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A Ten-Year Systematic Review on Linguistic Behaviors

—Oral and Written Communication as Predictors of Anxiety

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Abstract: The purpose of this article is to conduct a systematic review of the literature over the past decade on the relationship between linguistic behavior and anxiety-related mental disorders. Anxiety is a universal and complex mental health problem with significant societal implications, and it has been one of the focuses of extensive attention, investigation and research in the psychological community. Many psychiatric disorders, especially anxiety disorders, are associated with severe anxiety. In recent years, as more and more scholars began to focus on the link between verbal behavior and anxiety, certain unique linguistic features have been identified in people with anxiety disorders, such as using less positive emotional words and fewer long sentences. However, some issues remain to be addressed. For instance, the majority of studies conducted in this field have not employed long-term observational experimental designs, which has hindered researchers from exploring the deeper effects of language behavior on the onset and development of anxiety symptoms. Additionally, in-depth research is challenging because some studies focus on specific populations, have limited sample selection, and rarely make cross-cultural comparisons. Anxiety disorders associated with decreasing quality of life and impairing social functioning. Therefore, it is crucial to study the relationship between anxiety and linguistic behavior from practical perspective. Future research should focus on solving the limitations of existing studies, exploring the mechanism of linguistic behavior's influence on anxiety symptoms, and exploring the relationship between anxiety and language in different cultures, to provide more effective strategies for the diagnosis and treatment of anxiety disorders.

Keywords: Anxiety, Anxiety Disorder, Linguistic, Linguistic markers, language.

1. Introduction

Anxiety disorders are one of the most common mental health problems in the world and have received significant attention from the clinical psychology community. According to the DSM-5, anxiety disorders include a variety of disorders, such as generalized anxiety disorder (GAD), social anxiety disorder (SAD), and phobias [1]. Although symptoms may vary between anxiety disorders, they are all characterized by excessive fear and intense, persistent anxiety, as well as physical physiological responses such as sweating, palpitations, and shortness of breath. In the past decades, the most common methods of diagnosing and treating anxiety disorders have been self-measurement scales and clinical interviews with clinicians. Nowadays, more and more scholars have begun to

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emphasize the importance of including more objective, directly observable measures in diagnostic assessments, language being one of them. In this paper, researchers will systematically review the research on the association between anxiety symptoms and language markers over the past ten years and answer the following questions: What are the most commonly used research designs in this field? What are the language features that have been concluded to be associated with anxiety disorders at this stage? Can language be used as a more objective assessment tool to predict anxiety disorders?

Through an analysis of the research designs, linguistic-behavioral features discovered, and their potential uses in the diagnosis of anxiety disorders, this paper will offer helpful resources and new perspectives for future investigations into this area.

2. Methods

The content of this paper was subjected to a literature search through two databases, PsycINFO and PubMed, using the following combinations of search terms: "linguistic", "language", "linguistic behavior", "linguistic analysis", and " anxiety", "anxiety disorder", "anxiety symptoms". These combinations of search terms were designed to ensure the researcher was able to access a wide range of literature on the relationship between anxiety and verbal behavior.

The criteria for inclusion and exclusion during the literature search in this paper are as follows:

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2014 and 2024	Articles published outside the timeframe of 2014 and 2024
Articles published in academic journals	Publications in non-academic formats such as books, dissertations, electronic collections, etc.
Studies involving a comparison between individuals with anxiety disorders and non-anxious controls, or conducting association analyses	Studies comparing anxiety disorders with other mental disorders (e.g., anxiety vs depression)
Empirical research studies focusing on the learning of science	Literature reviews, commentaries, or meta-analysis
Articles written in English	Pilot studies
	Articles written in other languages

3. Results of the Correlations between Linguistic Behaviors and Anxiety Levels in Various Contexts

3.1. Research Design

In past studies, all researchers have used self-report measurement tools to assess participants' anxiety level or mental health status, such as GAD-7, LSAS, PHQ-8, etc. In the stage of language sample collection, different studies used different methods, including verbal recordings, written narratives, reflective diaries, and so on. However, eventually, all these samples were transformed into transcript form to be used for subsequent language analysis. For language analysis tools, all studies consistently chose Linguistic Inquiry and Word Count (LIWC). This tool helped the researchers quantify specific elements of linguistic expressions and analyze them in correlation with self-report measures. Various statistical analyses were also used in these studies to explore the relationship between the self-report measures and the language samples, including correlation analyses, regression analyses, etc.

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3.2. Findings of Linguistic Behaviors

In the study conducted by Matteo et al. in 2021, researchers recruited 112 Canadian nonclinical adult English speakers (86 valid participants, mean age 30.1 (SD=8.6)) [2]. Each valid participant was asked to complete four self-report measures (LSAS, GAD-7, PHQ-8, SDS) to measure anxiety levels before and after the start of the 14-day experiment. During the experiment, each participant made regular recordings through an Android phone smart app. The transcripts of these recordings were analyzed by LIWC to count for specific word frequencies. An important finding of this study was a positive correlation between the proportion of words related to the concept of death and all self-reported measures, meaning that people who said more death-related words in the audio had more self-reported symptoms of mental health-related dysfunction such as social anxiety and generalized anxiety. In addition, the experiment found positive correlations between visual-related words (e.g., "view", "saw", “look”, etc.) and self-reported symptoms of social anxiety; and negative correlations between rates of reward-related words and self-reported symptoms of generalized anxiety.

Teferra et al. recruited 2,000 participants for an online study (1,744 valid participants were included in the final analysis) [3]. Each participant was asked to complete the GAD-7 scale to measure GAD levels, and the TSST (a five-minute sample of impromptu speech provided in this task). The results of the study showed that the number of words and length of speaking time were negatively correlated with anxiety scores, indicating that participants with higher anxiety scores spoke less. The frequency of using shorter sentences, on the other hand, was positively correlated with anxiety scores. In addition, only for men, function words, including personal pronouns, had a significant positive correlation with anxiety. The count of power-related words was positively correlated with anxiety values for women, whereas it was negatively correlated for men. The LIWC category of "look" and anxiety values were positively correlated for females, while the category of "listen" was positively correlated for males. Words related to death had a significant positive correlation in the male sample and the all samples dataset. Another study by Teferra et al. in 2023 showed that the transformer-based neural network model had stronger predictive power compared to the word-based LIWC model [4].

Rook et al. attempted to see if the linguistic characteristics of written narratives could predict GAD through expressive writing exercises [5]. 144 college students were recruited (142 participated), and each participant was asked to complete two self-report measures (GAD-7, BIS/BAS). The GAD-7 was used as a criterion for determining whether a participant had GAD, with <10 indicating no GAD; on this criterion, 87 had no GAD, and 55 had GAD). Participants were then asked to complete a narrative writing task on "anxious moments in college life," which was recorded using the LIWC. The final results showed a significant negative correlation between GAD and longer words, positive emotions, and concern for the future; and a significant positive correlation between anxiety and BAS for those with high GAD scores. For participants with low GAD scores, there was a significant negative correlation between BAS, affective processes, and negative emotions.

Dirkse et al. produced open research on treating GAD with therapist-assisted ICBT [6]. There were 59 participating GAD patients (mean age=42). The experiment consisted of 12 treatment Modules for GAD, each Module was preceded by a GAD-7 scale self-report, PHQ-9, and a PDSS-SR. In addition, at the end of each module participants were asked to write down their feelings or thoughts about the treatment in the form of an email to researchers, and this text content was used to conduct the LIWC word frequency analysis. The results showed that as the treatment time increased, the frequency of words related to negative emotion words, causation, and insight decreased, and the number of past tense words increased (negative emotion words were positively correlated with anxiety level).

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Avram conducted an online study in 2023 [7]. In that study, researchers recruited 104 undergraduate students. Each participant was asked to complete the State-Trait Anxiety Inventory-X2 scale to identify levels of anxiety and then to engage in weekly reflective journal writing (for a total of eight weeks). The writing content should focus on emotions, cognitions, and feelings, and then be analyzed by the LIWC for word frequency. The results showed that people who were experiencing anxiety were more likely to use the words related to "ingestion" and "reward" in their reflective writing.

Peterson et al. recruited a total of 624 participants (578 valid participants) and experimented on the Qualtrics web platform [8]. Each participant was asked to complete the short health anxiety inventory (SHAI) to assess anxiety levels (as well as the BVS and the FIVE, but both of these were used to measure COVID-19-related content and are not relevant to this study, so they will not be mentioned later). Then a qualitative narrative essay was completed describing how the recent events of the COVID-19 pandemic have caused disruption and/or distress in participants' daily lives, and finally, LIWC will be used to analyze word frequency. The results of this study showed a positive correlation between the level of General health anxiety and the frequency of use of emotion-focused words (especially anxiety words), and a positive correlation with the frequency of use of cognition-focused language (e.g., ought, cause, and especially distinction words) and motivation-focused language.

3.3. Synthesis of results

The results of these earlier studies indicate that there are some common tendencies in language use among people with higher levels of anxiety: symptoms of anxiety associated with a higher frequency of using negative emotion words and a lower frequency of using positive emotion words. The use of cognition-focused and motivation-focused language had a negative relationship with anxiety. So did writing styles. Higher levels of anxiety are also associated with a decrease in number of words spoken and the use of shorter sentences. In addition, the language used by men may differ from what women use, for example, females may use more visual-related words, and males usually use more auditory-related words. There are also contradictions exist in previous studies' findings: for example, Matteo et al. found a negative correlation between the frequency of reward-related words and generalized anxiety symptoms, whereas, in Avram's study, reward-related words were positively correlated with the level of anxiety, which might have resulted from sample characteristics, design issues or methodology that were adopted for data analysis purposes.

4. Discussion

4.1. Limitations and implications

Previous studies provide valuable insights, but few limitations may affect the interpretation and generalizability of experimental outcomes. First, all these studies used self-report measures such as GAD-7 to assess anxiety levels. These kinds of scales are highly subjective because they mainly depend on the honesty and self-perception of individuals; hence they are usually influenced by participants' subjective feelings and recall bias thus making it relatively difficult to achieve high-objectivity results through these scales. A second major problem is that varying practices were used to collect language samples. Some examples of such inconsistencies are online data collection versus offline data collection, recording at home instead of outdoors, using different software and websites for collecting writing/recording samples, and so on. All these factors above may negatively influence the authenticity of the results. Moreover, some studies used limited samples from a specific population like within one country or only one particular university (or even within a particular grade level), and there was an overrepresentation of females in most samples, which may have some implications on representativeness. Besides, it should be noted that the study lacked controls for other

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variables such as divergent life backgrounds, experiences, and cultural differences among individuals that could have influenced the results thereby raising doubt over this fact. Therefore, when interpreting and applying these findings limitations must be taken into account. Furthermore, more comprehensive and integrated research should be carried out to corroborate and increase the depth of previous studies.

4.2. Future Studies

Future studies could further explore and identify linguistic markers of different types of anxiety disorders, their similarities as well as differences. In addition, since most of the studies are cross-sectional, this may hinder the understanding of the cause-effect relationship between verbal behavior and anxiety development, future studies could use a long-term observational design (longitudinal study) to follow up on verbal behavior changes in people prone to anxiety. Also, intervention studies targeting linguistic behavior can be performed to test whether the alteration of verbal expressions can help reduce anxiety symptoms. Moreover, language behaviors may be examined through other physiological and psychological indicators such as fMRI or EEG for better comprehension of how language behavior relates to anxiety objectively. Besides, cross-cultural comparisons are also important. This will help researchers understand how cultural factors influence the diagnosis and treatment of these conditions by investigating commonalities among language marks across cultures as well as exploring the effects of cross-cultural aspects on diagnosing and treating individuals experiencing anxiety disorders successfully.

5. Conclusions

In conclusion, this systematic review of research on the relationship between linguistic behavior and anxiety over the past decade found a series of valuable insights. This study has indicated that: first, people with anxiety disorders have some similar aspects in their language, such as more frequently using negative emotional terms and avoiding positive ones, and lacking self-assurance and decisiveness. Moreover, the intensity of anxiety is associated with personal concerns' contents as well as social phobias and death-related language expressions. All of these indicate the feasibility of using verbal behavior as an objective indicator to measure symptoms of anxiety.

Secondly, there are some limitations in existing studies in this field, including the subjectivity of the self-report measurement tools used in the research, the singleness of sample selection, and the possible existence of some other uncontrolled or confounding variables, etc. Furthermore, since most studies are cross-sectional, researchers cannot draw any causative links and it is necessary to conduct more study longitudinally. These limitations must be controlled and addressed better in subsequent research.

Finally, future studies could also explore more deeply the linguistic markers that distinguish different forms of anxiety disorders. Matteo et al. have shown that visual-related words are more related to social anxiety disorder while reward-related words are more related to GAD. Similar differences may exist among other kinds of anxiety disorders. Also, it is better to apply long-term observational methods in checking whether verbal behavior causes anxiety and comparing them across different cultures. These directions will provide better insight into the relationship between language and anxiety, thus coming up with alternative diagnoses and treatment options for these conditions.

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