric properties. The means for the two methods were not significantly different for both ES and SS (FF variabilities differed on the first session only). The two methods demonstrated high inter-item consistencies (.83 to .94) and strong correlations to the BDI (.68 to .88) for both languages. Test-retest reliabilities for the two methods were very good (.84 to .89), however the coefficient for the ES CT method was moderate (.47). Total administration times between the two methods did not significantly differ because of the elimination of template-training. Although the two language groups rated both methods highly, both groups preferred the FF method. For the acculturation variables, Latinos who affiliated more with the Hispanic domain reported significantly higher depression scores than Latinos who were bicultural. Also, linguistic proficiency was inversely related to depression scores for the FF (-.32) and CT methods (-.31).

Among Latinos, low English proficiency was related to higher levels of depression. The analysis of participant language and automated interviewer gender indicated that the SS group did not display a preference for either gender of the automated voice, but significantly more ES chose a female voice. The speech behavior variables displayed remarkable relationships to depression levels. The CT method demonstrated higher response latencies than FF for both language groups. Also, FF response latency was positively correlated to depression scores for the ES sample in the first (.29) and second sessions (.46).

For the ES and SS groups, the CT administration time was directly related to depression levels, (.27) and (.37) respectively. Computer recognition accuracy for both language groups was negatively correlated with depression scores, ES (-.28) and SS (-.29). For the SS group, total CES-D item presentations was positively correlated to depression symptoms (.37). In other words, depressed persons tended to experience more voice recognition complications during the computer interview, requiring more repetitions of the items and more time to complete the interview. In sum, the findings of the study suggested that the computerized CES-D was feasible to administer, psychometrically sound, positively acceptable, and equivalent to the face-to-face method in administration time. Acculturation analyses indicated that Latinos who had low English proficiency reported more distress than Latinos who were bicultural. Participant gender demonstrated an interaction with automated interviewer gender, language, and depression levels. Speech behavior displayed meaningful promise as general markers of depression symptoms. A manuscript for publication in a refereed scientific journal is under preparation (González, 1998). Data collection for the second study is underway.

## General Findings

In summary, the studies provided evidence that the bilingual voice-interactive speech recognition prototypes were generally feasible to administer, reliable, valid, and equivalent (means and variabilities) to standard interview methods. Technological advancements have made computerized administration time comparable to a face-to-face interview. The English and Spanish-speaking samples positively rated the automated interviews. By and large, most Chicano/Latino participants reported very little familiarity with computer technology. However, the vast majority responded favorably to the automated interviews suggesting that the computer applications were culturally and linguistically viable tools. In addition, the interaction of the participant and automated interviewer gender requires further exploration (i.e. relation to self-disclosure, acculturation, and language) (Kaplan et al., 1991). Thus, the computer-assisted voice-interactive method serves as a potential alternative for screening depression. Most importantly, the findings compelled further research on the speech behavior of adults suspected of having depression. Specifically, a closer examination of patient voice characteristics

will yield meaningful clinical data. To develop a more precise depression screener, it is important to examine human-computer verbal interaction - not only what the patient says but how the patient says it. The exploration of the analysis of voice characteristics is a crucial step toward developing an accurate and valid depression screening instrument that extends beyond the limitations of self-report measures, including interviewer, respondent, and cultural biases and moderate predictive value.

## Limitations

Speech recognition accuracy is very good but not flawless. Constraints with current computerized speech recognition systems included imprecise recognition of verbal responses resulting in occasional substitutions. Speaker-independent speech recognition systems based on a phonetic structure are sensitive to respondents' pronunciation of words. For example, differences between the system's phonetic grammar and the respondent's actual pronunciation may significantly diminish recognition (Noyes and Frankish, 1994). As a result, respondents may experience difficulty with attaining correct recognition. In the current program, the computer says "Pardon" when it cannot recognize a phrase. A fair number of "Pardon" prompts from the program is frustrating for some respondents. Furthermore, significant background noise impedes recognition since the continuous speech recognition system attempts to recognize all acoustic input and utterances. However, continuous speech recognition systems are still favored because of the potential for effectively interpreting a participant's natural speech (Agou, Raskin, and Salvendy, 1993). New advancements in technology, such as the IBM and Dragon System's continuous speaker-independent speech recognition systems for dictation are designed to transcribe verbatim responses. Thus, applications that integrate content analyses and the evaluation of semantic properties of speech may be explored (Oxman et al., 1988). Several participants in our study employed a conversation style in response to the items by using interrupters and mumbles. A voice recognition program must be flexible enough to deal with various speech styles and pronunciations. A goal of the research is to develop computerized speech recognition systems that utilize the state-of-the-art technology to minimize incorrect recognition and offer flexibility with natural speech and diverse speaking styles.

## Future Directions

There are several stages to the author's programmatic research for developing voice-interactive screening for Chicano/Latino populations. In addition to this project, the author plans the following future research investigations using voice-interactive screening methods.

Validation studies will be conducted with various ethnic/racial populations (African American, Asian American, and Native American) and languages. These studies will lead to further advancement of voice-interactive screening through collaboration with colleagues who have expertise in the specific language and cultural groups. The aims are to generate normative data (intragroup and gender norms) and to validate voice-interactive screening for a larger number of populations.

A reliable and valid voice-interactive screening method can provide data on the incidence and prevalence of depressive disorders in the general population. Voice-interactive screening can assess the history of clinical depression, including past and current depressive episodes. Once validated, voice-interactive screening may become a viable survey technique for epidemiological research which can be adapted to assess various psychiatric disorders, such as substance abuse and anxiety disorders.

Voice-interactive screening will be used for assigning participants to randomized, controlled, depression prevention trials. Individuals identified by voice-interactive screening as displaying subclinical high depression symptoms levels are ideal candidates for referral to a depression prevention group intervention. The prevention studies will test a cognitive-behavioral intervention (Beck et al., 1979; Lewinsohn et al., 1986) based on a depression prevention randomized program for English and Spanish-speaking primary care medical patients (Muñoz et al., 1987; Muñoz, 1993), and a depression group intervention for Spanish-speaking methadone maintenance patients (González et al., 1993). The intervention will be a short-term (12-16 weeks), culturally-responsive and educationally-oriented cognitive-behavioral course known to effectively reduce depression symptom levels and to decrease barriers to services. (Muñoz and Ying, 1993). Voice-interactive screening can obtain repeated measures of

the participants' depressed mood and symptoms throughout the intervention to assess change in depression levels.

Computer-assisted voice-interactive interviewing represents a powerful methodology for developing objective assessment of depression. Among the most promising approaches is the digital analysis of voice characteristics (Starkweather, 1992). Voice characteristics serve as useful clinical markers for depression symptoms because vocalizations (respiration, articulation, and tension/relaxation of larynx and oral muscles) are mediated by psychomotor disturbance stemming from neurophysiological and subcortical (mesolimbic) dysfunction (Flint et al., 1993; Nilsson, 1988). Research demonstrated that various quantitative voice characteristics were good predictors of depression, such as narrow variability in tone (monotone), low fundamental frequency (pitch), and low amplitude (Hargreaves and Starkweather, 1964; Scherer, 1986; Vanger et al., 1992). Multilingual research has generated a model of depressed voice prosody (tempo and rhythm) represented by slower, flatter, and softer voice waves (Breznitz, 1992; Darby et al., 1984; Kuny and Stassen, 1993; Nilsson et al.,

1988; Scherer and Zei, 1988). Cross-cultural studies also suggested that depressed individuals displayed distinctive speech behavior compared to non-depressed persons, including longer pauses and fewer utterances (Friedman and Sanders, 1992; Mandal et al., 1990; Stassen et al., 1991), and longer response latencies (reaction times) to presented items (González, Costello, et al., 1995; Stout, 1981; Talavera, et al., 1994). Most importantly, changes in speech variables were better predictors of mood change than psychiatrists' impressions (Siegman, 1987). Table 2 summarizes the research on vocal cues for various affective states (Murray and Arnott, 1993). Basically, a sad mood displays identifiable vocal markers (e.g. slow, soft, monotonic speech) that are distinguishable from vocal effects in normal mood and other affective states.

In sum, the objective of the research is to develop a reliable and valid multilingual computer-assisted method for accurately screening depression in Chicano/Latino populations. An automated screening method is an ideal tool to increase the early detection of depression cases. The aim is to implement the computerized screening in high volume health care

**Table 2 Summary of Research on Vocal Emotional Effects Relative to Neutral Speech**

	<i>Sadness</i>	<i>Fear</i>	<i>Disgust</i>	<i>Anger</i>	<i>Happiness</i>
<i>Speech rate</i>	<i>slightly slower</i>	much faster	very much slower	slightly faster	faster or slower
<i>Pitch average</i>	<i>slightly lower</i>	very much higher	very much lower	very much higher	much higher
<i>Pitch range</i>	<i>slightly narrower</i>	much wider	slightly wider	much wider	much wider
<i>Pitch changes</i>	<i>downward inflections</i>	normal	wide, downward inflections	abrupt, on stressed syllables	smooth, upward inflections
<i>Vocal Intensity</i>	<i>lower</i>	normal	lower	higher	higher
<i>Voice quality</i>	<i>resonant</i>	irregular voicing	grumbled, chest tone	breathy, chest tone	breathy, blaring
<i>Articulation</i>	<i>slurring</i>	precise	normal	tense	normal

(Murray and Arnott, 1993)



settings that serve Chicano/Latino patient populations, but lack bilingual personnel. For example, a Spanish-speaking patient can be directed to the automated interview while waiting for their medical appointment. The computerized screening will collect patient data and generate a report that can inform health care staff of the patient's mood and symptoms. As a result, the automated tool may increase access for non-English-speaking individuals who are unlikely to initially seek mental health services. The computer-assisted methods and prevention strategies are intended to increase the accessibility to mental health prevention services and to ultimately reduce the occurrence of clinical depression in the Chicano/Latino population.

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