Changes in self and object representations following psychotherapy measured by a theory-free, computational, semantic space method

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Abstract
We propose a theory-neutral, computational and data-driven method for assessing changes in semantic content of object representations following long-term psychodynamic psychotherapy. Young adults in psychotherapy are compared with an age-matched, non-clinical sample at three time points. Verbatim transcripts of descriptions of the self and parents were quantified in a semantic space constructed by Latent Semantic Analysis. In the psychotherapy group, all representations changed from baseline to follow-up, whereas no comparable changes could be observed in the comparison group. The semantic space method supports the hypothesis that long-term psychodynamic psychotherapy contributes to sustained change of affective-cognitive schemas of self and others.

Keywords: technology in psychotherapy research and training; statistical methodology; process research; outcome research; long-term psychotherapy; latent semantic analysis; object representations

Changes in object representations are assumed to play a fundamental role in psychodynamic psychotherapy (e.g., Blatt, Auerbach, & Aryan, 1998; Blatt, Zuroff, Hawley, & Auerbach, 2010; Fonagy & Kächele, 2009). In previous research, various methods for assessing object representations have been developed (Huprich & Greenberg, 2003). Typically, instruments are based on theories of what constitutes an object representation (e.g., Blatt, 2008; Blatt & Auerbach, 2003; Blatt, Auerbach, & Behrends, 2008; Westen, 1991), including what the most important properties of object representations are, and which of these properties are likely to change during psychotherapy. Such theory-driven measures of object representations may be useful for evaluating the particular theory they were designed for. However, they may be biased to some theory-specific aspects thereby being at risk of ignoring other potentially important characteristics. In this paper we suggest and evaluate a method that avoids these risks. In particular, we show how semantic changes in verbal descriptions of self, mother and father can be quantified and statistically tested by a computational method that measures the semantic content of verbal statements. This is done by first constructing a semantic representation from a huge corpus of

natural language using information of co-occurrence of words, a method called Latent Semantic Analysis (LSA). Next, we insert the verbal descriptions of self and others into this semantic representation and apply appropriate statistical techniques to assess semantic differences.

Perhaps the most common method for computerized text analysis is Content Analysis (CA), a method based on frequency counts of words that are matched to pre-defined word lists thematically ordered into categories according to some theoretically anchored assumptions (cf., Bucci, 1997; Bucci & Maskit, 2006; Buchheim & Mergenthaler, 2002; Mergenthaler, 2008; Mergenthaler & Bucci, 1999). In contrast, LSA is an inductive method that first builds up an extensive semantic representation of language and which allows for studying semantic changes in object representations without theory-driven measures that otherwise could influence the results. Salvatore, Tebaldi and Poti (2008) applied a mathematically sophisticated method and analysed lexical variance as a function of time in a single subject during psychotherapy. Using Factorial Analysis of Lexical Correspondence (FALC; Lancia, 2002), they found a reduction of semantic dimensionality across the time of psychotherapy. This approach differs

fundamentally from ours in several ways, including a lack of an elaborated semantic representation from a huge text corpora and no direct test of general changes in semantic representations.

This study has three aims: (1) To propose a method for investigating semantic changes in spoken-language data in psychotherapy research based on the quantification of semantic representations by means of LSA. (2) To evaluate the applicability of this method for studies of semantic change in representations of the mother, father and self among young adults undergoing long-term psychodynamic psychotherapy. (3) To compare the representations of mother, father and self of young adults undergoing psychotherapy with those of an age-matched, non-clinical sample.

Latent Semantic Analysis

The rapid development in the field of information technology, in particular natural language programming, provides an abundance of new possibilities regarding research methods. To date, however, these advances have little influenced psychotherapy research. This is unfortunate, since spoken language is the very essence of psychotherapy, and therefore language technology may have a significant impact and allow for measuring and studying aspects of psychotherapy hitherto not accessible.

Latent Semantic Analysis was originally developed as a computational model of acquisition and representation of semantic, or lexical, knowledge (Landauer & Dumais, 1997). LSA does not rely on pre-defined word-lists, but employs a relatively simple method of induction to extract and represent semantic information from large text corpora. The logic of the method rests on the simple concept that some domains of knowledge contain vast numbers of weak interrelations that, if appropriately utilized, can greatly ameliorate learning by a process of inference (Landauer, Foltz, & Laham, 1998).

In LSA, a high-dimensional semantic space is created from a very large text corpus, where this corpus may differ from the text data that a researcher ultimately wants to analyse. A matrix is set up in which the columns correspond to text contexts (paragraphs, clauses or any other unit comprising a number of words), while every individual word is represented by a row. The result is a huge matrix describing the incidence of words in contexts, i.e., every cell contains information about how many times a word occurs in the corresponding context. Next, the cell entries are subjected to a transformation in which each cell frequency is weighted by the logarithm of the frequency plus one, so that common words in particular context are weighted

lower compared to the original matrix. The resulting matrix then undergoes a mathematical procedure known as Singular Value Decomposition (SVD), a data compression algorithm related to factor analysis, which diminishes the huge number of original contexts to a modest number of semantic dimensions while maintaining as much information as possible from the original matrix (Landauer & Dumais, 1997; for a detailed account of the computational procedures see Landauer et al., 1998).

Certain features are vital to the understanding of LSA. First, the resulting semantic space is not a perfect representation of the cell values in the original matrix, but is rather a best fit, where mutual constraints have been taken into account. This means that a change of a single cell value in the original matrix may entail changes to all values in the high-dimensional semantic space. This can be envisioned as a two-dimensional scatter-plot where the distances between every dot (representing a word) and every other dot are represented by a number. Thus, if the position of one single dot is changed, all distances in the scatter-plot change. Second, the space can be thought of as representing the probability that a certain word appears in a certain context or the substitutability of words (cf., probabilistic latent semantic analysis, pLSA; Blei, Ng, & Jordan, 2003). Third, words that are closely related in meaning are situated close to each other in the space. Thus, one would expect proximity between *baby* and *infant*, but not between *baby* and *coffee*. Fourth, words that occur very frequently are given relatively little weight. A word that occurs in a large number of valid sentences, for example the word *and* (in English), carries relatively little information distinguishing one sentence from another. In summary, the semantic space is a spatial model of the meaning of words, generated not by human input but by a mathematical method of induction and generalization.

Note that the only information LSA makes use of is the co-occurrence of words in contexts. LSA does not have access to the dimension of lived experience, where the meaning of words could also be derived by co-occurring information in the physical or social contexts, including other modalities such as vision, smell, etc. Nor does it make use of syntactic relations, morphology or etymology as clues to the meaning of a word. Despite these limitations, LSA has been shown to learn semantic aspects of language with a quality comparable to that of humans. On a multiple-choice synonym test included in the Test of English as a Foreign Language, TOEFL, an LSA-based system scored as well as academics from non-English-speaking countries (Landauer et al., 1998). LSA has also

been successfully employed for assessing the quality of essays (Miller, 2003), measuring textual coherence (Foltz, Kintsch, & Landauer, 1998), examining gender stereotypes expressed in media texts (Sikström, 2007), and to compare the degree of incoherence in speech of patients with schizophrenia with controls (Elvevåg, Foltz, Weinberger, & Goldberg, 2007). However, this method has not been adapted to studies of object representations and therapeutic change.

Object Representations, Psychopathology and Therapeutic Change

Lasting symptom reduction is deemed an essential component of successful psychodynamic psychotherapy; however, it is typically regarded as secondary to fundamental changes in psychic structure and personality organization (Fonagy & Kächele, 2009; Kernberg, 2004; Shedler, 2010). This statement calls for scientific inquiry of changes in psychodynamic long-term psychotherapy beyond the symptom-related outcome measures. The concept of cognitive-affective schemas or mental representations of emotionally significant relationships is widely acknowledged in many fields of psychology and offers a viable way of investigating the intrapsychic aspects of therapeutic change (Blatt & Auerbach, 2003). Most models of psychodynamic, long-term psychotherapy suggest a non-directive, explorative way of helping people overcome a broad spectrum of difficulties assumed to originate from unconscious remainders of early relationships (Kernberg, 2004; Shedler, 2010).

The notion of object representation is derived both from clinicians' experiences in the psychoanalytic treatment setting and from infant observation. It is conceptually closely related to the notion of cognitive-affective schemata found in attachment theory, developmental psychology and social cognition. According to both attachment theory and Blatt's psychoanalytical model, cognitive-affective schemas or representations of emotionally significant relationships develop through the internalization of aspects of early transactions between the self and significant others (Behrends & Blatt, 1985). Representations of the other and the self are revised and modified throughout development, enabling individuals to think of themselves and others in a more differentiated and integrated fashion and to relate to others in more mature ways. The idea of a progression from sensorimotor to perceptual to iconic and finally to conceptual object representation has its roots in the cognitive developmental work of Piaget (1954/1937). Object representations are assumed to evolve from lower to higher levels of

differentiation and integration, whereas a person with mature object representations may operate at a less developed level in times of distress (Blatt, Wiseman, Prince-Gibson, & Gatt, 1991). These cognitive-affective schemas regulate a wide range of subsequent behaviour and mould interpersonal relationship and social interactions (e.g., Ainsworth, 1969; Anderson, 1983; Beebe & Lachmann, 2002; Blatt, 2008; Bowlby, 1979; Brewer & Nakamura, 1984; Horowitz, 1988; Huprich & Greenberg, 2003; Main, Kaplan, & Cassidy, 1985; Mandler, 1988; Markus, 1977; Sandler & Rosenblatt, 1962; Stern, 1985; Westen, 1991).

In empirical exploration of object representations, researchers have employed projective methods, such as the Rorschach and the Thematic Apperception Test (TAT), expert scoring of narrative material from projective tests (Blatt, Brenneis, Schimeck, & Glick, 1976; Westen et al., 1991), self-report questionnaires, and percept-genetic techniques (Eklund & Nilsson, 1999; Huprich & Greenberg, 2003). Evaluation of object representations coming from open-ended questions tends to be complex, consisting of a number of sub-scores and theory-driven. For example, the Object Relations Inventory (ORI; Blatt, Wein, Chevron, & Quinlan, 1979; Diamond, Kaslow, Coonerty, & Blatt, 1990; Gruen & Blatt, 1990) is a set of procedures for evaluating open-ended descriptions of the self and significant others. Three aspects of object representations are evaluated: Conceptual level (articulation and complexity); thematic dimensions (qualitative characteristics); and level of differentiation-relatedness (the capacity to form an integrated, mature sense of self, and at the same time to establish empathic and reciprocal relationships).

Research findings suggest that the complexity, integration and content of object representations are closely related to various forms of psychopathology. The conceptual level of parent descriptions has been found to be significantly related to depression, emotional awareness and self-reported acting out; psychotic and borderline individuals' descriptions of their parents are less differentiated, less conceptually complex, more negative and more ambivalent compared to a non-clinical sample (Blatt, 2004, 2008; Blatt, Auerbach, & Levy 1997). Length and complexity of parental representations has been found negatively correlated to level of psychopathology, as assessed on the Global Assessment Scale (Blatt, Stayner, Auerbach, & Behrends, 1996). Young adult inpatients have been shown to have more negative perceptions, express greater ambivalence, and express themselves with less articulation and complexity regarding both parents than matched controls (Bornstein & O'Neill, 1992). Furthermore,

young patients' self-descriptions were characterized by greater negativity, weaker sense of agency, less tolerance of contradiction, poorer differentiation and less substantiality (Bers, Blatt, Sayward, & Johnston, 1993).

The therapeutic progress appears to occur through similar mechanisms, as in normal psychological development (Blatt, Auerbach, & Behrends, 2008). Several studies (Blatt et al., 1991, 1996; Gruen & Blatt, 1990; Vermote, 2005; Vermote et al., 2010) confirm that patients describe their parents in more relational terms and in a more differentiated and nuanced way after psychodynamic psychotherapy. These changes correlate with clinical improvement. Studies of cognitive-affective schemas of self and significant others provide a method for investigating therapeutic change (Blatt & Auerbach, 2001).

Objectives and Hypotheses

Previous research suggests that changes in object representations constitute a highly relevant aspect of progress in psychodynamic psychotherapy. The methods hitherto employed for examining change in object representations are typically based on scales derived from psychoanalytic and cognitive developmental theories. In the studies cited above, statistical testing is performed on theoretically constructed scales and measures rated by human observers. Latent Semantic Analysis can contribute to the understanding of change in object representations by quantifying what is actually said, and thus providing a clear and theory-free measure of object representations.

In the current study, young adults in psychodynamic psychotherapy were compared to an age-matched non-clinical comparison group (not applying for psychotherapy). The following hypotheses were tested:

(1) Initially, self-representations in the psychotherapy sample will differ from those in the non-clinical sample. Theoretically speaking, the patients' symptoms are connected with their self-representations. At termination and at post-therapy follow-up, self-representations in the psychotherapy sample will change and become indistinguishable from those in the non-clinical sample.
(2) Parental representations in the psychotherapy sample will differ initially from those in the non-clinical sample and will change following psychotherapy. Furthermore, in the non-clinical sample, parental representations will not change over the equivalent time interval. The theoretical assumption here is that psychodynamic

psychotherapy has specific effects on parental representations not reducible to the effects of natural development and maturational process in young adulthood.

Method

The present study is based on material collected in the naturalistic, prospective and longitudinal Young Adults Psychotherapy Project (YAPP). A total of 134 patients applying for psychoanalytic individual ($n = 92$) and group psychotherapy ($n = 42$) between 1998 and 2002 were included in YAPP. Mean age at inclusion was 22 years (range 18–25; *SD* 2.2), and 73% of the participants were women.

Every second patient in individual psychotherapy and all patients in group psychotherapy were interviewed prior to psychotherapy. All patients were also interviewed at termination and at follow-up 1.5 years after termination. All patients completed a battery of self-rating instruments pre- and post-treatment, as well as at follow-ups. Treatment outcome was studied at termination and long-term follow-up (Lindgren, Werbart, & Philips, 2010; Philips, Wennberg, Werbart, & Schubert, 2006).

Participants

Psychotherapy sample. All women in individual psychotherapy who completed interviews on all three occasions at the time of the present study were included ($n = 25$). Due to the small number of men in individual psychotherapy ($n = 5$), men in group psychotherapy were also included ($n = 11$), raising the sample size of men to 16. Thus, the psychotherapy sample comprises 41 cases in all. The mean age at baseline was 22 years ($SD = 2.2$). Socio-demographic data and DSM IV diagnoses (American Psychiatric Association, 1994) are presented in Table I.

The sample's scores in terms of expert-rated Global Assessment of Functioning (GAF; American Psychiatric Association, 1994) and self-rated symptom severity according to SCL-90-R (GSI; Derogatis, Lipman, & Covi, 1973; Derogatis, 1994) (Table II) improved significantly post-treatment. No significant differences in age, functioning (GAF) and severity of symptoms (GSI) were found between the participants and dropouts prior to psychotherapy.

Comparison group. A non-clinical sample of 20 young adults in general, i.e., not applying for psychotherapy (11 women and nine men) was recruited using directed sampling (Barker, Pistrang, & Elliott, 2002). Various meeting places where young adults

Table I. Socio-demographic data (psychotherapy sample and comparison group) and DSM IV diagnoses (psychotherapy sample) at baseline

	Psychotherapy sample ($n = 41$)		Comparison group ($n = 20$)	
	n	%	*n*	%
Occupation				
Employed	12	29.3	7	35.0
Studies	28	68.3	10	50.0
Sick-leave	1	2.4	1	5.0
Work and studies	0	0	2	10.0
Living				
Alone	18	43.9	5	25.0
With a partner or spouse	14	34.1	9	45.0
With parents	7	17.1	6	30.0
With roommates	2	4.9	0	0
Family of origin				
Grown up with both parents	39	95.1	18	90.0
Grown up with mother	2	4.9	2	10.0
Children	0	0	3	15.0
Country of origin				
Born in Sweden	36	87.8	15	75.0
Born abroad	5	12.2	5	25.0
At least one parent born abroad	9	22.0	7	35.0
Previous psychiatric contact	18	43.9	3	15.0
Previous psychotherapeutic contact	15	36.6	0	0
Axis I diagnoses	22	53.7		
Depression spectrum disorders	11	26.8		
Anxiety spectrum disorders	6	14.6		
Substance abuse	3	7.3		
Other diagnoses	2	4.9		
Axis II diagnoses	16	39.0		
Cluster A	4	9.8		
Cluster B	5	12.2		
Cluster C	12	29.3		
Depressive Personality Disorder	3	7.3		
Personality Disorder NOS	6	14.6		
Multiple PD diagnoses	9	22.0		
Both Axis I and Axis II diagnoses	4	9.8		
No psychiatric diagnosis	8	19.5		

could be expected to be found, e.g., Youth Employment Office, restaurant chains etc., were contacted. Half of the sample was added through stratified convenience sampling and informal inquiries, a maximum of one subject from each source, in order to best complement the sample with regard to gender, age and housing area. The mean age was 22 years ($SD = 2.4$). The subjects were interviewed and completed the same battery of self-rating instruments as the clinical sample at baseline, 1.5 and 3 years later.

The mean self-rated symptom severity (GSI) at baseline was at about the same level as for the young adult population in Stockholm County ($M = .76$, $SD = .62$; Jacobsson, Lindgren, Werbart, & Boalt Boëthius, 2004) and did not change significantly 1.5 and 3 years later (Table II). This relatively high level of symptom severity reflects the increased prevalence of mental disorders among young adults in the Western world (Grant & Potenza, 2009). The subjects were neither diagnosed nor GAF rated.

Treatments and Therapists

The 41 patients in the psychotherapy sample were treated by 22 therapists, of whom eight were psychoanalysts, 13 were psychotherapists and one was a psychologist with basic training in psychotherapy. Mean age of the therapists was 56 years (range 36–64; SD 6.8), and 14 of them were women. The therapists were highly educated and experienced in psychotherapeutic work, and most were also engaged as teachers and supervisors at an advanced psychotherapy training programme. The mean length of individual psychotherapies was 22.6 months (SD 13.02, range 5–55) with a frequency of two sessions a week ($n = 18$) or one session a week ($n = 12$). The 11 men in group psychotherapy participated in two mixed-gender groups that met for one double session per week. The men stayed in group psychotherapy for an average of 18.4 months (SD 5.9, range 5–38).

Table II. Descriptive statistics and effect sizes of outcome data for psychotherapy sample and comparison group

	Pre-treatment		Termination		Follow up				
	M	*SD*	*M*	*SD*	*M*	*SD*	es^1	es^2	es^3
Psychotherapy									
GAF[a]	56.29	5.93	69.66	11.91	67.20	12.62	2.25	−.21	1.84
GSI[b]	1.28	.64	.73	.73	.73	.61	.85	.01	.86
Comparison									
GSI[b]	.71	.43	.55	.36	.62	.51	.39	−.17	.22

Note: es^1, pre-treatment to termination.
es^2, termination to follow-up.
es^3, pre-treatment to follow-up.
[a]Global Assessment of Functioning Scale.
[b]Symptom CheckList-90, Global Severity Index.

The psychotherapies were conducted in accordance with standard descriptions and procedures of psychoanalytic psychotherapy without use of an explicit treatment manual. The treatments generally aimed at helping the patients overcome hindrances on the threshold of adulthood and better handle strains in everyday life. The treatment option depended on what modality was available at the moment. Treatment duration was adapted to the needs of the individual patient and was formalized in a written, renegotiable contract between therapist and patient. All included treatments ended by mutual agreement.

Material and Preparatory Arrangements

The data material in the psychotherapy sample was collected between 1998 and 2008, and in the comparison group between 2000 and 2004. The questionnaires and interviews were administered in the same setting for both groups. The interview protocol followed the Object Relations Inventory (ORI; Blatt et al., 1979; Diamond et al., 1990; Gruen & Blatt, 1990). Participants were asked to give a description of her or his mother, father, herself/himself, and the therapist (not used in the present study). Upon the spontaneous response, the interviewer asked the respondent to elaborate on each adjective or descriptive phrase in the spontaneous description. The audio-recorded interviews were conducted by trained interviewers. The verbatim transcripts were adapted for the computerized semantic analyses by removing the interviewers' utterances and dividing the transcripts into sections concerning mother, father and self, respectively. Thus, each utterance consisted of one participant's answer to one question concerning mother, father or self. The resulting text consisted of 492 utterances in total for the therapy group, and 240 utterances for the comparison group. Accounts of hesitation, laughter and other paralinguistic information were deleted from the transcripts, because these verbal markers were not present in the written corpus from which the semantic space was generated using LSA.

Data Analysis

A Swedish semantic space was created using Infomap software (http://infomap-nlp.sourceforge.net/). The space was based on 100,000 news articles published in 100 different Swedish newspapers and magazines in the autumn of 2008. Access to these was provided through the courtesy of Affärsdata (www.ad.se), a company that provides access to a database of Swedish news media. The context size in the LSA algorithm was a set of 15 words before and after the processed word. The number of dimensions in the space was set to 100, because either fewer of more dimensions gave poorer performance as measured by synonym test (Sikström, 2007).

Swedish newspapers, rather than the interview transcripts, were used to build the semantic space, simply because the interview data set was not sufficiently large to construct a high-quality semantic representation. A reasonably representative semantic space requires a corpus of 100 Mb or larger (we used approximately 250 Mb), whereas the size of the interview data was less than 1 Mb, which would have led to a space with arbitrary or idiosyncratic associations.

All utterances for each description of self and others were mapped onto the space. Every utterance was summarized in the semantic space by the average location of all the words included in the utterance. This means that we find a point in the semantic representation that best summarizes all the words in the utterance, where each word also represents a separate point in the space.

The resulting "utterance" vectors in the semantic space were normalized to a length of one. Normalization is used because semantic distance is

measured by the *angle* between two vectors, and thus the vector length is irrelevant for this measure. The normalization is performed by first calculating the length of the vector, which is simply the square root of the sum of the squared values on each dimension (i.e., the Pythagorean equation). The normalized vector is then equal to the old vector divided by the length of the old vector.

Analysis of semantic change. Statistical tests of whether two conditions differ in semantic content are rarely, if ever, done in psychology. Here, we apply this method for the first time in psychotherapy research, testing unpaired conditions in comparisons between the psychotherapy and the non-clinical samples, and paired conditions in within-subjects comparisons.

Unpaired test of semantic difference. First, we summarized all statements in a condition as the average location of the statements in this condition and normalized the length of the vectors to one. Then we measured the semantic distance between the conditions. Following the convention in the LSA literature, we measured this semantic distance in the semantic space as the cosine of the angle between the two vectors representing the conditions. Because the vectors are normalized to a length of one, the cosine of the angle can simply be calculated as the sum of the pairwise multiplication of each semantic dimension, or commonly referred to as the dot product between the vectors. If the vectors are identical, then this value is simply $+1$, if they are exactly opposite then the value is -1, and if they are unrelated the value is zero (i.e., the expected value of two randomly drawn vectors).

To establish whether the differences observed were due to random variability or not, statistical bootstrapping was employed. The bootstrap is a statistical procedure of re-sampling with replacement (Efron & Tibshirani, 1993). In this context, it is used to estimate the degree of random variability when the statements were randomly assigned to conditions. The obtained semantic distance scores can be compared with the distances obtained when the statements were divided according to which condition it belonged to. A statistical P-value can then be calculated by counting the number of random assignments that have a larger semantic distance than the non-randomly assigned trials. Because the family-wise error rate increases with multiple pairwise comparisons, the P-level was adjusted with the Holm-Bonferroni correction (thus, since there were three possible comparisons, the lowest P-value

was deemed significant if $< .0167$, the second lowest if $< .025$, and the highest if $< .05$) (Holm, 1979).

Paired test of semantic difference. When comparing the same subjects on repeated testing, a paired testing is preferable, where the between-subject variability can be removed to further improve the sensitivity of the test. For paired tests, it is not suitable to use the semantic distance measure as the cosines of the angle, simply because this measure is symmetrical and therefore will not be affected by the order in which the conditions are subtracted. To avoid this obstacle, we measure the semantic distance with the Euclidean distance measure along the vector representing the difference between the conditions. Thus, this distance can be positive or negative for a given participant, providing a support for the paired distance test. To get P-values statistically we apply the bootstrap method as described above, where the random assignments are made pair-wise on a subject-by-subject basis. The semantic difference in the semantic space within subjects is tested between baseline vs. termination/second interview, termination/second interview vs. follow-up/third interview and for baseline vs. follow-up/third interview for either the therapy or the comparison group.

While calculating the significance we also produced z-values by z-transforming the semantic distance scores (calculated as described above), i.e., by subtracting the semantic distance between the two conditions by the semantic distance during random assignment of the utterances, and then dividing the resulting value by the standard deviation of the semantic distance during random assignment of the utterances. The effect size (Cohen's d) was calculated in the same way, with the exception that we divided by the standard deviation rather than standard deviation of the mean of a group of utterances (i.e., by dividing the z-value by the square root of the number of utterances). The standard deviation is obviously larger than the standard deviation of the mean for a group of utterances.

Results

Semantic Difference between the Psychotherapy and the Non-Clinical Sample

Unpaired tests were performed to find out whether the psychotherapy sample differed from the non-clinical sample in semantic content of their descriptions of self, mother and father, respectively, where the results in Table III are presented as effect sizes. At baseline, the descriptions of self in the psychotherapy sample were different from those of

Table III. Effect sizes of differences in semantic content between psychotherapy sample and comparison group

Description	es^1	es^2	es^3
Mother	.00	.08	.40*
Father	.19	.07	.32†
Self	.55***	.23	.03

Note: es^1, baseline/first interview.
es^2, termination/second interview.
es^3, follow-up/third interview.
*Significant at the .05 level.
***Significant at the .001 level.
†Tendency, $P=.052$.

the comparison group ($z = -5.198$, $P<.001$). This is graphically illustrated in Figure 1 (upper graph), whereas there were no differences at termination (middle graph) and follow-up (lower graph). At follow-up, the descriptions of mother (Figure 2, lower graph) in the psychotherapy sample were different from those in the comparison group ($z = -1.963$, $P<.05$). Regarding descriptions of father, a tendency for difference ($z = -1.651$, $P=.052$) was observed at follow-up (Figure 3, lower graph). All other comparisons were non-significant.

Semantic Difference Across Time

Semantic changes between the three time points were statistically tested separately for the semantic content of self-descriptions and descriptions of mother and father. Paired semantic tests were conducted for changes between baseline and termination/second interview, termination/second interview and follow-up/third interview, and between baseline and follow-up/third interview. The results in Table IV show the effect size, i.e., the semantic distance between the two groups divided by the standard deviation for the semantic distance when groups are generated by random assignment. In the therapy group, descriptions of mother changed from baseline to follow-up ($z = -1.842$, $P<.001$), as did descriptions of father ($z = -3.587$, $P<.001$). Descriptions of self also changed from baseline to follow-up ($z = -1.998$, $P<.05$). For the descriptions of self, a tendency of change was observed from baseline to termination ($z = -1.510$, $P=.068$). In the comparison group, no changes were observed over time.

Main Findings

In the therapy group, representations of self, mother and father changed from baseline to follow-up. In addition, a tendency toward change was observed for self-representations between baseline and

termination. The non-clinical sample displayed no such changes in self- and object representations during a comparable time span.

At baseline, self-representations in the psychotherapy sample were different from the self-representations in the non-clinical sample. This difference did not persist post-treatment. At termination and follow-up there was no difference between the psychotherapy sample and the comparison group regarding self-representations. At follow-up, the representations of mother and father in the psychotherapy sample were different from those in the non-clinical comparison group.

Discussion

The results are partially consistent with our hypotheses:

(1) At baseline we expected self-representations in the psychotherapy sample to differ from those in the non-clinical comparison group, because of the clinical problems that the patient group had been applying for psychotherapy. The results show a significant and strong such effect. Following successful therapy, we predicted that this difference would disappear, paralleling the recovery from symptoms in the psychotherapy sample. This prediction is supported by a lack of a difference in self-representation between the two samples at termination and at follow-up. Thus, the application of LSA to the semantic content of verbal self-descriptions gives results consistent with previous findings regarding self-representation, psychopathology and therapeutic change (Blatt et al., 2010; Harpaz-Rotem & Blatt, 2009).

(2) Following previous literature that had suggested a link between parental representations and clinical symptoms, we also expected a difference in parental representations at baseline between the groups. Surprisingly enough, this hypothesis was not supported by our results: we found no significant differences between the psychotherapy sample and the non-clinical sample. A possible reason for this is that the psychotherapy group was selected due to their need of therapy, which we interpret as an initial difference in the representation of the self rather than a difference in parental representations. We also postulated a change in the representation of the parents following therapy. This hypothesis was supported by the difference in the mother and the father representation between baseline and follow-up; however, there were no differences between baseline and termination. A possible but unexpected reason for this pattern of results is that psychodynamic therapy with young adults focused on the parent relationship, which caused a difference in
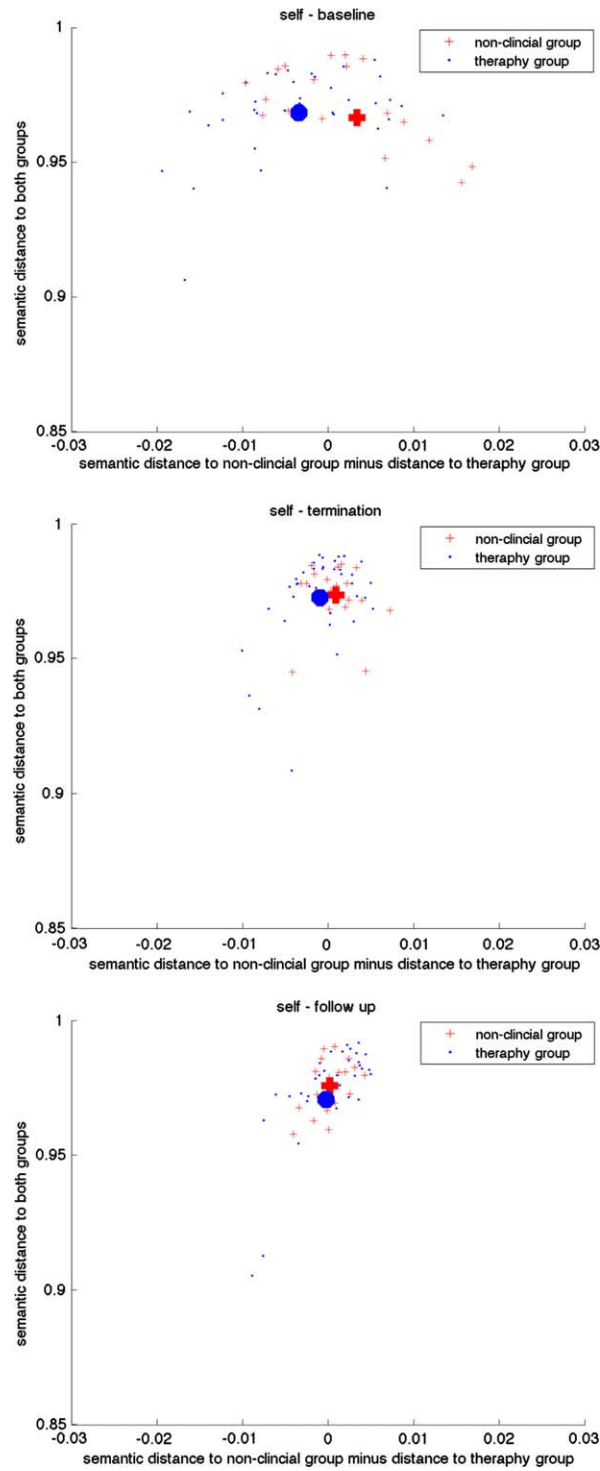
Figure 1. Semantic distance between the therapy sample (dots) and the non-clinical sample (plus signs) for self-descriptions at baseline/ first interview (upper graph), termination/second interview (middle graph) and 1.5-year follow-up/third interview (lower graph).
Note. Each marker represents one participant's description. The two large dots represent the group means. The values on the *x*-axis is calculated by first calculating the semantic distances from a statement to the mean of each condition, where the *x*-axis represents the semantic difference between these distances. This difference is corrected for the selection bias that is introduced by the selection of the two conditions, i.e., by removing the distance that occurs when statements are randomly assigned to the conditions (compare with the boot-strap method). The *y*-axis represents how similar the descriptions are to all statements (1 = identical, 0 = unrelated).
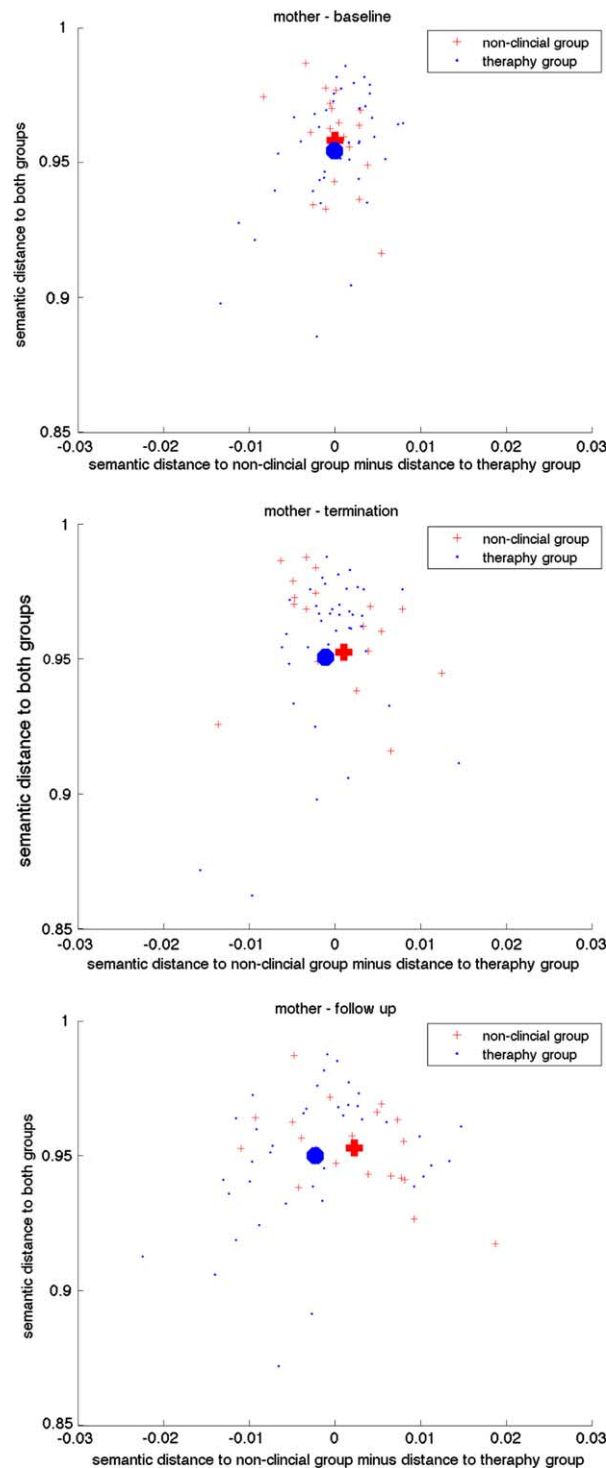
Figure 2. Semantic distance between the therapy sample (dots) and the non-clinical sample (plus signs) for descriptions of the mother at baseline/first interview (upper graph), termination/second interview (middle graph) and 1.5-year follow-up/third interview (lower graph).

representation of the parents that was not present prior to therapy.

Another reason for the lack of initial difference in parental representation is that our subjects had less severe problems than in earlier data. Previous research, demonstrating initial difference in parental representation between healthy subjects and people

applying for psychotherapy (Blatt et al., 1991, 1996, 1997; Bornstein & O'Neill, 1992; Vermote, 2005), comprised subjects in inpatient psychiatric care, thus probably suffering from more serious psychopathology than the participants in our study.

In fact, common complaints at baseline among young adult patients in YAPP were depressive
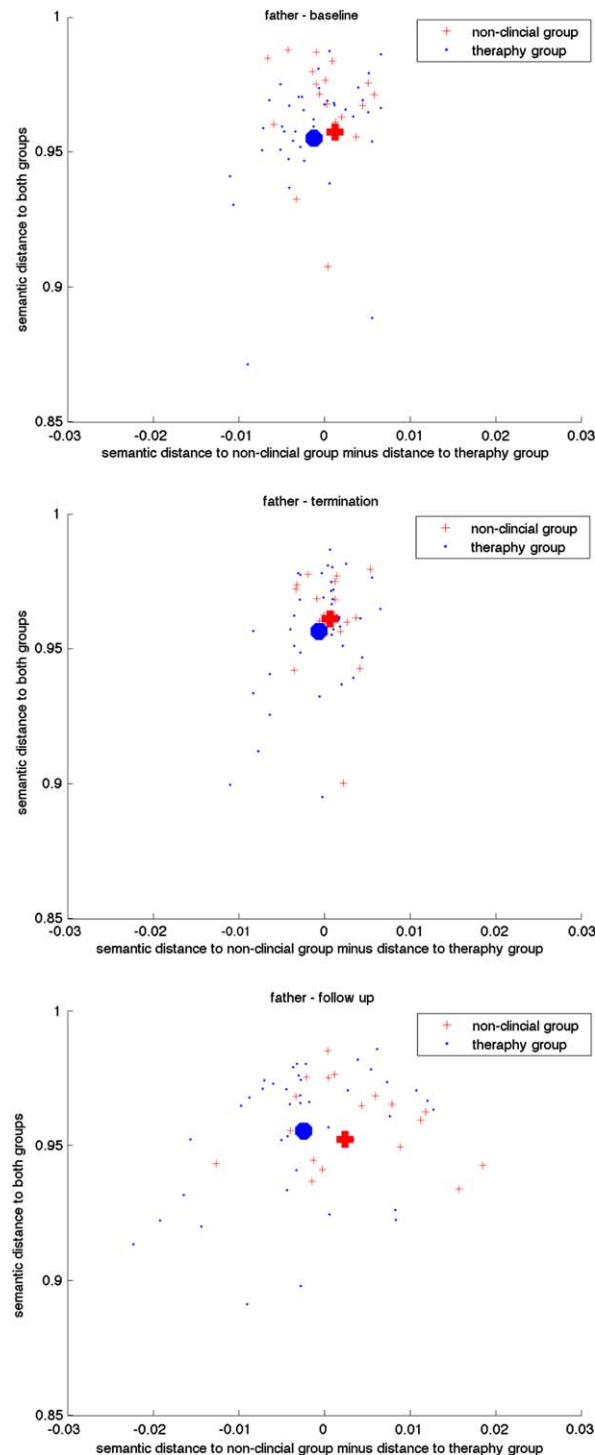
Figure 3. Semantic distance between the therapy sample (dots) and the non-clinical sample (plus signs) for descriptions of the father at baseline/first interview (upper graph), termination/second interview (middle graph) and 1.5-year follow-up/third interview (lower graph).

mood, anxiety and low self-esteem (presumably influencing self-representation), and problems in the relationship with parents (presumably influencing parental representations). The patients attributed the origins of their problems just as often to themselves as to their parents, and the most frequent background idea was being ill-treated as a child by

the parents (Wiman & Werbart, 2002). Previous investigation of the same non-clinical group as in the present study showed that young adults in general attributed their problems as often to relationships with friends of the same age as to their parents (Jacobsson, 2005). Thus, the attribution of problems to oneself was unique for the young psychotherapy

Table IV. Effect sizes of changes in semantic content for the psychotherapy sample and comparison group

Group	Description	es^1	es^2	es^3
Psychotherapy	Mother	.210	−.150	.428***
	Father	.097	.285	.630***
	Self	.336†	−.183	.308*
Comparison	Mother	.215	.234	.304
	Father	.100	.316	.052
	Self	.135	−.179	−.035

Note: es^1, baseline/first interview to termination/second interview. es^2, termination/second interview to follow-up/third interview. es^3, baseline/first interview to follow-up/third interview.
*Significant at the .05 level.
***Significant at the .001 level.
† Tendency, $P = .068$.

group, but the attribution of problems to the parental generation was common for young adults. From the analysis conducted we cannot draw any conclusion regarding attribution to the friends. However, there is a significant difference in parental representations found between the two groups at follow-up. We hypothesized that parental representations would change in the psychotherapy group, due to the fact that therapy was theoretically and practically based on a psychoanalytic frame of reference. Accordingly, our results demonstrate a significant change in parental representations in the psychotherapy sample between baseline and the 1.5-year follow-up (but not between baseline and termination). These changes also led to the significant difference in parental representations between the two samples at follow-up. It may also be that the patients who discussed their parental relations may talk differently about them due to therapy.

The observed changes in representations of the self and parents from pre-treatment to the 1.5-year follow-up in the psychotherapy sample and the absence of such changes in the non-clinical sample during a comparable period of time suggest that the changes are an effect of psychodynamic psychotherapy rather than of normal development in young adulthood. It was not possible to correlate measures of change in semantic representation with symptom measures. However, the differences in semantic content between the psychotherapy sample and the comparison group, as well as temporal changes, paralleled differences and changes in self-rated symptoms. In the comparison group, but not in the psychotherapy sample, the GSI level at baseline was close to the population of young adults in general. In the psychotherapy sample, but not in the comparison group, the GSI level decreased significantly at the second and third time point. Thus, our data suggest an association between changes in the representational structure and clinical improvement,

as also suggested by previous research findings based on theory-driven methodology (Blatt et al., 1979, 1991, 1996, 1998, 2010; Gruen & Blatt, 1990; Vermote et al., 2009). In these more disturbed samples of patients with personality disorders, patients moved from object relations dominated by polarization and splitting to object representations involving emergent object constancy. Vermote et al. (2010) demonstrated changes in self and object representation and felt safety, but not in reflective functioning, in patients who completed hospitalization-based psychodynamic treatment for personality disorders.

The present study demonstrates different patterns of semantic changes in spoken-language descriptions of self and parents. It could be claimed that this difference parallels changes in DRS scores in the total YAPP population (Lindgren et al., 2010). At therapy termination, representations of father and self were characterized by greater differentiation and relatedness compared to baseline. This change remained stable throughout the follow-up period. Mother representations changed significantly from baseline to follow-up, but not during the treatment or follow-up period separately, suggesting that representations of mother change slower than those of father and self. One conclusion from previous research was that representational structures change slowly, following a developmental sequence, but the changes are stable, and enduring changes have consequences after termination (Harpaz-Rotem & Blatt, 2009). According to both Blatt's (2008) theoretical model and previous empirical studies (Blatt, Auerbach, & Smith Behrents, 2008; Harpaz-Rotem & Blatt, 2005), pathological introjects expressed in the therapeutic relationship are eventually replaced by more stable and autonomous identifications with benevolent aspects of the representation of the therapist. These changes in self-representations precede changes in parental representations following disengagement from an intense involvement with parents.

To sum up: Our study confirms the conclusion of Blatt et al. (2010) that intense long-term psychodynamic psychotherapy can be regarded as a reactivation of normal developmental processes resulting in reduction of distorted representations of self. However, we found no evidence that the parental representations were normalized by therapy.

Potentials and Limitations of the Method Applied

From our view, the greatest advantage with the proposed method is that it allows a quantification of freely spoken language. Today, the semantic content

of speech is often ignored in quantitative research, presumably due to a lack of methods to measure semantic content. At the same time, in everyday life, the semantic content of language is perhaps the most commonly and possibly the most efficient way of gaining access to other peoples' minds. The proposed method allows for quantitative studies of semantic content. Measuring the semantic content also provides a more direct and less constrained way of gaining access to the research question posed. For example, when we explore a person's view of her mother (i.e., mother representation), our method allows quantifying the result from an open-ended question such as "Please give a brief description of your mother." The advantage of this approach is that the respondent can freely generate all the semantic dimensions that are relevant for her, and our method can quantify them. In contrast, quantitative research today is typically limited to questions that map the qualitative data into a single dimension for each item: "I put energy into providing for, looking after, developing myself" (SASB IN-TREX; Benjamin, 1974) or "It is hard for me to feel close to people" (IIP; Horowitz, Rosenberg, Baer, Ureño, & Villaseñor, 1988). For many subjects, these one-dimensional questions may not be relevant, and the mere fact that they are presented may influence the subject's view. When approaching qualitative data with pre-constructed categories one is not really studying the subject's experience but rather how well reported experience fits with the researcher's previous knowledge. The high dimensionality of semantic spaces allows us to capture and measure a multitude of aspects at the same time and to efficiently communicate these findings.

The present study applies computational linguistic methods, in particular semantic spaces, to the field of psychotherapy research. In psychology, there has traditionally been a boundary between qualitative, language-oriented, and quantitative, measurement-oriented, research. This gap is usually narrowed by constructing questionnaires, rating systems or quantifying qualitative material post-hoc. The benefit of semantic spaces, such as that generated from LSA, lies in the transgression of this boundary—it offers possibilities of quantifying the meaning of words and utterances in their raw form. Semantic changes may thus be measured independently of human raters' prejudices and theoretical constructs.

In particular, the present study has examined the possibility of utilizing semantic spaces for statistically testing the meaning content in object representations, a task that would be difficult and laborious for humans to do. This difficulty lies in the fact that there is no direct frame, or one-dimensional scale, on which the researcher directly can rank

individual object representation, and that covers the full complexity of possible semantic differences in object representations.

Another advantage of the semantic space method is that it offers an automated alternative for the study of texts, or spoken language, less time-consuming and labour-intensive than other methods. An extensive ranking of text or speech from subjects in an experiment may, in many cases, take a longer time than the original data collection. This method thus allows for analysis of larger quantities of language data than was previously possible for practical reasons. There are, however, some caveats to consider.

Our study focuses on the semantic content of self and parental representations, and how they are influenced by the therapeutic process. We find changes over time in the psychotherapy sample but not in the non-clinical comparison group. Probably, psychotherapy influences not only the semantic content of self and parental descriptions but also other patient narratives. In future studies, the method proposed here can be used for investigating changes in semantic relationships in other interview formats and in transcripts of psychotherapy sessions.

In the present study, the semantic space representation was constructed from Swedish news articles, i.e., material different to the texts analysed with the space. Does this difference in content influence the validity of our approach? As the size of the text corpus is probably the most important factor for achieving good quality, our choice of news articles was mainly governed by the accessibility of such a huge corpus. Typically, if the corpus is smaller than 1 Mb (which is the case with the interview data in our study) the association provided by the space is "strange" (e.g., *mother* may be associated with *street*) and statistical tests fail to show significance. However, for corpora larger than 100 Mb the semantic associations typically become meaningful (e.g., *mother – child*). The reason why the corpus needs to be so large is related to degrees of freedom in the semantic space. To avoid over-fitting, a several-fold incidence is needed for a given word over the number of dimensions that one is trying to fit the space with (typically a factor of 3). Given a space of 100 dimensions and 10,000 words (e.g., a frequency of 1/10,000), several hundred occurrences of each word (e.g., 3×100) with a word length of 7 are needed, suggesting that the size of the corpora should be of an order of at least megabytes (e.g., $10,000 \times 3 \times 100 \times 7 = 21$ Mb). It is by no means necessary that the content of these corpora exactly matches the context to be analysed. In fact, the LSA method works because the documents are very different, which elicits the possibility

of discriminating between words with different meanings best found in different contexts.

On the other hand it is also beneficial if the corpus includes topics that are relevant in psychotherapeutic meetings. Words describing relationships and inner states may have been relatively few in number, causing such topics to occupy a relatively small fraction of the semantic space. Therefore it would have been advantageous to a mix the corpus with domain-specific psychotherapy-related texts. The Ulmer Textbank (2008), a collection of German-language transcripts of psychoanalytic sessions, offers possibilities for a domain-specific semantic space for psychotherapy research. These differences in semantic content suggest that there is room for further methodological improvements, which may provide even more interesting and detailed results in forthcoming research.

A similar aspect is that the semantic space is based on written language, while the material of study was spoken language, i.e., verbatim transcripts of audio-recorded interviews. This may yield consequences for the analyses, since spoken language differs from written in certain respects. Writing is generally the result of a deliberate effort at conveying information according to relatively unambiguous rules; one has the opportunity of thinking ahead and revising, but one does not have access to the reactions of the people for whom the message is intended. Spoken language, on the other hand, is generally generated in a social context; the speaker may take the reaction of her interlocutor into account and does not have much time to think about what to say. In addition, when speaking one does not adhere to the same rules of grammar as when writing, one uses words not normally found in writing, and punctuation is not clear; this entails that ambiguities are more frequent in spoken communication (Dahl, 2004). Further research is needed on the effects of spoken and written language on semantic spaces. Corpora of spoken language, e.g., the Gothenburg Spoken Language Corpus (Allwood, Björnberg, Grönqvist, Ahlsén, & Ottesjö, 2000), may offer a viable alternative in constructing spoken-language LSA spaces; however, the gain of using such a spoken database may be lost by the fact that the sizes of these databases are currently considerably smaller than those available with written texts.

Semantic space is a convenient method for representing and analysing language at the semantic level; however, it is important to keep in mind that this is the only level of analysis. Syntactic relations, which may well exert a substantial influence at the level of meaning, are not taken into account. For example, one may consider the diametrical

difference between the statements "Mum is very kind" and "Mum is not very kind." The four words of the first statement are all included in the second, but the second also contains a negation that inverts its meaning. LSA does not parse sentences syntactically, but assigns a statement a position in the space based on the words included (regardless of their order). Thus, these two statements would be deemed quite similar in meaning, contrary to the perception of a human observer. However, it should be noted that even though the two statements are poles apart in meaning, they are closely related at the topical level; they both treat the same person, and the same feature is mentioned in relation to that person. From a psychological perspective the two statements may be more similar than what is first apparent; the person making them seems to be in some respect concerned with the kindness, or lack thereof, of her mother. Another linguistic quality not taken into account in LSA is the pragmatic level of spoken communication: tone of voice, facial expression and irony are not accommodated.

It is important to emphasize that the proposed method is designed to answer the question of whether semantic difference exists between conditions. Thus, the method is not designed to answer questions regarding the nature of these differences. We think this is a strength of this method, because it allows inductive studies of semantic differences without the need of specific hypotheses about what semantic dimensions to select, and how these dimensions should differ. Typically, answers to such questions also involve choice of theoretical framework and lead to concerns about multiple comparisons, as the number of interesting semantic dimensions easily inflates. As our method has identified semantic differences between the studied conditions, the nature of these differences becomes an important and relevant issue. Future studies may focus on specific semantic dimensions, e.g., positive-negative valence or degree of abstractness of self and object representations, and how they are affected by psychotherapy. However, development of such measures is a topic for coming research. Furthermore, theoretical considerations are needed for selecting appropriate semantic dimensions for study, as well as to formulate specific hypotheses regarding how these dimensions may be influenced by psychotherapy.

Alternatively, our method may be triangulated by use of inductive qualitative approaches. In a qualitative study of parental representations in the same psychotherapy sample, ideal-type analysis demonstrated change over time in terms of belonging to different ideal-type clusters of mother and father representations, as well as important improvements in the quality of the descriptions. These changes

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continued after termination of psychotherapy. How-ever, most of the parental representations remained negative (Werbart et al., 2011). These findings of changes in the patients' experiences and reflections of self and their parents are complementary to the results found by our semantic method. The semantic method presented here only answers the question whether there are differences in semantic representations.

In order to validate the semantic space method to studies of object representations, comparisons with other measures are needed. It would be inter-esting to compare changes in object representa-tions, as measured in this study, to expert-ratings of Differentiation-Relatedness of Self and Object Representations (DRS; Diamond, Blatt, Stayner, & Kaslow, 1991) and Global Assessment of Func-tioning (GAF; American Psychiatric Association, 1994), as well as patient-rated symptom severity according to SCL-90-R (GSI; Derogatis, Lipman, & Covi, 1973; Derogatis, 1994) or other instru-ments commonly used in psychotherapy research. However, this is a topic for forthcoming studies.

At a time when psychotherapy research begins to appreciate idiosyncrasy as well as generalities, the therapist as a person as well as the treatment method, and the patient as well as the diagnosis, semantic spaces offer a novel alternative to both questionnaire-based quantifications and traditional qualitative methods. Despite its high level of abstrac-tion, the semantic space method carries the advan-tage of studying the very essence of the talking cure: what is actually said.

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