

# Measuring Potential Cues for Depression in Adolescents

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## ABSTRACT

So far, depression research has mainly relied on adult data and self-reports. For better prevention and treatment, it could be of great importance to diagnose additional behavioral cues in earlier stages of life. We therefore analysed video recordings of adolescents (low versus high risk groups with regard to developing depression) performing a free speech task using linguistic, nonverbal and acoustic methods of measurement. High risk adolescents used fewer words and talked more about home and family than their low risk counterparts, suggesting possible relations with introvert and attachment-related behavior. Nonverbally, females showed more affiliation and flight behavior than males, possibly reflecting gender-specific coping strategies. Moreover, interactions show gender differences between risk groups; high risk females use less words and more flight behavior than low risk females, whereas males show the exact opposite pattern. These findings might contribute to better prediction and treatment of depression in the future.

## Author Keywords

Depression, behavior, verbal, nonverbal, acoustic, adolescents, prediction.

## INTRODUCTION

Mood disorders currently cover a substantial part of mental health problems of the population, with major depression disorder (MDD) being the most significant one. Worldwide, 8 to 12 percent of all people experience at least one episode of depression during their lifetime [8].

First depressive episodes typically develop during adolescence [11]. Early diagnosis of depression could be of great importance for prevention and improvement of

clinical treatment. In this study, we therefore analyzed video recordings of adolescents (belonging to low or high-risk groups with regard to depression) on linguistic, nonverbal and acoustic behaviors in order to identify behavioral cues with potentially predictive value with regard to depression.

The current way of diagnosing depression is on the basis of the well-known DSM-IV criteria, which use a great majority of diagnostic tools (interviews and questionnaires). The diagnosis is mainly based on self-reports of the patient on how he or she feels, behaves, and thinks. The assumption hereby is that the respondent is both honest and able to adequately verbally report on these issues. An additional assumption is that these aspects of behavior are the only or most important for clinical decision making.

However, there are also additional behavioral features, which distinct between depressed individuals and healthy people, which, however, do not have the official status of symptoms. Research showed that, for example, depressed individuals use more self-references and negatively valenced words [12]. On a nonverbal level, they showed a global restriction of expression, reflected by decreased motor activity, body movements and reaction times [13,16]. On an acoustic level, voice analyses have shown that depressive patients display less pitch variability, speak faster and use more pause time when speaking [1,10]. We expected these or similar findings to manifest themselves in adolescents belonging to the high-risk group, thereby distinguishing themselves as possible predictors of depression.

## METHODS

### Sample

The sample was taken from the TRacking Adolescents' Individual Lives Survey (TRAILS), a large prospective cohort study in which Dutch adolescents are measured biennially until at least the age of 25.

The data used for the current analyses were collected during the third assessment wave, conducted between September 2006 and December 2007. At this wave, approximately 750 adolescents (age 15-17 years) were measured while

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performing extended laboratory tasks. Based on demographic data (temperament scores, parental psychopathology and living in a single-parent family situation), each individual adolescent was assigned to one of eight risk-groups varying from score 0 (low-risk for developing depression) to 7 (high-risk for developing depression).

Our analyses were done using video recordings in which the adolescents had to perform the so-called Groningen Social Stress Test (GSST); a standardized protocol based on the Trier Social Stress Task [9]. Its goal is to induce moderate performance related social stress by the inclusion of a public speaking task and mental arithmetics.

### **Test Procedure**

We analysed video recordings of 20 “low-risk” and 20 “high-risk” adolescents (50% female) while they performed the GSST. Data collection took place in sound-proof rooms with blinded windows at the participants’ town of residence. The social stress test was always the last part of a three hour test session covering various other psychological and medical tests.

Participants were instructed to prepare a six-minute non-stop speech about themselves and their lives and to deliver it in front of a video camera. Preceding their performance, they were told they would be judged on several aspects, such as content of speech as well as the use of their voice and posture. In order to induce a threat of social rejection, it was also suggested that they would be rank-ordered by a panel of peers afterwards. The test leader watched the whole performance carefully and took care not to show any sign of empathy or encouragement.

### **Analyses**

All analyses were conducted blind; the experimenter and analyst never knew what group the adolescent belonged to.

#### *Linguistic Analysis*

All words uttered during the given six-minute speech time were transcribed using ELAN software, to analyse the data for possible underlying linguistic dimensions. These annotations were then subjected to the Linguistic Inquiry and Word Count (LIWC) program, which analyses texts on a probabilistic word-by-word basis to a default dictionary of words and word stems [12]. This dictionary comprises over 70 language categories, ranging from linguistic dimensions (such as words per sentences, articles), relativity (e.g. in time and space), psychological processes (emotional and cognitive) and personal concerns. The LIWC analysis produces an output in which the analysed text is given in percentages of total words found along the aforementioned language categories. Since all participants spoke Dutch, we used the 2004 Dutch LIWC-version, which has a dictionary of 6568 words divided over 66 predefined word dimensions. These Dutch dimensions show a high correlation with their corresponding English equivalents [18]. In addition to the analysis of the aforementioned

words and language categories, we also calculated the speaking rate by counting the amount of spoken words per minute.

#### *Nonverbal Behavior Analysis*

For the analysis of nonverbal behavior, we used the Ethological Coding System for Interviews (ECSI), developed by Alfonso Troisi [15]. This system was specifically designed to measure nonverbal behavior during clinical interviews using ethological principles.

The version of ECSI we used includes 37 different behavior patterns (varying from hand and body movements to facial expressions) divided over eight behavioral categories. ECSI categories have been shown to discriminate between control and psychiatric patients in clinical interviews, as well as between different psychiatric subgroups [15]. Specifically with regard to depression related research, it has been shown that the behavioral categories used in our study derive from the combination of behavior patterns reflecting a distinctive set of antecedent situations, or of consequent responses or events [3,15]. Based on these findings, we scored the video recordings on 25 behavioral patterns divided over four categories: Affiliation (associated with ECSI behaviors 2-6: e.g. head tilt, smile, raising eyebrows), Flight (behaviors 10-15: e.g. to look away/down, eyes shut, chin to chest), Displacement Behavior (24-32: e.g. hand-face touching, yawning) and Relaxation (33-37: e.g. settle, fold arms, laugh).

Before the actual analysis, it was made sure that the observer reached an inter-observer reliability ( $\kappa$ ) of at least 0.70 for each behavior pattern. This evaluation was based on a sample of 40 different video recordings also rated by another observer.

For the current analysis, we cut out the first minute of the free speech task (from the onset of the first spoken word) and removed the sound. While watching the video, the observer recorded whether each behavioral pattern occurred during these 60 seconds or not. The occurrence of each pattern was scored as “1”, no occurrence as “0”. Following this, the scores for each individual were then summed up per behavioral category in order to obtain “amounts” of behavior.

#### *Acoustic Analysis*

From the video recordings used in the nonverbal behavior analysis, the first minute of audio was isolated and normalized at a maximum amplitude of -3 dB using Audacity software, resulting in 40 audio clips in total. It was made sure only the participant was speaking, without any interruption of the test leader.

The first measure we analysed was average fundamental frequency (F0). In order to obtain this, a CSL pitch contour analysis was run from each individual sound file using PRAAT software. Second, we also calculated speech onset time for each participant. This measure was defined by the

time between offset of the last spoken word by the test leader and the onset of the very first spoken word by the participant.

#### Statistical Analysis

All statistical analyses were performed using a 2 (low versus high risk for developing depression) x 2 (male versus female) ANOVA.

## RESULTS

### Linguistic Analysis

Contrary to our expectations, no effects with regard to first person singular words were found between the risk groups ( $p > .05$ ). We did find a group effect for word rate ( $F(1,37) = 4,514, p = .040$ ); low-risk adolescents talk more than high-risk ones. Moreover, we did find group effects for family ( $F(1,36) = 7,052, p = .012$ ) and home related words ( $F(1,36) = 5,223, p = .028$ ); adolescents belonging to the high-risk group used these words significantly more than those belonging to the low-risk group.

Figure 1 shows an interaction between group and gender ( $F(1,36) = 5,802, p = .021$ ) with regard to the number of words used during the whole measuring period. In the low-risk group, female adolescents speak more than males, whereas the high-risk group shows the opposite pattern.

### Nonverbal Analysis

No group effects were found on any of the four behavioral categories (all  $p > .05$ ). However, we did find significant gender effects for affiliation ( $F(1,36) = 4,714, p = .037$ ) and flight behaviour ( $F(1,36) = 13,226, p = .001$ ); overall, female adolescents show more affiliation and flight behaviour than males. Moreover, an interaction between group and gender was found for flight behaviour ( $F(1,36) = 6,339, p = .016$ ).

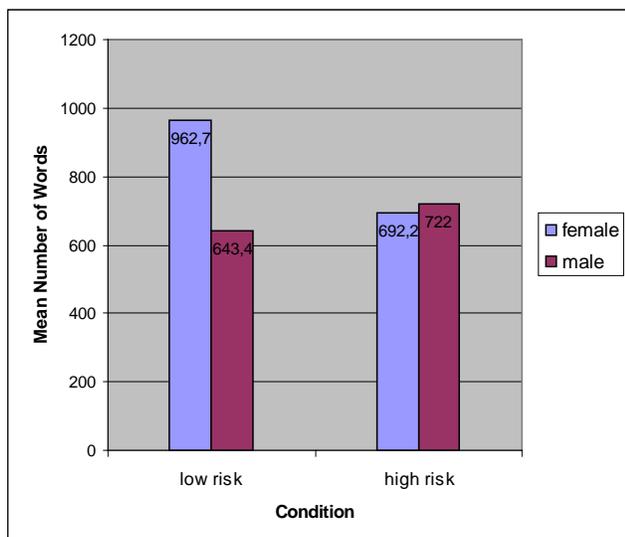


Figure 1. Mean word use (number of words spoken in 6 minutes) compared between a) males and females and b) low versus high risk of developing depression (n=40).

(Figure 2). Men show less flight oriented behavior in the high-risk compared to the low-risk condition, whereas women display exactly the opposite behavior.

### Acoustic Analysis

In addition to the expected difference in fundamental frequency between males and females ( $F(1,37) = 209,261, p = .001$ ), no effects were found for average fundamental frequency and speech onset time for both condition and gender (all  $p > .05$ ).

## DISCUSSION

Our analyses yielded promising results with regard to linguistic and nonverbal features. Adolescents who have a low risk of developing depression talk more during the first minute than their high-risk counterparts. These results are in line with earlier findings, showing that introverted individuals have a higher probability of being depressed [2,6].

Moreover, family and home related words were used more in the high-risk condition, showing possible attachment-related behavior. Previously, Irons and Gilbert [5] showed that insecure attachment in adolescents is positively correlated with submissive behaviour, depression and anxiety symptoms. Since the high risk-adolescents in our study comply with insecure attachment characteristics (for instance, growing up in a single-parent family), our findings are likely to correspond with these earlier data.

The interactions found on both linguistic and nonverbal analyses show both decreased word use and increased flight behaviour for females in the high-risk condition. Contrary to this, high-risk male adolescents talk more in and display significantly less flight behavior. In line with this, earlier research showed that depressed or homesick boys tend to

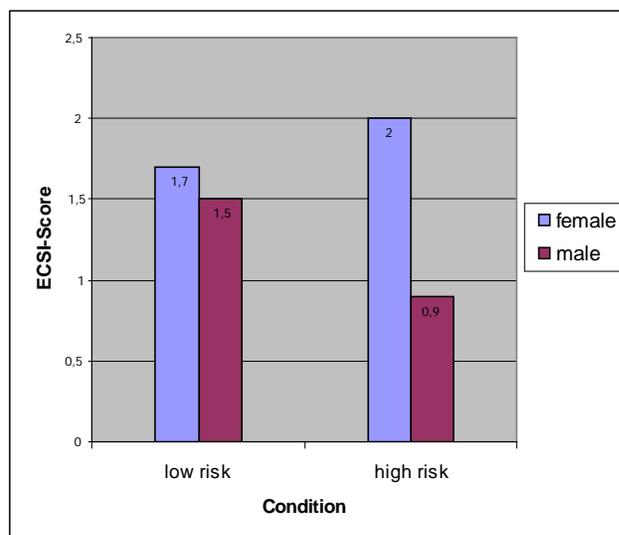


Figure 2. Average amount of nonverbal behavior in the ECSI category Flight compared with a) males and females and b) low versus high risk of developing depression (n=40).

display more aggressive and extravert behavior compared to girls [14], possibly indicating gender-specific coping strategies. The main gender effects on a nonverbal level for increased affiliation and flight behavior in women compared to men, might reflect this as well.

In conclusion, these multilevel measurements show interesting results which might be valuable to early detection or prediction of depression. Whether these findings convey predecessors or actual symptoms of depression remains open for further exploration.

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