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Linguistic Analysis of Communication in Therapist-Assisted Internet-Delivered Cognitive Behavior Therapy for Generalized Anxiety Disorder

Dale Dirkse[1]*, Heather D. Hadjistavropoulos[1], Hugo Hesser[2]** and Azy Barak[3]†

[1]*Department of Psychology, University of Regina, 3737 Wascana Pkwy, Regina, SK, Canada S4S 0A2;* [2]*Department of Behavioral Sciences and Learning, Linköping University, Linköping, 581 83 Linköping, Sweden;* [3]*Department of Counseling Psychology, University of Haifa, 199 Aba Khoushy Ave., Mount Carmel, Haifa, Israel*

Abstract. Therapist-assisted Internet-delivered cognitive behavior therapy (ICBT) involves elements of expressive writing through secure messaging with a therapist. Expressive writing has been associated with psychological and physical health benefits in past research; furthermore, certain linguistic dimensions in expressive writing have been identified as particularly beneficial to health, such as less frequent use of negative emotion words and greater use of positive emotion words. No research, to date, has analyzed linguistic dimensions in client communication over the course of therapist-assisted ICBT for individuals with symptoms of generalized anxiety. This naturalistic study examined messages sent to therapists during the course of ICBT using linguistic analysis, and explored covariation of word use with symptom improvement. Data were obtained from patients with symptoms of generalized anxiety ($N = 59$) who completed 12 modules of therapist-assisted ICBT and rated symptoms of anxiety, depression, and panic at the beginning of each module. Linguistic analysis categorized text submitted to therapists into different word categories. Results found that patients' use of negative emotion, anxiety, causation, and insight words reduced over the course of treatment, while past tense words increased. Furthermore, negative emotion words significantly covaried with symptom ratings over the course of treatment. While causal statements cannot be made, findings improve our understanding of patient communication in ICBT and suggest that the further study of linguistic dimensions as psychological indicators and the potential utility of expressive writing strategies in therapist-assisted ICBT may be worthwhile. *Key words: Internet-delivered; therapist-assisted; cognitive behavior therapy; generalized anxiety; linguistic analysis.*

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Correspondence address: Heather D. Hadjistavropoulos, PhD, Department of Psychology, University of Regina, 3737 Wascana Parkway, Regina, SK, Canada S4S 0A2. Tel: +1 306 5855133. Fax: +1 306 3373227. Email: hadjista@uregina.ca

Introduction

Generalized anxiety disorder (GAD) is a debilitating condition characterized by excessive anxiety related to multiple areas of concern causing significant impairment for the individual (American Psychiatric Association, 2013). It is estimated that as many as 57% of affected individuals remain untreated for GAD (Kohn, Saxena, Levav, & Saraceno, 2004), even though effective treatment options exist. Cognitive behavior therapy (CBT) shows particular promise with the most recent meta-analysis finding that CBT demonstrated significant large effect sizes ($g = 0.84$) for reducing anxiety compared to control groups (Cuijpers et al., 2014).

Over the last decade, therapist-assisted Internet-delivered cognitive behavior therapy (ICBT) has become recognized as an option for increasing access to CBT for conditions such as GAD. In this delivery model, treatment materials are presented in weekly modules with patients assigned offline exercises at the end of each module. The patient

and therapist exchange correspondence via asynchronous secure messaging, with the therapist commonly checking in once a week to respond to patient messages. Therapist-assisted ICBT is attractive for various reasons such as anonymity, convenience, and the opportunity for those without access to in-person services to participate in therapy (Andersson, 2010). The anonymous text-based nature of ICBT has been described as a possible disadvantage of this approach with patients potentially finding the treatment impersonal and limiting information shared with therapists (Postel, de Haan, & De Jong, 2008). In contrast to this assumption, however, there is evidence to suggest that patients can form a strong therapeutic alliance in ICBT that is comparable to the alliance formed in face-to-face therapy (Preschl, Maercker, & Wagner, 2011). The content of therapists' emails in their asynchronous guidance has been found to be associated with module completion and symptom improvement among patients with GAD treated with therapist-assisted ICBT (Paxling et al., 2013). There are also some conceivable benefits of text-based communication. For example, patients may feel more comfortable expressing themselves openly through email versus face-to-face encounters (Suler, 2004). Writing thoughts and feelings down may also serve to facilitate adaptive ways of reappraising situations and restructuring cognitions (Caplan & Turner, 2007).

Results of several randomized controlled trials have provided strong evidence (large effect sizes; Cohen's d's > 0.80) in support of therapist-assisted ICBT in comparison to waiting list controls for improving symptoms of GAD (Paxling et al., 2011; Robinson et al., 2010) with gains still found at 1 and 3 years post-treatment (Paxling et al., 2011). These trials are consistent with the broader literature on therapist-assisted ICBT showing large effects for therapist-assisted ICBT (e.g., Barak, Hen, Boniel-Nissim, & Shapira, 2008). As the efficacy of ICBT has been well established, the authors of a recent extensive review of the ICBT literature stated that future ICBT research should focus on examining outcome predictors in clinically representative samples (Andersson & Hedman, 2013). Patient language use could be an important predictor of success in therapist-assisted ICBT, but has not yet been investigated in the context of ICBT.

The effect of writing about one's thoughts and feelings, however, has been empirically tested with an expressive writing paradigm. In this research paradigm, participants are randomly assigned to complete an expressive writing task about an emotional experience or a control topic for approximately 15 min for 3–5 consecutive days (Pennebaker, 1993). The most recent and comprehensive meta-analysis of this approach examined 146 randomized studies with over 10,000 participants examining objective or subjective indicators of physical/psychological health with diverse populations (Frattaroli, 2006). The research overall identified a small ($r = .075$), but nevertheless positive effect showing that expressive emotional writing is associated with reductions in distress, depression, anger, and anxiety and increased positive emotion. Of interest, effect sizes appear to be larger if disclosures are completed at home, last at least 15 min, and individuals are provided directed questions; features that are to some extent comparable to patient correspondence in therapist-assisted ICBT.

Increased interest in the benefits associated with expressive writing led to the development of an objective method of analyzing language use, namely the linguistic inquiry word count (LIWC) program (Pennebaker, 1993; Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007). The LIWC program categorizes text, word-by-word, into 64 different linguistic categories, such as positive or negative emotions (e.g., happy, angry), self-references (e.g., me, my), causal words (e.g., because, reason), and insight words (e.g., realize, understand). Of note, analysis of text from early studies using the expressive writing paradigm found three linguistic dimensions that are associated with improved health: (a) high use of positive emotion words, (b) a moderate use of negative emotion words, and (c) an increase in both causal and insight words over the course of writing (Pennebaker, Mayne, & Francis, 1997).

Recent research has examined linguistic dimensions in relation to psychotherapy. For example, Arntz, Hawke, Bamelis, Spinhoven, and Molendijk (2012) used linguistic analysis to measure psychotherapeutic change over time in patients with personality disorders. Analysis of essays written by patients revealed

that first person singular pronouns, negative emotion, causation, and past and future tense verbs significantly declined over the course of treatment, while present tense verbs and positive emotion words increased. Moreover, reduced use of negative emotion words and negations over the course of treatment predicted improved personality disorder severity, general distress, and positive affect.

Zinken, Zinken, Wilson, Butler, and Skinner (2010) analyzed linguistic dimensions of participants with GAD or depression who participated in a guided self-help program. The program involved working through a treatment book and having brief weekly face-to-face meetings with a clinician to discuss progress. Zinken et al. (2010) were interested in whether brief narratives written by participants about their current and previous problems written prior to treatment would predict successful participation in the guided self-help program. The authors explored several predictors of completion (e.g., number of words and clauses, percentage of insight and causation words, percentage of keyword clauses, simple sentences, adverbial clauses, and complement clauses), and found that the use of non-finite complement clauses (e.g. "I want *to get better*") significantly predicted completion. Of those participants who completed treatment, causation words and complex syntax (adverbial clauses) arose as significant predictors of improvement in symptoms. This exploratory research provided initial evidence to suggest that linguistic properties can predict successful participation in a self-help program.

Purpose and objectives

While the writing paradigm and the LIWC program have existed for a substantial period of time, there is a paucity of research examining language dimensions over the course of psychological therapy. This area is of particular importance with the emergence of therapist-assisted ICBT that involves written expression between patient and therapist. Although this study was not designed to make causal claims, it is on track with recommendations for the future of ICBT research (Andersson & Hedman, 2013) by exploring language dimensions that have the potential to predict successful participation in therapist-assisted ICBT in a clinical setting. Finding a relationship between language use and symptoms could serve to stimulate future research in this area, such as the use of linguistic markers to identify patients who are not progressing in treatment or the use of expressive writing to enhance treatment outcomes. Currently, no research has analyzed natural language dimensions of patients with symptoms of GAD during the course of therapist-assisted ICBT. Two research questions rather than specific hypotheses were posed due to the lack of prior research examining linguistic dimensions in the context of psychotherapy, including: (1) Does use of various word categories change over the course of treatment in therapist-assisted ICBT? And (2) Does use of various word categories covary with ratings of anxiety, depression, and panic over the course of therapist-assisted ICBT? As evident in the above literature review, several word categories have been associated with psychological functioning and thus were examined in this study including negative emotion (e.g., hurt, ugly, nasty), positive emotion (e.g., love, nice, sweet), insight (e.g., think, know, consider), causation (e.g., because, effect, hence), self-referential (e.g., I, me, mine), anxiety (e.g., worried, fearful, nervous), and past/present/future tense words. We also explored anger and sadness words as, although not examined in past research, these words fit under the umbrella of affective words and are relevant to the therapeutic context of this study.

Method

Participants

Data were derived from individuals who participated in an open trial of therapist-assisted ICBT for GAD. Full details regarding all participants and treatment are provided in the original report (Hadjistavropoulos et al., 2014). Here, we report details for the 59 adults with symptoms of GAD who completed all 12 modules, since our interest was in how linguistic communication varied with symptom report over the course of treatment.

Participants learned of the open trial through various means (e.g., referral by provider, community advertising), and prior to participating underwent a pre-screening telephone interview to determine whether they were (a) 18 years or older, (b) a resident of Saskatchewan, (c) experiencing symptoms

suggestive of GAD (score of at least 5 on the GAD-7; Spitzer, Kroenke, Williams, & Lowe, 2006), (d) able to access and were comfortable using a computer and the Internet, (e) willing to provide contact information for a medical provider in case of an emergency, (f) not currently participating in psychotherapy, (g) either not on, or had a stable dose of medication for anxiety for one or more months, and (h) not reporting recent or current problems with psychotic disorders, manic episodes, alcohol or substance dependence or abuse or suicide plan or intent as assessed by the Mini-International Neuropsychiatric Interview (Sheehan et al., 1998).

Participants ranged in age from 21 to 67 years with a mean age of 41 years. The majority of the sample were female ($n = 37$; 62.7%) and identified themselves as Caucasian ($n = 48$; 81.4%). Over three quarters of the sample reported post-secondary education ($n = 49$; 83.0%; ranging from some college to university graduate degrees), and most participants reported being employed at the time of participation ($n = 45$; 76.3%). Over half of the sample reported being married or common-law ($n = 37$; 62.7%), followed by being single or dating ($n = 19$; 32.2%), with the remainder being divorced, or widowed. Just over half of participants reported having children ($n = 34$; 57.6%). Finally, approximately half of the sample reported living in large cities (populations $>200{,}000$; $n = 33$; 55.9%), with the other half living in small cities (populations $<40{,}000$; $n = 12$; 20.4%), or towns, villages, or farms ($n = 14$; 23.7%).

Materials and procedure

Internet-delivered cognitive behavior therapy. Participants meeting eligibility criteria were provided with login credentials providing access to 12 modules that covered psychoeducation about GAD and a variety of cognitive and behavioral strategies for managing GAD using a range of media (e.g., text, graphics, audio, and video). Program content was licensed from Swinburne University of Technology National eTherapy Centre in Australia (see Klein, Meyer, Austin, & Kyrios, 2011 for a review). Patients were encouraged to work on one module per week, but on average took 2 weeks per module ($M = 24$ weeks to completion, SD = 8.5 weeks).

Patient–therapist communication. Patients were required to complete a check-in at the beginning of each module; the check-in asked the patient to provide examples and answer optional questions about recommended offline exercises. In addition, patients could send messages to their therapist an unlimited number of times during the week through an internal secure messaging system. Therapists in turn messaged their patients on a set day once a week answering patient questions, providing encouragement and guidance in response to the check-ins and messages. Phone contact was also made on occasion if therapists were encountering difficulties communicating with patients by secure messaging (e.g., patients not responding to messages). Communication was always patient directed; some patients chose to communicate solely through the use of the check-in box, while others chose mainly the email feature, or a combination of the two. Due to this, text from patient check-ins and email messages was combined per module and analyzed together. In addition to the 12 check-in boxes, patients sent an average of 13 emails over the course of the program (SD = 11.90). Average length of all communication analyzed ranged from 190 to 365 words per module, with an average of 292.59 words (SD = 284.40) per module (see Table 1).

Self-report measures. At the beginning of each module, patients completed ratings of anxiety, depression, and panic. Ratings were made on a 0 (no symptoms) to 10 (extremely severe) scale. Patients also completed symptom measures at baseline, mid-intervention, and post-intervention. Measures of interest for this paper included the GAD-7 scale (Spitzer et al., 2006), the Patient Health Questionniare-9 scale (PHQ-9; Kroenke, Spitzer, & Williams, 2001) and the Panic Disorder Symptom Scale—Self Report (PDSS-SR; Houck, Spiegel, Shear, & Rucci, 2002). The GAD-7 scale asks patients how often they have been bothered by a list of seven anxiety symptoms in the past 2 weeks with each item rated on a 0 (*not at all*) to 3 (*nearly every day*) scale. It has good reliability, as well as construct, criterion, factorial, and procedural validity (Lowe et al., 2008). The PHQ-9 scale (Kroenke et al., 2001) assesses symptoms of depression, with items rated using a scale from 0 (*not at all*) to 3 (*nearly every day*). Responses

Table 1. *Descriptive statistics for mood ratings and linguistic dimensions for completers per module (N = 59)*

	Module #											
	1 *M* (SD)	2 *M* (SD)	3 *M* (SD)	4 *M* (SD)	5 *M* (SD)	6 *M* (SD)	7 *M* (SD)	8 *M* (SD)	9 *M* (SD)	10 *M* (SD)	11 *M* (SD)	12 *M* (SD)
Word count	199.4 (159.4)	365.0 (317.7)	299.0 (310.3)	284.8 (264.7)	283.4 (266.0)	363.0 (265.6)	316.2 (298.7)	347.3 (366.1)	298.3 (325.9)	272.0 (266.1)	292.2 (319.0)	190.5 (187.0)
Mood ratings[a]												
Anxiety	5.8 (1.9)	5.7 (1.9)	5.7 (1.8)	4.8 (1.9)	4.9 (2.0)	4.9 (2.1)	4.3 (2.0)	4.0 (2.0)	4.0 (2.2)	3.8 (2.0)	3.7 (2.1)	3.1 (2.1)
Depression	3.3 (2.4)	2.9 (2.3)	2.8 (2.5)	2.8 (2.4)	3.1 (2.5)	3.0 (2.6)	2.3 (2.1)	2.4 (2.2)	2.2 (2.1)	2.4 (2.4)	2.1 (2.2)	1.8 (2.2)
Panic	2.4 (2.3)	2.9 (2.5)	2.8 (2.4)	2.5 (2.3)	2.5 (2.2)	2.6 (2.3)	2.0 (2.3)	1.9 (1.9)	1.9 (2.0)	1.8 (2.2)	1.6 (2.2)	1.4 (2.1)
Word categories[b]												
First person singular	9.6 (3.1)	10.3 (2.9)	9.3 (2.9)	10.1 (2.8)	10.0 (2.7)	10.1 (3.0)	9.4 (2.6)	9.9 (2.2)	10.1 (3.0)	10.2 (3.2)	9.8 (3.3)	8.8 (4.1)
Affective												
Positive	4.2 (1.7)	3.5 (2.2)	4.6 (2.6)	4.6 (2.3)	4.6 (3.0)	4.5 (3.5)	3.7 (1.8)	3.8 (2.0)	4.4 (2.4)	4.5 (2.6)	4.4 (3.2)	4.6 (3.8)
Negative	4.4 (2.7)	4.3 (2.0)	3.2 (1.7)	3.3 (1.7)	2.9 (2.1)	3.0 (1.9)	4.0 (2.4)	2.7 (1.6)	3.6 (1.7)	3.8 (2.1)	2.8 (2.1)	2.3 (2.0)
Anxiety	3.2 (2.5)	2.9 (1.7)	2.1 (1.3)	2.3 (1.3)	1.4 (1.9)	1.5 (1.4)	2.5 (2.0)	1.3 (1.2)	2.1 (1.4)	2.4 (1.9)	1.6 (1.9)	1.5 (1.7)
Sadness	0.4 (0.8)	0.4 (0.5)	0.4 (0.6)	0.2 (0.4)	0.4 (0.5)	0.4 (0.7)	0.3 (0.5)	0.3 (0.5)	0.3 (0.4)	0.4 (0.6)	0.4 (0.8)	0.3 (0.4)
Anger	0.3 (0.5)	0.4 (0.05)	0.3 (0.5)	0.3 (0.4)	0.4 (0.7)	0.4 (0.5)	0.3 (0.5)	0.4 (0.6)	0.3 (0.5)	0.3 (0.8)	0.3 (0.5)	0.1 (0.4)
Cognitive processes												
Causation	2.3 (2.4)	2.1 (1.2)	2.0 (1.8)	2.0 (1.2)	1.7 (1.1)	2.0 (1.1)	1.8 (1.3)	2.2 (1.1)	2.0 (1.6)	2.1 (1.3)	1.6 (1.2)	1.4 (1.2)
Insight	4.2 (2.5)	3.8 (1.6)	3.9 (1.7)	3.8 (1.7)	4.5 (2.5)	5.2 (2.8)	4.1 (1.8)	3.5 (1.4)	4.0 (1.7)	4.0 (2.1)	3.9 (1.7)	3.4 (2.4)
Time												
Past tense	2.1 (1.8)	3.4 (2.1)	3.9 (2.7)	3.1 (2.0)	3.3 (2.0)	3.8 (2.1)	4.0 (2.2)	4.2 (2.3)	3.4 (2.1)	4.0 (2.5)	3.3 (2.0)	2.8 (2.3)
Present tense	10.4 (3.0)	9.8 (3.3)	10.1 (3.4)	10.6 (2.6)	10.7 (3.1)	10.6 (2.9)	10.6 (3.0)	10.1 (2.8)	11.0 (3.4)	11.1 (3.1)	10.5 (3.6)	9.5 (4.3)
Future tense	1.4 (1.2)	1.3 (1.0)	0.9 (0.9)	1.1 (1.0)	1.1 (0.9)	1.0 (0.7)	1.1 (0.9)	1.1 (0.9)	1.2 (1.2)	1.0 (0.9)	1.0 (0.8)	1.0 (1.2)

[a] *Mood ratings are reported on a scale of 0–10: 0, no anxiety/depression/panic; 10, severe anxiety/depression/panic.*

[b] *Statistics for word categories represent the percentage of total words for each word category.*

are summed for a total severity score ranging from 0 to 27. The PHQ-9 scale has been found to be a reliable diagnostic tool with good psychometric properties (Kroenke et al., 2001). The PDSS-SR (Houck et al., 2002) consists of seven items, each rated on a 0 (no symptoms) to 4 (severe symptoms) scale, resulting in a total score from 0 to 28. Items assess frequency of panic attacks, distress caused by panic, anticipatory anxiety, panic-related sensation fear, and work and social impairment. The PDSS-SR has demonstrated excellent psychometric properties and sensitivity to change (Houck et al., 2002).

Linguistic coding

The check-ins and messages were screened for typographical errors and analyzed using the LIWC program to obtain the degree to which patients used different word categories. Scores for each word category were created for communication occurring over each module. Each word category score represents a percentage of total words expressed by a patient (Tausczik & Pennebaker, 2010).

Data analytic approach

Prior to conducting the main analyses, we explored correlations between the ratings of anxiety, depression, and panic and the corresponding established outcome measures (i.e., GAD-7, PHQ-9, PDSS-SR). To examine change and associations over the full active treatment phase for variables of interest (word categories and weekly mood ratings), we performed mixed-effects repeated-measures regression for continuous and count (proportions) data (Hedeker & Gibbons, 2006; Verbeke & Molenberghs, 2000). Mixed-effects regression analysis for longitudinal data incorporates both fixed and random effects and provides accurate statistical inferences with nested data structures that are inherent in repeated-measures data (i.e., observations nested within individuals). Fixed effects express the average level and change across individuals, whereas random effects capture individual heterogeneity in level and change. To examine change over the entire active treatment phase, we included time as a predictor in the regression model (coded as 0–11 to represent equal distance between assessment points and an intercept centered at first measurement point). The fixed coefficient associated with time expressed the average change across all individuals per time score.

To be able to examine the covariation between weekly assessed mood ratings and use of word categories over the full active treatment phase in a single omnibus test, we implemented mixed-effect regression analysis using the mood ratings (weeks 1–12) as the dependent variable, and the word category, measured at the same time points, as a time-varying predictor. That is, a vector of mood ratings from weeks 1–12 served as the dependent variable and a vector of word category scores from weeks 1 to 12 served as an independent variable in the model. Separate repeated measures regression models were performed for each of the word categories of interest. In these analyses, the relationship between the word category scores and mood ratings was examined in a single omnibus test using data from all repeated observations over the active treatment phase. If the test of the effect of the independent variable (word category) was significant, it indicated that the independent variable was associated with the dependent variable (mood ratings). Random effects were retained when they significantly contributed to the model and were assumed to follow a multivariate normal distribution. Significance was determined by the Wald ratio (estimate/standard error) and alpha level was set at .05 (i.e., $z > 1.96$).

Given the presence of substantially skewed data distributions for the linguistic variables, we chose to analyze these data using a mixed-effects Poisson regression (Hedeker & Gibbons, 2006), rather than a mixed-effects linear regression for continuous outcomes. Appropriate data analytic approaches for count data, such as Poisson regression, are often preferred over data transformations and are the state-of-the-art methods in handling such data (see e.g., Elhai, Calhoun, & Ford, 2008; Gardner, Mulvey, & Shaw, 1995).

To signify the magnitude of effect on continuously distributed outcomes, we followed the recommendations and formula provided by Feingold (2009) and calculated a standardized mean difference effect size measure (d) for growth models. To our knowledge, no established standardized effect size measure is available for mixed-effects Poisson regression and time-varying associations in this type of analysis.

Results

Table 1 shows means and standard deviations of scores for linguistic variables and mood ratings on a weekly basis for participants who completed all treatment modules ($N = 59$).

Preliminary analyses

Because our primary analyses used weekly single-item mood ratings and given the importance of establishing that these measures corresponded to the intended constructs (i.e., anxiety, depression, and panic symptoms), we correlated responses on these measures with scores on established measures of similar constructs (GAD-7, PHQ-9, PDSS-SR) that were administrated at pre-, mid-, and post-treatment. Indeed, we found evidence of high agreement between responses on weekly mood ratings and scores on the established measures: anxiety mood ratings at first treatment week were significantly correlated with scores on the GAD-7 scale measured at pre-treatment ($r_s[59] = .69$, $p < .001$); anxiety mood ratings at week 6 (i.e., mid-treatment) were significantly correlated with scores on the GAD-7 scale at mid-treatment ($r_s[59] = .52$, $p < .001$); and anxiety mood ratings at week 12 (i.e., final assessment) were significantly correlated with the GAD-7 scale at post-treatment ($r_s[55] = .65$, $p < .001$). Likewise, mood ratings of depression and panic were significantly and positively correlated with established measures of depression and panic symptoms, PHQ-9 and PDSS-SR, respectively, at pre-, mid- and post-treatment (all $r_s > .62$; all $p < .001$).

Prior to our primary analyses, we also examined whether weekly mood ratings changed over the course of treatment using a series of mixed-effects repeated-measures regression analyses for continuous outcomes. There was a significant effect of time on weekly responses on anxiety mood ratings, est $= -.24$, 95% CI $[-.28, -.19]$, $z = 10.55$, $p < .001$, $d = 1.38$, indicating that participants on average decreased in symptoms rating by 2.64 points over the full assessment period (i.e., 0.24 points decrease per week). Similarly, there was a statistically significant change on weekly mood ratings of depression, est $= -.12$, 95% CI $[-.16, -.07]$, $z = 5.04$, $p < .001$, $d = 0.56$, and panic, est $= -.12$, 95% CI $[-.16, -.08]$, $z = 5.53$, $p < .001$, $d = 0.59$, over the course of treatment. These results mirrored the primary outcome analyses on established measures that showed that participants with GAD improved significantly over the course of treatment (see Hadjistavropoulos et al., 2014).

Change in word use over the course of treatment

To examine whether word use changed over the active treatment phase, a series of mixed-effects repeated-measures regression analysis for count data (proportions) were implemented. Results of these analyses can be found in Table 2.

Affective words. The use of emotional negative words and anxiety words decreased significantly over the course of treatment (p's $< .01$). The use of sadness words also declined over the course of treatment and effect of time approached, but did not reach significance ($p < .1$). The effect of time on use of angry and positive words was not statistically significant.

Cognitive words. Among the cognitive process word categories, causation and insight both decreased over time. The effect of time for the causation category was statistically significant ($p < .01$) and the effect of time for the insight word category approached, but did not reach significance ($p < .1$).

Time words and first person words. The use of past tense verbs increased significantly over the course of treatment ($p < .05$). Among the time word categories, no other significant change was observed. Likewise, the use of first person words did not change over time.

Word use associations with symptom ratings over the course of treatment

To examine the covariation of word use and mood ratings over the course of treatment, a series of mixed-effects repeated-measures regression analyses for count data were implemented. In each analysis, the mood ratings (weeks 1–12) served as the dependent variable and the word category, measured at the same time points, as a time-varying predictor. The effect of the word category on mood ratings over multiple assessment points was examined in a single omnibus test. The results of the mixed-effects regression analyses are presented in Table 3.

Table 2. *Results of mixed-effects repeated-measures Poisson regression of change on rates of word use over the course of treatment*

Word category	Est. of time effect	SE	Intercept variance	Slope variance
First person singular	−0.003	0.004	0.026	< 0.001
Affective				
Positive	0.004	0.006	0.04	<0.001
Negative	−0.033**	0.006	0.054	<0.001
Anxiety	−0.052**	0.009	0.10	<0.001
Sadness	−0.034†	0.019	0.101	<0.001
Anger	−0.031	0.025	0.19	0.002
Cognitive processes				
Causation	−0.023**	0.008	0.009	<0.001
Insight	−0.009†	0.006	0.032	<0.001
Time				
Past tense verb	0.012*	0.006	0.057	0
Present tense verb	0.001	0.003	0.012	<0.001
Future tense verb	−0.018	0.011	0.046	<0.001

Notes. N = *59*. *The variances associated with the intercepts and the slopes are all significantly different from zero, with the exception of the slope variance for past tense verb word category*. *SE, standard error of estimate* *p < *.05*. **p < *.01*. †p < *.1*.

Anxiety ratings. Negative, anxiety, and sadness emotional word categories were all significantly (p's < .05) and positively correlated with anxiety ratings over the course of treatment (weeks 1–12), indicating that increased use of any of these word categories was associated with heighted anxiety symptoms. The use of positive words demonstrated a tendency to be inversely related to anxiety ratings, but the effect merely approached significance ($p < .1$). None of the other word categories were significantly related to ratings of anxiety symptoms.

Depression ratings. Negative, sadness, and angry emotional word categories were all significantly and positively correlated with depression ratings (p's < .01) over the course of treatment (weeks 1–12), indicating that increased use of any of these word categories was associated with heighted depression symptoms. None of the other word categories were significantly related to ratings of depression symptoms.

Panic ratings. Negative and anger emotional word categories were significantly (p's < .05) and positively correlated with ratings of panic symptoms over the course of treatment. Sadness emotional word category also had a positive covariation with ratings of panic over the course of treatment, but the effect merely approached significance ($p < .1$). None of the other word categories were significantly related to ratings of panic symptoms.

Discussion

Therapist-assisted ICBT is a well-established efficacious method of delivering therapy for mental health disorders including GAD (Paxling et al., 2011; Robinson et al., 2010). In addition to the standard cognitive and behavioral elements found within face-to-face CBT, therapist-assisted ICBT also includes the element of expressive writing. Given that past research has demonstrated psychological and physical benefits associated with expressive writing (Frattaroli, 2006), the ways in which patients express themselves and communicate with their therapists may have an added positive or negative impact on their psychological functioning. Research has demonstrated language changes over the course of therapy with personality disorders (Arntz et al., 2012) and depression (Van der Zanden et al., 2014), and shown associations between linguistic dimensions and symptom improvement (Zinken et al., 2010); however, prior to this study no studies have examined potential associations between language use in patients with symptoms of GAD receiving therapist-assisted ICBT. In addition to this limited research base, this study found significant

Table 3. *Results of mixed-effects repeated-measures regression of time-varying associations between linguistic variables and weekly symptom ratings over the course of treatment*

Word category	Est. of association	SE	Intercept variance
Anxiety ratings			
First person singular	0.004	0.007	0.095
Affective			
Positive†	−0.013	0.008	0.096
Negative***	0.036	0.009	0.095
Anxiety***	0.033	0.010	0.095
Sadness*	0.076	0.031	0.095
Anger	0.049	0.033	0.096
Cognitive processes			
Causation	0.016	0.012	0.096
Insight	−0.002	0.009	0.096
Time			
Past tense verb	−0.007	0.009	0.1
Present tense verb	−0.005	0.006	0.097
Future tense verb	0.011	0.019	0.096
Depression ratings			
First person singular	0.003	0.009	0.846
Affective			
Positive	−0.012	0.01	0.847
Negative***	0.046	0.012	0.854
Anxiety	0.009	0.015	0.849
Sadness***	0.176	0.039	0.833
Anger**	0.111	0.042	0.842
Cognitive processes			
Causation	0.014	0.016	0.848
Insight	0.008	0.012	0.850
Time			
Past tense verb	−0.012	0.012	0.847
Present tense verb	0.007	0.008	0.843
Future tense verb†	0.041	0.023	0.841
Panic ratings			
First person singular	0.002	0.010	1.112
Affective			
Positive	−0.015	0.010	1.115
Negative***	0.046	0.0138	1.106
Anxiety	0.023	0.017	1.111
Sadness†	0.090	0.047	1.113
Anger*	0.102	0.045	1.099
Cognitive processes			
Causation	0.013	0.018	1.116
Insight	0.001	0.013	1.113
Time			
Past tense verb	0.010	0.012	1.117
Present tense verb	−0.007	0.009	1.117
Future tense verb	−0.013	0.026	1.114

Notes. N = *59. We also estimated models with a random effect for the time-varying predictor (i.e., random effect of slope), but these models did not converge due to non-significant variance. The variance associated with intercept is significant in all models. SE, standard error of estimate.*
*p < *.05*. **p < *.01*. ***p < *.001*. †p < *.1*.

changes in how patients naturally communicated over the course of ICBT and found that patient's language use was significantly associated with their symptomatology.

Consistent with Arntz et al. (2012), we found that negative emotion, anxiety, and causation words declined over the course of treatment. Moreover, in line with findings by

Arntz et al. (2012), we found that negative emotion words showed the strongest link to symptom improvement. Unlike Arntz et al. (2012), however, we observed an increase in past tense words over the course of treatment, as opposed to a decrease. We also found an increase in the use of causation words over the course of treatment, but unlike Zinken et al. (2010), causation words were not linked to symptom improvement.

Changes in some of the linguistic categories were consistent with what clinicians would expect to observe in successful treatment of GAD. That is, a decline in negative emotions words and anxiety words in communication over the course of ICBT suggests that patients may be becoming more successful at expressing balanced thoughts as opposed to negatively distorted thoughts (Arntz et al., 2012). Of note, there was also a decline in insight words and causation words. The meaning of these changes deserves further research attention. Potentially, a decrease in causation words over the course of the program could indicate a change in thinking patterns. In terms of insight words, examination of the pattern suggests that there was a sharp increase in the use of insight words until approximately mid program, where these words decreased dramatically. This is also of potential interest and future research could explore if this could be a marker of the point when patients are garnering the most insight into their thoughts, behaviors, and feelings. While it is apparent that therapist-assisted ICBT for GAD is effective as evidenced by outcome scores, this linguistic data provides researchers and clinicians with a richer understanding of when and how change is occurring for patients.

The results of this study have potential clinical implications for delivery of therapist-assisted ICBT. In addition to obtaining richer knowledge about patient communication in ICBT, linguistic data may prove to be of assistance in clinical practice. Identifying differences in patients' communication early on, for example, not observing a decline in negative emotion words or causation words may indicate to clinicians that a patient is struggling. Attrition is a significant challenge faced in ICBT (Melville, Casey, & Kavanagh, 2010); therefore, having an additional method of identifying those at risk and intervening may help to increase patient engagement.

In this study, we demonstrated that word use was associated with symptomatology; however, we cannot be certain of the directionality of this relationship. Given that this was a study of a treatment program, we assume that a large proportion of the change in word use is due to successful change in thinking due to treatment; however, working within the cognitive behavioral framework and with evidence acquired from research with the expressive writing paradigm, we know it is also possible that the way we write could impact thoughts and behaviors. Given that we have some knowledge of what type of communication is beneficial for patients (e.g., reduced negative emotion words), future research on this topic would be valuable. For example, would guidance in writing maximize outcomes? Previous research has found that giving different instructions on ways to write can increase benefit within experimental disclosure studies (e.g., Lu & Stanton, 2010), but investigating this in a therapeutic context warrants further attention.

There are several limitations of this study that are important to acknowledge. First, patients took a variable amount of time to complete treatment. While all were encouraged to complete one module per week, most took longer, which could have impacted the type or amount of communication in each module. Patients also varied in the amount of text they wrote to their therapist. Amount of communication was patient directed, as the objective of this study was to improve our understanding of patients' natural course of communication with their online therapists over the course of ICBT. Nevertheless, results may be different if constraints were placed on the amount of text sent to therapists. This study computed correlations between linguistic dimensions and simple ratings of mood measured at each module, rather than symptom measures which were only collected at three time points. Although mood ratings and symptom measures were correlated, it would have been ideal to have full symptom measures available at each of the 12 time points to compare with linguistic dimensions. With regard to generalizability, this study only analyzed those participants that completed all 12 modules; therefore, results may not be comparable to intent-to-treat samples or treatment programs of different lengths. Furthermore, the findings from this study are from

an ICBT program for patients with symptoms of GAD; therefore, we know that negative emotion words and anxiety words are especially relevant for patients with symptoms of GAD. Future research is needed to determine whether the results obtained in this study are unique to patients with symptoms of GAD or whether they are generalizable to different patient populations. Lastly, we acknowledge that the LIWC program categorizes words into 64 different linguistic categories. In order to reduce the probability of finding spurious results, we focused on affective categories or categories that arose as significant and were linked to psychological well-being in past research which increases our confidence that our findings are not due to chance. It is possible that the study of other word categories could produce different results. Since completing this study, a study by Van der Zanden et al. (2014) explored whether language use in group chat sessions predicted successful treatment in an online cognitive behavioral six-session group course for young adults with depressive symptoms. The authors found that increasing discrepancy words predicted improved depression scores.

In sum, this study demonstrated that patients' communication over the course of a therapist-assisted ICBT program changes in significant ways. The strongest results emerged for negative emotion words, with patients demonstrating a decline in negative emotion words over the course of the program. Furthermore, negative emotion words were associated with symptom measures of anxiety, panic, and depression over the course of the program. While causal statements cannot be made, findings improve our understanding of patient communication in therapist-assisted ICBT and suggest that the further study of linguistic dimensions as psychological indicators and the potential utility of expressive writing strategies in therapist-assisted ICBT may be worthwhile.

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Notes

* dale.dirkse@gmail.com
** hugo.hesser@liu.se
† azy@edu.haifa.ac.il

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