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Single-Case Pilot Study For Longitudinal Analysis Of Referential Failures And Sentiment In Schizophrenic Speech From Client-Centered Psychotherapy Recordings

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The Doctorate Program in Clinical Psychology
Illinois School of Professional Psychology
at National Louis University

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in Schizophrenic Speech From Client-Centered Psychotherapy Recordings

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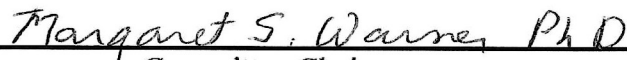
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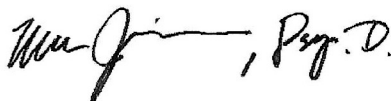
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Single-Case Pilot Study for Longitudinal Analysis of Referential Failures and Sentiment
in Schizophrenic Speech From Client-Centered Psychotherapy Recordings

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A Clinical Research Project submitted to the faculty of The Illinois School of Professional Psychology at National Louis University in partial fulfillment of the requirements for the degree of Doctor of Psychology in Clinical Psychology.

Chicago, Illinois
March 2023

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Dedication

To my sister, Tracie Elizabeth,
who was my biggest cheerleader, my best friend, and my twin soul.
I could not have completed this dissertation without your love and support,
and I dedicate this work to your memory with all my heart.
I miss you every single day and I will love you forever,
always.

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Abstract

Though computational linguistic analyses have revealed the presence of distinctly characteristic language features in schizophrenic disordered speech, the relative stability of these language features in longitudinal samples is still unknown. This longitudinal pilot study analyzed schizophrenic disordered speech data from the archival therapy audio recordings of one patient spanning 23 years. End-to-end Neural Coreference Resolution software was used to analyze transcribed speech data from three therapy sessions to identify ambiguous pronouns, referred to as referential failures, which were reviewed and confirmed by multiple raters. Speech samples were analyzed using Google Cloud Natural Language API software for sentiment variables (i.e., score, valence, and magnitude). Referential failures and sentiment variables were analyzed within each session and all sessions combined to study the relationships between these variables within single sessions and over a span of 23 years. Results and implications for this study are discussed.

Keywords: schizophrenic disordered speech, formal thought disorder, referential failure, ambiguous pronouns, sentiment, natural language processing, longitudinal, pilot study, single-case

Single-Case Pilot Study for Longitudinal Analysis of Referential Failures and Sentiment in Schizophrenic Speech From Client-Centered Psychotherapy

Recordings

Introduction

Statement of the Problem

The current study involved an analysis of longitudinal samples of therapy sessions held over a 30-year period with a single schizophrenic client code named as “Luke.” These therapy sessions involved an entirely nondirective approach such that the therapist followed the client’s self-directed processing of personal issues of his choice using language as he saw fit. Luke showed a pronounced thought disorder in his speech while manifesting no other complicating disorders such as a personality disorder, bipolar disorder, or a substance abuse disorder.

This single case was particularly appropriate for study as Luke both enjoyed and benefited from the therapy process over these 30 years, becoming more self-confident and socially engaged while no longer having major emotional crises or hospitalizations. This is particularly relevant because historically, proponents of many therapy orientations have advised against engaging directly with psychotic process in therapy. The study is also relevant to the emerging study of schizophrenic speech using computerized linguistic analysis, as longitudinal data showing a schizophrenic client pondering life issues in his own language without direction or interpretation are rare.

This longitudinal pilot study involved an analysis of schizophrenic disordered speech text data from archival client-centered therapy audio recordings for one patient. The audio recordings were transcribed into text and analyzed for (a) referential errors

(i.e., the use of a reference in speech for which the referent is unclear or not introduced, and changes the message conveyed) using End-to-end Neural Coreference Resolution software (e2e-coref), and (b) sentiment (valence and magnitude) using the natural language processing Google Cloud Natural Language API software. Referential failures are linguistic features observed in schizophrenic speech that have been proposed as biomarkers for schizophrenia due to their ability to distinguish clinical populations from unaffected controls (Corcoran et al., 2020). The study involved analyzing differences in the rate of referential failures from therapy session recordings spanning three intervals of time as well as the relationship between referential failures and sentiment magnitude and valence. For the purpose of understanding variability in referential failures within a session and over an extended period of time, an analysis for both referential failure and sentiment was completed for speech sample data within each individual therapy session and across the three therapy sessions analyzed.

Literature Review

Mental Illness and Linguistics

Linguistics, or the science of language, involves making sense of how human beings use language by describing the nature and characteristics of language. In particular, focus is given to the structure of languages and the rules that appear to govern their use. By and large, languages are regarded as a type of code through which humans convey meaning in a process called communication. According to Merriam-Webster (n.d.-b), language can be defined as “the words, their pronunciation, and the methods of combining them used and understood by a community . . . a systematic means of communicating ideas or feelings by the use of conventionalized signs, sounds, gestures, or marks having understood meanings” (para. 1-2). The first part of this definition indicates language is a means of conveying and receiving messages between persons through specific pronunciations and combinations of words. The second part of the definition expands the first definition to include not only the pronunciations and combinations of words, but also the sounds, gestures, and signs that convey meaning. This elaboration allows for the use of language through means that are not exclusive to verbal exchanges for conveying information, but also the symbolic representations conveyed in gestures similar to those of sign language, as well as the meanings understood through written language. Communication is then defined as “a process by which information is exchanged between individuals through a common system of symbols, signs, or behavior” (Merriam-Webster, n.d.-a, para. 1). Therefore, communication is differentiated from language as a process of conveying information, rather than the means for conveying that information. Such a process occurs when

information is either conveyed or received, as well as when it is exchanged. Language can be defined as a manner or style of speech used in human communication that is shared by more than one person through verbal, written, or alternative forms of speech using words to express thoughts, feelings, desires, and needs.

Through the use of a shared standardized code, humans speaking the same language understand each other's encoded meanings. However, misunderstandings do occur; from time to time, communication appears to involve a code failure. Of course, a code cannot really fail—people can only fail in their knowledge or appropriate use thereof. Slips of the tongue, mishearing, second-language speakers, children learning their first language, jargon, and ambiguity all represent everyday opportunities for miscommunication. In recent decades, the focus of linguistics has expanded to cases of a sustained and pathological breakdown in communication; for certain individuals, the effortless conveyance of meaning they have come to expect from language no longer occurs. In some, the broader cause is fairly obvious; lesions caused by trauma or disease mean the destruction of brain tissue formerly dedicated in some way to language. For others, the disturbance seems to be linked to one or more mental illnesses. The definitive causes of such mental illnesses are still unknown, though they are widely regarded as having origins in abnormal brain structure or function. It is this latter group of mental illnesses that were the focus within this paper, and the speech of those diagnosed with schizophrenia, specifically.

Schizophrenia

Schizophrenia is a serious mental illness that affects the thoughts, emotions, behaviors, and relationships of those who are affected. The prevalence of schizophrenia

and other psychotic disorders in the United States ranges from 0.25%–0.7% (American Psychiatric Association, 2013, p. 104; see also Desai et al., 2013; Kessler et al., 2005; National Institute of Mental Health [NIMH], 2020; Wu et al., 2006). Genetic risk factors include both common and rare allele groups, although information about the disease process is not solely based on these genetic risk factors. Generally speaking, common alleles for schizophrenia are also associated with multiple forms of serious mental illness; their role in the disease process is not deterministic, but rather additive to a person’s risk for schizophrenia. By contrast, rare alleles are much more selective for schizophrenia and are associated with a higher risk for developing the disorder (American Psychiatric Association, 2013, p. 103; Mukai et al., 2019). The risk for developing schizophrenia is associated with environmental factors such birth during late winter months and living in an urban environment as a child or ethnic minority (American Psychiatric Association, 2013, p. 103). According to the American Psychiatric Association (2013), other risk factors associated with schizophrenia include “prenatal and perinatal adversities, including stress, infection, malnutrition, maternal diabetes, and other medical conditions . . . However, the vast majority of offspring with these risk factors do not develop schizophrenia” (p. 103). Persons affected by this disorder experience significant impairments in their social and occupational functioning. As a result, persons with schizophrenia often experience a diminished quality of life, which may explain why 20% of this population has attempted to commit suicide and 5%–6% of this population dies as a result of suicide (American Psychiatric Association, 2013, p. 104).

The chronic neurodevelopmental disorder of schizophrenia manifests with bizarre experiences that are not normative or based in a shared reality (American Psychiatric

Association, 2013). Many persons have auditory, visual, and tactile sensory experiences that cannot be explained by an external stimulus. In the absence of external validity, these idiosyncratic sensory experiences are assumed to originate from the person's mental processes and internal subjective world. Such a disconnect from ordinary reality may cloud a person's understanding of actual events and their judgment of how those events are related. Consequently, a person with schizophrenia may hold delusional beliefs that may become fixed despite contradictory evidence, reason, or logic. These delusions and hallucinations may be frightening, often leading to social withdrawal and poor functioning in interpersonal relationships. People often have difficulty communicating with persons who have schizophrenia because their speech may be strange, confusing, or completely unintelligible. Persons with schizophrenia may be perceived by others as behaving strangely during social interactions. Examples of strange behavior include extended periods of silence without any movement, acting in paranoid ways in the absence of any threat, or engaging in dialogue with someone who is not present.

The first psychotic episode tends to occur between 16 and 30 years of age, although women tend to present with symptoms later than men (American Psychiatric Association, 2013, p. 103; NIMH, 2020). Schizophrenia does not present with a consistent set of symptoms across each person who receives the diagnosis. Moreover, there is no general profile for the first episode of psychosis in a person who converts to schizophrenia. In order to receive a diagnosis of schizophrenia, a person must experience psychotic symptoms that persist for at least 6 months, after which a person experiencing first episode of psychosis is considered to have converted to schizophrenia. The large variability in symptom presentation is consistent with overall variability in disease course

and recovery. Roughly 20% of persons diagnosed with schizophrenia experience positive outcomes whereas many of them experience significant impairment over the course of their lifetime (American Psychiatric Association, 2013, p. 103). As a result of the large variability in symptom presentation, schizophrenia is often regarded as a heterogeneous clinical syndrome rather than a single disorder. Conceptualizing schizophrenia as a cluster of similar, related disorders opens the possibility for researchers to gain a better understanding of the diverse presentations of the disease. In addition, it allows for a refinement of their pathogenesis as researchers observe distinct differences in neurobiological profiles between symptom presentations (Clementz et al., 2016). The broad range of symptoms associated with schizophrenia is often separated into two characteristically different groups, those which are *negative* and those which are *positive*.

Negative Symptoms

According to the most recent version of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*; American Psychiatric Association, 2013), schizophrenia in its most extreme levels of functional impairment is characterized by *negative symptoms* that are almost exclusive to schizophrenia rather than other psychotic disorders. One of these is *diminished emotional expression*, which is the marked loss of emotional expressiveness in its various forms, such as facial movement, eye contact, prosody, or the intonation of speech. Reduced emotional expression manifests in both speech and congruent physical expressions that emphasize the emotional expression through movement of the face, head, and hands. A similar loss of purposeful, self-initiated activities is another negative symptom referred to as *avolition*. The symptom is observed in persons with schizophrenia who may sit for extended periods with an apparent loss of interest in

engaging in activities for work or social purposes. Similarly, *associability* refers to the loss of interest in social interactions, which may be observed in self-isolation rather than as a manifestation of avolition. In addition to diminished expression and self-initiated activity, negative symptoms also include a reduction in speech output and experiences of pleasure, which are referred to as *alogia* and *anhedonia*. The latter symptom refers to both the diminished experience of pleasure derived from activities as well as the person's attribution of less pleasure to a past event than was experienced at that time.

The central characteristic or feature of all negative symptoms is a reduced or diminished quality to the normal functions necessary for successful interpersonal and occupational tasks. The loss of these functions manifests as a significant barrier and distress in social and occupational functioning, which leads to overall reduced outcomes and poor general quality of life. Therefore, negative symptoms are more associated with poorer prognoses than are positive symptoms. Persons with predominantly negative symptoms of schizophrenia have a higher risk of comorbidities and are less responsive to many treatments, which show little effect on negative symptom improvement.

Positive Symptoms

The *DSM-5* (American Psychiatric Association, 2013) identifies positive symptoms of schizophrenia as more overt psychotic symptoms such as delusions, hallucinations (e.g., auditory, visual, or tactile forms), disorganized speech, and abnormal psychomotor behavior (Criterion A). One of the earliest signs of schizophrenia is difficulty with speech during childhood, although altered language begins to present noticeably around the time of a person's first psychotic episode (American Psychiatric Association, 2013, p. 102). Positive psychotic symptoms tend to decrease over time as

persons with schizophrenia age; this trend is known to be associated with overall age-related reductions in dopamine activity.

Formal Thought Disorder

Thought disorder is a group of abnormal language or speech symptoms present in some forms of schizophrenia as well as other disorders such as dementia. Historically, these symptoms were referred to as thought disorder because they were understood theoretically as a reflection of disordered thought or thinking rather than as distinct language processes that contribute to speech production (Kuperberg, 2010). For the purposes of this paper, schizophrenic speech refers to the many symptoms relating to language and speech that have been associated historically with formal thought disorder in schizophrenia. Similarly, these symptoms can be referred to as disorganized thought or thinking about inferences made from qualities of speech. Speech qualities that indicate the presence of formal thought disorder include derailment or loose associations and tangential, incoherent speech or “word salad.” Many of these symptoms may present occasionally without significant impairment or impact on day-to-day functioning. In the event that these speech symptoms significantly impair effective communication, the severity has significance for diagnostic purposes. These symptoms are culturally bound in that they can only be identified very cautiously under circumstances where raters come from different cultural and linguistic backgrounds, especially because thought disordered speech presents with distinctly different features specific to language and region (American Psychiatric Association, 2013; Ratana et al., 2019).

Theoretical Perspectives of Schizophrenic Speech

Though many psychological theoretical orientations have included attempts to offer hypotheses as to the etiological bases for schizophrenia and schizophrenic disordered speech, psychoanalytic theory was the first to conceptualize the language disturbances observed in persons with schizophrenia. An historical review of psychodynamic theoretical conceptualizations for schizophrenic speech is provided below. These perspectives are then contrasted with the major client-centered theoretical perspectives, which offered a paradigm shift in clinical psychological theories for psychopathology.

Psychodynamic Theories

Freud's Early Theory. Freud conceptualized schizophrenia as resulting from a failure to resolve oral issues in the first year of life (Spotnitz, 2004). At that age, infants were seen as living in their own reality. Their consciousness was seen as dominated by primary process thinking in which their own wishes were not separated from reality or from those of caregivers. Persons with schizophrenia were seen as not having resolved oral issues in a way that let them move into the higher anal or phallic psychosexual stages in a solid way. As a result, later in life these higher levels of functioning were likely to collapse, leaving the client immersed in primary process thinking. Freud saw human beings as having a wish to be able to stay in their own reality, only relinquishing this as positive parental relationships drew them into wanting to participate in a shared social reality. As a result, connecting directly with psychotic or primary process thinking would be thought of as gratifying the person's wish to stay in their own world. Notably, Freud, as well as subsequent psychodynamic theorists, hypothesized that schizophrenia was a

disorder that emerged from impaired parental relationships in the first year of life rather than being primarily biologically or genetically based.

Fromm-Reichmann. Building on Freud's initial theories, Fromm-Reichmann (1948) developed the following description of characteristics of a person with schizophrenia based on the behaviors of the schizophrenogenic mother: "The schizophrenic is painfully distrustful and resentful of other people, due to the severe early warp and rejection he encountered in important people of his infancy and childhood, as a rule, mainly in a schizophrenogenic mother" (p. 265). According to the American Psychological Association (n.d.), the schizophrenogenic mother was first described and defined as

emotionally disturbed, cold, rejecting, dominating, perfectionistic, and insensitive. At the same time, however, she is overprotective, fosters dependence, and is both seductive and rigidly moralistic. Historically, this type of mother was considered to play a causal role in the development of schizophrenia, but this view is no longer held. (para. 1)

Although this perspective is no longer the dominant perspective for the pathogenesis of schizophrenia, several theorists have attributed object-relations between the infant and a similar maternal archetype as the foundation for the development of a schizophrenic language. In this context, the mother-child relationship was seen as so ambivalent and emotionally contradictory such that a "crazy" way of speaking came to be felt as the only sensible alternative.

Sullivan. Sullivan's (1953) interpersonal theory of anxiety presented one of many psychodynamic theoretical perspectives of the schizophrenic's pathological development

resulting in a disordered use of language. The theory presented a pathogenesis for schizophrenia that originates during development beginning at infancy with the infant's relationship to its mother. The relationship is characterized by the passive infant victim being exposed to an overly anxious mother in what is referred to as "not-me experiences." The child experiences the mother's intense anxiety that communicates a degree of "not-me experience[s]" that creates "a special vulnerability to *not-me experience*" (p. 106). Pao (1979) described that the mother's not-me experience is imparted onto the infant as

severe conceptual confusion from her consistent blurring of her communications—saying what she did not mean, diffusing the meaning what she did mean, substituting generalizations for specifics or vice versa, tangenting off to a new but vaguely relating topic, etc. This conceptual confusion threatens his sense of well-being and enhances the motivation to identify with her. (p. 291)

According to Sullivan (1953), the not-me experience can only be repelled when the self-system is crystallized—the same time that the infant develops speech. The self-system repels the not-me experience through the protective use of dissociation, relied on heavily as a security operation due to considerable not-me experiences that render the infant feeling useless. In this way, dissociation acts as a protective function preventing the onset of schizophrenia that results from not-me experiences and associated feelings of uselessness. Later, the adolescent's development of lust dynamism has a detrimental effect on the already compromised self-dynamism, which limits the self-system's functioning. The self-system loses the dissociative security operation that once repelled the not-me experience. Consistent with the co-occurring development of the self-system

and acquired speech, the schizophrenic's use of language or speech is affected by the diminished function of the self-system.

According to Sullivan (1953), the not-me experience induces panic as the result of its integration into the new state that is disorganized unlike before. The panic state arises from a disequilibrium state that signifies a loss of the schizophrenic's entire foundation, as if the individual's beliefs, securities, guarantees, and previous understandings of the universe are gone. This becomes the personality's new state of schizophrenia, where the individual experiences early referential processes with such clarity that they are undifferentiated from their awareness of outward experiences.

The integration of the not-me is an eerie experience that results in equally inexplicable strong emotions, specifically terror (Sullivan, 1953). This emotion resembles panic; however, terror is enduring and continuously builds in intensity with no certainty of an end. This emotion originates in the fear that the affective not-me experience will eventually lead to a complete loss of the self-system and result in a perpetually unpleasant nothingness. The individual urgently attempts to avoid this fear but is still unable to differentiate their outward experience from the very real not-me experience. Frantic efforts to avoid the not-me experience, which may be confused with outward experiences, can lead to destructive activities that may result in actual harm to self or others. These efforts lack resolution and eventually lead to immobility and catatonia, allowing the self-system to maintain function. Contrary to the schizophrenic's terror, even in the absence of security, the self-system remains intact, as present in those with paranoid- or thought-disordered types of schizophrenia. In Sullivan's (1953) more

detailed hypotheses, schizophrenic language was noted to involve a regression to infantile confusion of me and not-me or to serve as a defense against the panic of that state.

Pao. Pao (1979), building on earlier psychoanalytic theory, explicitly defined language with respect to “the schizophrenic’s use of language” when he stated:

When we speak of schizophrenic’s use of language, we are actually referring to his communicative style during the subacute and chronic phases, when the patient is in a more or less dreamlike state, he does not seem to have any control over how to use language. (pp. 282–283)

Pao narrowed his use of language to refer to only more severely disturbed persons with schizophrenia whom he categorized as schizophrenics-III and -IV, potentially including schizophrenic-I and -II earlier in the subacute phases. Pao explicitly referred to the schizophrenic person’s use of language as a communicative *style*. This use of the word *language* to infer a communicative style is consistent with the common usage of the word language.

Pao (1979) referred to the language used by schizophrenic people as “idiosyncratic” (p. 281). With the understanding that this definition infers a person’s communication style may be without a cause, it is entirely reasonable to suggest that a person’s communication may be peculiar or specific to that individual. This is evidenced by the use of the word language in the phrase, “Now you’re speaking my language!”

Pao (1979) further considered a “purpose of the patient’s language” (p. 282), suggesting there may be a purpose for schizophrenic clients’ use of an absurd or idiosyncratic communication style. One example of language being purposeful is the use of sign language to communicate with another person who interprets sign language and

avoiding communicating with persons who cannot. In this context, the communication style may be purposefully used to communicate with one person and not another, or to communicate and not communicate at the same time. A person may perceive language to be unintelligible when such language use is intended to be uninterpretable by that person.

Pao's (1979) definition of schizophrenic language demonstrates coherence with Pao's addition to psychodynamic theory. The definition refers to the schizophrenic's use of language as a communication style because psychodynamic theorists had not identified the acquisition of language, specifically within the context of human development, nor had they identified it within the pathogenesis of schizophrenia. For this reason, Pao explicitly defined language as a communication style because it is closely associated with speech, which relates to a developmental period in psychodynamic theory. During the collapse of the self-system, speech or communication style (i.e., language) is consequently disrupted. This is indicated through the co-occurring development of speech that is acquired as the self-system is crystallized.

Additionally, Pao (1979) defined schizophrenic language as having purpose. This point is related to the organismic panic that becomes the schizophrenic's state upon the self-system's collapse. According to several scholars contributing to psychodynamic theory, the schizophrenic person is unable to differentiate between the inward not-me experience and the outward experience, and only acts with respect to security. According to Spotnitz (2004), rather than confronting or reacting to the actions of others, the psychotic person chooses to break with reality as a defense (p. 30). Even when the schizophrenic chooses to interact and communicate with outward reality, their need for security remains the priority. The conflict between interacting with reality and the need

for security creates a communication style that acts in favor of both interests. The definition of a schizophrenic language outlined earlier also incorporates a specific purpose into the definition, which implies the schizophrenic's use of language holds the covert intent to confuse and retaliate against the clinician. According to Spohnitz, this covert intent is fueled not only by terror and the need for security, but also by rage.

Modern psychoanalytic theory attributes schizophrenia's pathogenesis to the overly-anxious mother; however, the theory indicates the schizophrenic use of language is acquired by the mother. This would imply the child learns the mother's language, which can then be used as a communication style between the mother and the child—the schizophrenic and *another person*. However, this theoretical explanation for the pathogenesis of a schizophrenic language indicates a schizophrenic language is unintelligible and idiosyncratic to some people but not others.

Kohut and Self-Psychology. According to Garfield and Steinman (2015), Heinz Kohut's self-psychological approach to psychoanalytic therapy has contributed significantly to psychoanalysis by extending the limits of treatability to patients with narcissistic personality disorders, primarily, in addition to a list of other disorders, including schizophrenia. According to Pollack (1989), Kohut extended Freud's drive theory through the argument that normal development is not founded on the complete separation of the self and an "object" other. In Kohut's theory, he separated interpersonal relations (object love) and narcissism (self) into separate developmental processes, which provided the basis for the development of self-capacities such as humor, vicarious introspection, artistic creativity, wisdom, and empathy. These self-capacities develop through interactive experiences, such as "mirroring," "idealizing," and "twinship"

relationships with significant others that provide for normal developmental needs and internalize those structures, which, ultimately, enhances the functions of the self (Kohut, 1959). Whether or not these structures are internalized, the individual will continue to benefit from ongoing support from significant others, referred to as “self-objects” for self-functioning. A mirroring self-object provides an empathic, experience-near understanding, which is a legitimately expressed need for necessary psychological and functional support from others if the self is fragile or incomplete.

In therapy, the therapist becomes the patient’s self-object and a functional extension of the self whereby the patient experiences stability during periods of dysfunction, pain, and disorganization. The self-psychology model supports, encourages, and prescribes the use of empathic attunement for a complete psychoanalytic understanding of the subjective experience of schizophrenia. Kohut’s (1971) belief in the therapist’s potential for understanding the inner experience of schizophrenia provided meaning and addressed the limitations in understanding the schizophrenic’s experience from earlier psychodynamic and psychoanalytic theories. Ultimately, Kohut’s addition to psychoanalytic theory rejected an objectivist approach toward language, meaning, truth, and understanding, which can now be understood as subjective, interactional, and relative.

Josephs. Josephs (1989) considered the “concrete attitude” to be a developmental achievement that can be employed defensively and characterized this attitude as “ameliorating a disorienting sense of unreality by restoring a sense of the real. Clinging to the concrete attitude is then a means of maintaining one’s sense of reality, of possessing an ordered and orderly existence” (p. 492). In schizophrenia, a person

defensively approaches their experience and communicates with language that is not symbolic but concrete and literal in an effort to hold onto their weak grasp of reality. Whereas Freudian analysts approach language as symbolic and interpret the latent content, Kleinian analysts reinterpret the patient's words within the theoretical framework of object relations theory—however, both approach concrete language as a defensive retreat from symbolization and make large leaps in interpreting a patient's literal language. Rather than considering the concrete attitude as resistance, Josephs considered the concrete attitude in psychotic persons as a developmental arrest; the attitude serves the crucial function of preserving a sense of reality. The patient's concrete nature suggests they are unable to see reality as relative to another perspective; should the analyst suggest otherwise, it would be a threat to the patient's reality and the objectivity of their worldview. For this reason, Josephs recommended “entering the realm of the concrete” (p. 499) or the patient's reality, thereby suspending the analyst's objective view of reality, in an effort to provide a stable selfobject. Josephs and Josephs (1986) recommended approaching the patient as if there was a kernel of truth to the thought disordered material as a means for validating the patient's experience, which was ultimately beneficial in treating schizophrenic patients. The authors argued for this intensely experiential approach, which differed from that of analysts who took an archaeological approach toward interpreting the symbolic for latent content. In this application of self-psychology to working with schizophrenia, Josephs argued for the therapeutic benefit of engaging with schizophrenic speech.

Person-Centered Theories in Relation to Schizophrenic Process

Classical Client-Centered Theory. Rogers (1957, 1959) proposed a paradigm shift in theoretical approaches to psychotherapy. His research provided the foundation for a nondirective client-centered theory and therapy. Rogers proposed that the only necessary yet sufficient conditions for therapeutic change were a therapeutic relationship in which the therapist was genuine, empathic, and prizing of clients' experiences and the clients received the therapist's attitudes as intended. This paradigm shift removed the necessity of the therapist acting or intervening on behalf of the client. Rather, the impetus for change now rested in the client's self-directed process toward meaningful change. The practice of client-centered therapy removed the need for interventions and the diagnoses for which they were manualized. A shift in theoretical approaches to psychotherapy also extended the field of counseling and therapy to disorders that were previously understood as being untreatable. According to Rogers, change occurred from the inherent tendency toward self-actualization, particularly a human tendency to process experience. This change process was no different between diagnoses or categories of mental illness, including persons diagnosed with schizophrenia. Notably, given its emphasis on a universal human tendency to actualize and to process experience, the person-centered approach would proceed in similar ways whether the genesis of a disorder was genetic or related to early development, or whether speech was used in relationships in ways that were strategic.

Rogers et al. (1967) analyzed the impact of the client-centered therapeutic relationship with persons diagnosed with schizophrenia. The study did not yield results that were immediately understood; however, researchers have since evaluated data from

that study using more recent measures of outcome and change. These more advanced methods detected meaningful change in the research participants (Sommerbeck, 2002).

Pre-Therapy. Prouty (1994, 1999, 2000a, 2000b, 2008) proposed an extension of client-centered theory and therapy as applied to persons with schizophrenia who are not in psychological contact. For Rogers, psychological contact was a background condition essential for the other necessary and sufficient conditions (i.e., empathy, genuineness, and unconditional positive regard) to promote positive therapeutic change (Rogers, 1957). Prouty's theoretical extension on psychological contact is referred to as "pre-therapy."

Through the conceptualization of psychological contact, Prouty provided contact reflections that are inherently empathic and aimed toward enhancing psychological contact with the client. Contact reflections stay very close to the client's immediate words and gestures. In terms of earlier theory, contact reflections would be described as very "concrete." A manual for the application of contact reflections identified situational reflections, facial reflections, word-for-word reflections, body reflections, and reiterative reflections as responses the therapist can use to enhance the client's psychological contact (Prouty, 2007). Several research studies have demonstrated consistently strong outcomes for pre-therapy work with schizophrenic clients and other clients who have difficulty developing or maintaining psychological contact (Prouty & Kubiak, 1988; Prouty et al., 2005).

Difficult Process and Metaphacts. Through an ongoing clinical research project, Warner (2002a, 2002b, 2008, 2013a, 2013b) analyzed archival recordings of nondirective, client-centered therapy with Luke, the long-term client experiencing a schizophrenic formal thought disorder who was the subject of the current research. As a

therapist, Warner practices nondirective, client-centered therapy and uses pre-therapy to foster psychological contact with clients who are contact-impaired (Prouty, 1994).

In her theoretical work, Warner (2013a) expanded on Rogers's (1957, 1959) foundation for client-centered theory by incorporating Gendlin's (1968) experiential concept of the "felt sense" to describe the natural human development of *processing capacities*. Warner described *difficult process* as a consequence of the stunted development of these capacities that occurs when the client's self-directed process is experienced as difficult for either the client or therapist. According to Warner, individuals have the capacity to process experience that develops from attachment relationships in early childhood. With good enough attachment relationships, individuals will have developed capacities to *hold experience in attention, name and put words to experience, moderate the intensity of their experiences, and hold immediate experience in attention while taking in others' experiences*.

Warner (2013a) argued that although processing capacities usually develop during childhood, the development of these capacities may be stunted for various reasons, although usually due to poor attachment relationships. As a result of stunted development of processing capacities, a person may experience *fragile process* in which they have difficulties connecting with their experience in ways that their experience may seem not to exist at all or may be too intense. However, Warner also argued that the development of processing capacities may continue later in life within relationships that provide the same conditions of good early attachment relationships, such as a therapeutic relationship. In essence, the therapeutic relationship creates a safe holding environment for the client to develop and explore their emotional experiences.

Of the many ways in which a client's self-directed process may be difficult, *psychotic process* "occurs when clients' experiences and expressions are difficult to understand and are outside of ordinary norms of expression" (Warner, 2002a, p. 121). These experiences in therapy and outside therapy may appear as "bizarre or idiosyncratic" sensory experiences or the use of language that does not align with their environment or the experiences of those around them (Warner, 2013a, p. 132). In these circumstances, client-centered therapists such as Warner (2013) and Prouty (1994, 2001) tend to follow clients' experiences using *contact reflections*. These reflections stay close to clients' exact words or gestures until clients experience enhanced levels of psychological contact or their psychotic experience progresses into more normative understandings of their experience.

Warner (2002a, 2002b, 2008, 2013a, 2013b, 2020) added to Prouty's (1994, 2001) conceptualization of schizophrenic speech with the conceptualization of *metaphacts* as an unusual form of speech that sometimes occurs in psychotic process. While studying patterns of schizophrenic speech, Warner (2002a, 2002b; Warner & Trytten, 2008) observed that a client's idiosyncratic language usage can be described as a combination of metaphor and facts or logics without the client sensing the difference. Warner suggested these metaphacts can be processed in productive ways if the therapist stays with them very closely.

Student researchers have investigated therapy recordings of a client's use of metaphacts spanning one or more therapy sessions; their findings showed metaphact processing tended to occur when the client explored issues that were personally felt but not yet clear (Simmons, 2013; Trytten, 2002; Williams, 2013). These results support that

the use of metaphacts to process “felt sense” experiences that are not yet clear is most consistent with previous research by Gendlin and Tomlinson (1967), which showed attending to these experiences tends to be productive therapeutically and demonstrate strong outcomes.

In an effort to demonstrate the same pattern using longitudinal data, VanDerKlok (2017) analyzed the stability of metaphact usage and the client’s immediate felt sense across 12 different therapy sessions using the *parturience* item, which was designed to measure client processing while attending to immediate felt sense, using the Phase Rating Scale (Iberg, 1990). The results revealed a correlation between observances of the client’s use of metaphacts and attention to experiences that were felt but not yet clear. These results indicate the use of metaphacts in psychotic process remains stable over time and may even hold a productive function for persons with a schizophrenic thought disorder.

Cognitive and Affective Processes of Schizophrenic Speech

Linguistics

Computational linguistic analyses are computerized methods of analyzing language data such as words, phrases, sentences, and discourse from written text or transcribed speech data. One of the more popular computational software programs used to analyze text data is called natural language processing (NLP). This software has the ability to recognize and understand the many patterns, rules, and structures involved in human language. In order to train the software to recognize, measure, and analyze text input from speech data, large volumes of randomized speech sample data have been curated specifically for the use of building models of normative language use. Over the last decade, researchers in the fields of linguistics, psychology, computer science, and

other clinical sciences have used such NLP software to systematically investigate observable differences in language produced by normative and clinical populations.

These clinical researchers have investigated the disordered use of language observed in persons experiencing schizophrenia, and formal thought disorder specifically. Furthermore, researchers have used their significant findings on schizophrenic disordered speech to build robust models that can successfully differentiate schizophrenic speech from normative speech data (Corcoran et al., 2018). This research expanded on NLP methodologies by incorporating machine learning (ML) technologies to find the distinguishing natural language features of schizophrenic disordered speech. As a result, researchers have used their NLP and ML methodologies and findings to analyze speech data from a person's first episode psychosis (FEP) to accurately predict whether that person will convert to schizophrenia within the next 6 months (Bedi et al., 2015; Mota et al., 2017). Most significantly, researchers have used the same models to predict whether a young person is at clinical high risk (CHR) for later developing schizophrenia (Corcoran et al., 2018; Gutierrez et al., 2017; Morgan et al., 2021). These advances respond to the need for a biomarker of psychosis prodrome and schizophrenia as these technologies demonstrate clinical utility as a diagnostic biomarker for schizophrenia and those at CHR (NIMH, 2014).

In effect, the collective body of computational linguistic analysis research on schizophrenic disordered language demonstrates a use case scenario in which an individual can be screened for schizophrenia by analyzing their collected speech data. The person's speech is recorded and then transcribed into text language samples. Computational analyses use NLP to identify, label, and quantify various natural language

elements within the text sample. ML software uses predictive models to analyze the coded sample text and determine its membership to a previously identified category. In this case, future research could combine NLP software with ML to identify the probability that a text sample belongs to one of three groups: (a) someone who is or is not at CHR for developing schizophrenia in the next 10 years, (b) someone who is experiencing FEP and will or will not convert to schizophrenia in 6 months, or (c) someone who does or does not have schizophrenia. Essentially, ML can be leveraged to analyze text speech samples to accurately predict and categorize each sample's membership into groups associated with an appropriate diagnosis and prevention-intervention efforts.

Though research on schizophrenic disordered language has emphasized the use of NLP and ML to differentiate normative from schizophrenic disordered language samples, very little research has investigated the longitudinal intra-individual variability in the natural language biomarkers of schizophrenic language disturbance (Alonso-Sánchez et al., 2022; Holmlund et al., 2020; Mota et al., 2017; Mota et al., 2018). Corcoran et al. (2020) identified intra-individual variability within a single interview or multiple interviews within relatively short timeframes, although longitudinal research has yet to demonstrate the relative stability of these linguistic features over the extended course of the disease process and time. It can be argued then that mere observation of intra-individual variability of disordered language between short intervals or within a single interview demonstrates the need to investigate the relative stability of these linguistic features over the course of the process of schizophrenia. Finally, intra-individual fluctuations in language disturbance may demonstrate a correlation with other variables

that play a significant role in the disease process or symptom presentation. Should longitudinal research identify a correlation between such variables and linguistic disturbance fluctuations, those variables would necessitate further investigation as potential targets for prevention and intervention efforts.

Additionally, several studies have demonstrated intra-individual fluctuations in several natural language variables, such as semantic coherence or referential failures, which are sensitive to schizophrenic language disturbances (Corcoran et al., 2020; Docherty, Cohen, Nienow, Dinzeo, et al., 2003). Research has found significant intra-individual variability over time in these linguistic features of schizophrenia using speech samples, which was observed in speech samples collected during a single interview and between interviews (Docherty, Cohen, Nienow, Dinzeo, & Dangelmaier, 2003). However, the largest variability in schizophrenic language disturbances was observed in speech samples collected during emotionally evocative topics of discussion (Burbridge & Barch, 2002; Burbridge et al., 2005; Cohen & Docherty, 2004, 2005; Docherty et al., 2003; Docherty, Hall, & Gordinier, 1998; Seghers & Docherty, 2009). As a result, researchers have intentionally avoided the use of emotionally evocative content during interviews by narrowly defining the content for discussion, directing clients away from emotionally charged topics, and redirecting clients to less emotionally charged discussion points. These efforts are intended to avoid this phenomenon as a confounding variable in data collection practices. However, analyzing intra-individual fluctuations in schizophrenic language disturbance as they relate to sentiment may prove to be a defining variable of the disturbance and worthy of further investigation.

Elvevåg et al. (2007) were the first to use automated text analysis to accurately identify persons with schizophrenia ($n = 26$) from normal controls ($n = 25$). Results demonstrated accuracy of 78.4% of subjects correctly identified. This proof-of-concept application demonstrated the potential to use quantitative linguistic analysis of text speech data as an indicator for schizophrenia. Previously, these methods had been proposed to identify general and specific psychopathologies. Mota et al. (2012) deployed similar text analysis methods to differentiate schizophrenic versus manic patients from healthy controls. The researchers analyzed interview speech data using graphs as visual representations of language usage; these methods demonstrated precision in detecting thought-disordered schizophrenia from the categorically distinct disorganization seen during a manic episode. Bedi et al. (2015) used similar computational methods to analyze semantic coherence in youth at CHR for psychosis to predict a future psychotic episode and conversion to schizophrenia within 2.5 years. Their model correctly identified which participants would have a psychotic episode and then convert to schizophrenia in 100% of subjects. These studies demonstrate the robust use of computational linguistic measures to differentiate persons with schizophrenia from healthy controls, non-affected family members, and other clinical populations with disorganized speech. These studies also support that computational measures demonstrate utility in classifying schizophrenic disordered speech, especially with regard to large sample sizes and data sets in which manual coding is time and cost prohibitive.

Iter et al. (2018) investigated the automatic detection of incoherent speech to aid in the diagnosis of schizophrenia. The researchers used NLP techniques to analyze the interview transcripts of individuals with schizophrenia and healthy controls. Results

showed individuals with schizophrenia produced significantly more incoherent speech compared to healthy controls, and the NLP techniques were able to accurately classify individuals as having schizophrenia or not specifically based on the use of ambiguous pronouns as linguistic markers. The authors suggested the findings have the potential to enhance the accuracy and efficiency of diagnosing schizophrenia through the use of NLP techniques, but further research is needed to refine and validate these techniques.

Whereas the linguistic variables discussed above have demonstrated sensitivity and specificity to formal thought disorder and schizophrenic disordered speech, referential failures have demonstrated consistent sensitivity and specificity as a diagnostic measure to identify persons with schizophrenia and those at CHR for psychosis (Çokal et al., 2018; Holmlund et al., 2020; Iyer et al., 2018).

Affective Reactivity

As researchers in the field of cognitive linguistics introduce computational methods into their investigations of language, they have observed significant intra-individual fluctuations in several natural language variables that are most sensitive to schizophrenic language disturbances. Studies have shown significant intra-individual variability in speech samples collected during emotionally evocative topics of discussion. Although some researchers may have intentionally avoided the use of emotionally evocative material as a potential confound, other researchers have implicated a role of affective processing in the pathology of formal thought disorder (Cohen & Docherty, 2005; Dinzeo et al., 2008; Docherty, Evans, et al., 1994; Docherty & Grillon, 1995; Docherty & Hebert, 1997; Docherty, Sledge, & Wexler, 1994; Seghers & Docherty, 2009). A general relationship between schizophrenic disordered speech and affective

processing has been supported by the studies covered in this section, although further research is necessary to explore intra-individual variability in affective processing and disordered speech over time in persons with schizophrenia.

In exploring the association of speech disorder reactivity to affective condition in schizophrenic patients, Docherty and Grillon (1995) collected speech samples in affectively negative and positive conditions from schizophrenic outpatients before subjecting them to an acoustic startle test. Results of their analysis showed speech disorder reactivity to negative affect was associated with the degree of startle response, which led the authors to propose that language disturbances in schizophrenia that are reactions to negative affect may be one part of a more general psychophysiological reactivity to affective and sensory stimuli. Cohen and Docherty (2005) conducted a similar study using speech samples but focused exclusively on the effect of positive affect on speech disorder. Results were significant for improvement in disordered speech symptoms when introduced to positive affect, although these benefits were observed only in those with more symptom severity.

Docherty, Sledge, and Wexler (1994) found that only half of patients tested showed marked affective reactivity of language symptoms. Reactive patients were most often those with a family history of schizophrenia (Docherty, Sledge, & Wexler, 1994), and those with more severe “reality distortion” symptoms (i.e., delusions and hallucinations; Docherty, Evans, et al., 1994; Docherty, Sledge, & Wexler, 1994). This association of a more severely distorted perception of reality, a distinct reactivity startle response, and a family history of schizophrenia indicates these patients may have inherited a genetic trait that separated the reactive patients from their non-reactive peers.

Docherty and Hebert (1997) analyzed schizophrenic speech samples from positive and negative affective topics of discussion. These samples were coded for several communication failures using the Communication Disturbances Index. Although missing referents and syntactic unclarity did not change across affective conditions, results showed significantly more frequent incidence of overinclusive references, ambiguous word meanings, and ambiguous referents in the negative affective condition. Affective reactivity of speech was associated with positive schizophrenic syndrome, which indicates schizophrenic communication disturbances show a differential reactivity to affect, possibly as the result of different underlying pathophysiological processes.

Because negative affective reactivity and arousal have consistently exacerbated schizophrenic speech symptoms, Seghers and Docherty (2009) endeavored to identify neurocognitive predictors for disordered speech that would explain the speech reactivity to emotional variables. However, the neurocognitive variables of sustained attention, immediate auditory memory, organizational sequencing, and conceptual sequencing ability did not predict speech clarity in stress and non-stress conditions. Baseline depression and sensitivity to interpersonal stressors were the only variables that predicted affective reactivity of speech; stress sensitivity was the mediating variable. The findings indicate stress vulnerability has a role in speech reactivity, whereas neurocognitive factors had no role.

Other studies have shown schizophrenic thought and language symptoms in particular are exacerbated by stress. More specifically, Docherty, Evans, et al. (1994) reported that speech disorder in some acutely schizophrenic inpatients was reactive to the discussion of patient-selected affectively negative topics (i.e., in these reactive patients,

more speech disorder was detected in speech samples from interviews wherein affectively negative topics were discussed than in speech samples from interviews wherein affectively positive topics were discussed). Analyses using Andreasen's (1986) Scale for the Assessment of Thought, Language, and Communication (TLC) indicated the degree of language symptom affective reactivity varied among patients and may indicate different degrees of vulnerability to negative affect in different individuals (Docherty et al., 1994). Docherty and Hebert (1997) replicated this finding and additionally discovered that the increases in speech disturbances were found in measures of content (i.e., increased ambiguity) as well as in TLC scores.

Abnormalities in emotional experience, traditionally described as anhedonia (i.e., diminished capacity to experience pleasure), have long been considered a core feature of schizophrenia (Llerena et al., 2012). Current theories of emotion also posit the existence of a second dimension—arousal—that reflects the intensity of the activation of the motivational system. If individuals with schizophrenia are in fact anhedonic, in the sense of having a diminished capacity for pleasure, one might expect self-reported arousal to pleasant stimuli to be lower in people with schizophrenia compared to controls. To examine this possibility, a recent meta-analysis examined self-reports of arousal to pleasant, unpleasant, and neutral stimuli across 26 laboratory-based studies (Llerena et al., 2012). Schizophrenia patients and controls reported similar levels of arousal in response to pleasant stimuli. Thus, individuals with schizophrenia do not appear anhedonic when their self-reported experience of arousal to pleasant stimuli is evaluated in response to emotional probes (Llerena et al., 2012).

Rating one's level of pleasure, however, does not necessarily measure their objective capacity for experiencing pleasure, particularly when the rating involves the subjective reporting of non-current feelings and emotional experiences (Strauss & Gold, 2012). For example, when asked to reflect on and rate the extent to which a stimulus or event is pleasurable, participants with schizophrenia report significantly lower levels of pleasure compared to healthy controls (Blanchard et al., 2001). In contrast, when patients are actively exposed to emotionally evocative stimuli, they report experiencing pleasure to the same degree as healthy controls (Llerena et al., 2012). These contradictory findings have raised questions regarding the construct validity of previous self-report ratings of anhedonia and support reconceptualizing this construct as a level of arousal.

Dinzeo et al. (2008) examined the role of arousability, defined as changes in affect and physiological response, by measuring negative affect and cardiovascular activity. In response to a challenging group task, arousability as measured by change in heart rate was associated with increased negative affect and greater severity of symptoms. The findings indicate emotional and physiological response may play more of a significant role in the symptom development of schizophrenia and formal thought disorder.

Little is known about the biological mechanisms involved in stress processing in schizophrenia; however, sensitivity to stress has been postulated to more closely resemble the underlying vulnerability for psychopathology, especially in schizophrenia (Myin-Germeys & van Os, 2007). Whereas major life events may play a role in neurosis, persons with schizophrenia do not appear to experience more stressful life events than normal controls, but they do report greater subjective stress. Possibly, patients with

schizophrenia experience more stressful events as a consequence of illness, or inversely, stressful events trigger the onset of illness. People with schizophrenia respond with more negative emotions to everyday stressors than do controls. Rather than reactions to extreme life events, sensitivity to minor life events or daily frustrations is more frequent in schizophrenia (Myin-Germeys & van Os, 2007).

Another phenomenon, stress-sensitivity, might also explain the pathway from trauma to posttraumatic symptoms to psychosis (Myin-Germeys & van Os, 2007). Stress-sensitivity refers to the greater emotional intensity with which individuals with traumatic childhood experiences sometimes react to daily stressors compared to those without trauma histories. Hypothetically, stress-sensitivity can lead to the exacerbation of psychological difficulties through the disruption of affective and cognitive processes. Increased emotional reactivity to stimuli, of the sort that individuals with heightened stress-sensitivity experience, could then activate and perpetuate negative beliefs about the world, particularly when these individuals attribute these stimuli to external sources.

Myin-Germeys and van Os (2007) suggested stress-sensitivity could also result in psychotic experiences through cognitive disturbance. When individuals with heightened stress-sensitivity experience emotional reactions to unusual stimuli, including illusory sensory experiences, it could impel them to search for a source of these stimuli. Due to the emotionality associated with stress-sensitivity, these searches might be biased and cause these individuals to attribute perceptual anomalies that originate internally to external sources, akin to the process involved in a psychotic experience such as an auditory hallucination. Furthermore, stress-sensitivity is more common among individuals with one proposed subtype of schizophrenia that is characterized by positive

symptoms (e.g., delusions, hallucinations), acute onset of the condition, and episodic re-emergence of psychosis over time.

It is unclear whether the development of formal thought disorder is dependent upon the number of stressful events versus the severity of stressful events (or both). Both patients and high-risk individuals perceive their stressors as more stressful and rate themselves as having greater responses to stressors than healthy controls (Myin-Germeys & van Os, 2007). This tendency for patients to appraise stressors as more stressful has been a consistent finding throughout the literature on affective processes in formal thought disorder. It is believed these individuals are more sensitive to stress because they have greater emotional reactivity, as indexed by self-report measures of reactivity and arousal (Docherty et al., 2009). Docherty and colleagues (2009) found that emotional reactivity moderates the relationship between stressful life events and psychotic symptoms, such that only individuals who were high in emotional reactivity showed symptom exacerbations in response to stressful events. Overall, these findings indicate patients with schizophrenia and individuals at high risk for psychosis experience stressors as more subjectively stressful.

Gruber and King (2008) analyzed differences in disorganized speech and emotional (positive, neutral, and negative) personal narratives between schizophrenic patients and healthy controls. They found negative emotional narratives were significantly more disorganized than either neutral or positive emotional narratives in persons with schizophrenia. The clinical group was more disorganized and emotionally detached across conditions in comparison to healthy controls. Though healthy controls and schizophrenic patient groups demonstrate significant differences in disorganized

language across emotional narratives and speech text data, explorations of intra-individual variability in disorganized language across emotional narratives or expressed sentiment have been limited by time constraints associated with manual coding methods. NLP is a computational linguistic measure that may be leveraged for further exploration of expressed emotion or sentiment in schizophrenia clinical populations and large data sets.

Gutierrez et al. (2017) analyzed metaphoricity (i.e., alteration in metaphor production) and sentiment as expressed emotion with computational linguistic methods to compare differences in speech data among healthy controls, schizophrenic patients, and non-affected family members. The results demonstrated the predictive value of metaphoricity in classifying clinical groups from non-affected family members and healthy controls. However, the sample size was not large enough and longitudinal data are needed to demonstrate a relationship between the disorganized use of metaphor in positive, neutral, and negative sentiment expressions. This was the first study that analyzed schizophrenic speech and sentiment conditions using NLP tools. The methods followed the recommendations of Liu (2015) for a detailed, comprehensive overview of sentiment analysis that assigned sentiment values as either positive or negative, as well as assessing magnitude in either direction.

In order to understand the role of affective processes in the development of formal thought disorder, the affective reactivity observed in other findings must be consistent in very early stages of the disorder. Minor et al. (2016) studied affective reactivity in early-stage psychosis when intervention efforts are intended to prevent conversion from psychosis to schizophrenia. Results from the study showed there was large variability in

the early psychosis group with respect to speech production and disordered speech. However, this group exhibited the very same affective reactivity for disordered speech before they met the full criteria to receive a schizophrenia diagnosis. Their finding also showed the affective reactivity for disordered speech was ultimately linked to poor real-world outcomes and the development of serious social impairment.

Purpose of the Study

The current single-case pilot study involved using NLP and other computational linguistic analyses to investigate the relationship between schizophrenic disordered speech and affective reactivity of language using archival client-centered therapy recordings with a participant who has had schizophrenia spanning 23 years. To this end, the single-case study involved the use of longitudinal archival speech data to investigate the intra-individual variability in schizophrenic disordered speech by analyzing the relationship between referential disturbance and sentiment.

Referential failures, also referred to as referential disturbance or ambiguous pronoun usage, were defined by several previous linguistic studies and operationalized as the relative rate of ambiguous pronoun usage in the absence of a clear referent. The present study measured referential failures using Lee et al.'s (2017) End-to-end Neural Coreference Resolution software, which recent studies used to measure referential failures in schizophrenic language and speech (Hinzen & Rosselló, 2015; Iyer et al., 2018; Morgan et al., 2021).

The current study measured sentiment using Google Cloud Natural Language API, a NLP software that analyzes speech data and text to quantify the sentiment embedded within the language sample. For the purpose of analyzing sentiment from de-

identified speech samples in the current study, Google Cloud Natural Language API software measured sentiment that was quantified as a *sentiment score* within the range of -1 to 1. The current study also used these empirically supported sentiment score thresholds to transform sentiment scores into three distinct levels of sentiment valence: *positive sentiment* (1.0 and 0.3), *negative sentiment* (-0.3 and -1.0), and *neutral sentiment* (0.3 and -0.3). Finally, *sentiment magnitude* measures the strength or intensity of the expressed emotion or feeling regardless of positive or negative directionality. Google Cloud Natural Language API assigned sentiment magnitude scores that ranged between 0 and 5, in which 0 indicated no sentiment and 5 indicated the strongest possible sentiment.

Hypotheses

For the purposes of studying the stability of referential failures in schizophrenic speech over time, it was hypothesized that a longitudinal analysis of schizophrenic disordered speech data would reveal no differences across repeated measures of referential failures per utterance between three therapy session intervals.

With respect to (a) speech samples within a single session and (b) speech samples from all sessions combined, it was hypothesized that negative sentiment speech data would contain significantly more referential failures than neutral sentiment and positive sentiment, although there would be no significant difference in referential disturbance between positive and neutral sentiments.

It was hypothesized that schizophrenic disordered speech samples would demonstrate a positive correlation between sentiment magnitude and referential failures, meaning any observed increases in sentiment magnitude would occur with similar increases in referential failures.

Methods

Participants

Participant Inclusion Criteria

The participant in this study has been a long-term psychotherapy client at a private practice in Chicago, Illinois. The participant received a diagnosis of schizophrenia in his early 20s prior to receiving psychotherapy. The participant has met the *DSM-5* (American Psychiatric Association, 2013) criteria for schizophrenia in the absence of other psychiatric diagnoses over the last 30 years.

Number of Participants

Only one participant was used for the single-case pilot study.

Participant Demographics

The participant was an upper-middle class, native English speaker, Caucasian male in his mid-60s living in a Midwestern urban area in a lightly structured group home with supportive case management. The participant was able-bodied and his living environment was not restrictive; he was free to come and go from his group home as he wished. The participant received twice weekly client-centered psychotherapy on an outpatient basis while also receiving pharmacotherapy through his physician.

Recruitment

Recruitment for the current study was minimal because the research expanded on previously conducted research projects at the Illinois School of Professional Psychology. The participant volunteered to participate in ongoing research projects in which archival audio recordings of his psychotherapy sessions would be made available for the purposes of clinical research. The participant previously described the sense of purpose he derived

from contributing to ongoing research related to his significant life experiences. No monetary benefit or compensation was provided for participation in the research study, although personal benefit may have been gained from meaningful participation.

Informed Consent. The participant gave informed consent to his psychotherapist following a discussion of the potential risks and benefits of participating in the archival research project. The participant was informed of his right to withdraw consent for research participation, including the use of all archival therapy recordings. Finally, the client was informed that withdrawing consent would not affect his ability to continue receiving psychotherapy.

Risks and Benefits. There were no physical, political, economic, or social risks or benefits, nor any deception or concealment to the participant. There was minimal to no risk of emotional discomfort to the participant other than what was expected from daily life. All confidential information for this study was de-identified. Furthermore, the study used only archival data, which eliminated the need to interface with the participant; the only exception to this was the need to arrange informed consent. The participant expressed his continued interest in participating in future research projects by allowing his therapy session recordings to be archived. Though his mental illness demonstrated a degree of vulnerability for risk, that risk was minimal given the methodological design, informed consent, protections of confidentiality, and relative benefits of the study. Participation was entirely voluntary, and the participant had the right to withdraw his participation at any time without negative consequences. The participant was informed that he could contact the clinician, the student researcher, the research chairperson, or National Louis University's Institutional Review Board (IRB) during or after

participation in the research if he had any questions or concerns that were not already addressed. Contact information for each of these parties was provided to the participant at the time of informed consent.

Measures

The single-case longitudinal pilot study involved an analysis of schizophrenic disordered speech and affective reactivity using computational NLP tools. The study was designed to identify the stability of referential failures, a potential biomarker for schizophrenia, using speech samples from three transcripts of client-centered therapy with a client who has schizophrenia. Additionally, the study was designed to explore whether there was a relationship between referential failures and affect, which refers to experienced emotion. In conjunction with computational linguistic measures for referential failures, the study involved measuring sentiment valence and sentiment magnitude to quantify the emotional content and intensity of speech samples.

Because the study involved an analysis of participant speech during therapy sessions, speech samples referred to the participant's *utterances* or statements made between responses from the therapist. Thus, values for each measure corresponded with the participant's speech data from a single utterance, also referred to as a *line*, of the transcript.

Referential Failures

Coreference is a linguistic term that describes the relationship between multiple expressions that refer to the same entity or referent. Other mentions that refer to the referent are known as references. To demonstrate the relationship between a referent and reference, consider the sentence, "Nick woke up late for school and he missed the bus."

In the example sentence, “Nick” is the referent, and “he” is a reference to “Nick”; the coreference cluster includes both “Nick” and “he” as expressions referring to the same person. Additionally, coreference resolution is the term used for this process of analyzing language data, such as speech or text, to identify all coreference clusters or groups by pairing references with their referents. Pronouns (he, she, they, etc.) function as references that can easily be connected to a referent through properties like gender (she vs. he), number (she vs. they), and relative distance to the referent. When a pronoun does not refer to a referent clearly or lacks a referent entirely, the ambiguous use of the pronoun is referred to as a referential failure. Several recent studies measured referential failures in speech samples from persons with schizophrenia and results showed more frequent referential failures in clinical groups with psychosis and schizophrenia, leading to the recommended use of this linguistic measure as a biomarker for schizophrenia (Hinzen & Rosselló, 2015; Iter et al., 2018).

End-to-end Neural Coreference Resolution. Referential failures were quantified from transcribed speech samples using NLP software that specializes in identifying references and their referent. The researcher in the present study used End-to-end Neural Coreference Resolution (e2e-coref) software to analyze the participant’s speech data from therapy session transcripts. The researcher in this study selected the e2e-coref software from Lee et al. (2017) and followed the study’s protocols for using computational linguistic methods for coreference resolution. Additionally, the researcher in this study deployed the same computational linguistic methods that were used to measure referential failures in recent studies of language in schizophrenia (Hinzen & Rosselló, 2015; Iter et al., 2018; Morgan et al., 2021).

Before analyzing the transcripts with the software, transcripts were pre-processed to remove identifiable information and the therapist's speech data. The software identified all coreference clusters within the transcript. However, an additional process was required to identify any remaining pronouns that did not belong to a coreference cluster in the absence of a clear referent. For that purpose, transcripts were processed using the Python 3.10 implementation of the natural language toolkit (NLTK), which tagged and coded all pronouns within the transcript. After combining e2e-coref and NLTK software outputs, all pronouns that did not belong to a coreference cluster were labeled as referential failures. Because the study involved analyzing the participant's speech during therapy sessions, speech samples referred to the participant's utterances or statements made between responses from the therapist. Thus, values for referential failures corresponded with the count of referential failures observed from the participant's speech data within a single utterance or line of the transcript.

Ambiguous Pronouns. The researcher in the present study used a second measure for referential failures to confirm that the software correctly identified and categorized coreference clusters from ambiguous pronouns. The second measure was also used to minimize any errors in detecting referential failures that could arise from analyzing discontinuous speech data extracted from dialogue between the participant and the therapist. Previous studies used extended continuous speech data for each participant to measure the frequency of referential failures; however, these studies also deployed a secondary measure for referential failures. The researcher in the present study used the same criteria for ambiguous pronouns that were used by raters to manually measure the same variable in recent studies (Iter et al., 2018; Morgan et al., 2021):

Ambiguous pronouns are pronouns which were either (1) never resolved (e.g. “I think that’s their dog”, where “they” are never named) or (2) resolved only after the use of a proper noun (e.g. “I told him to go away, my friend, I didn’t want to see him”). (Morgan et al., 2021, p. 3)

Sentiment

The researcher in this study measured sentiment using Google Cloud Natural Language API, a NLP software that analyzes speech data and text to quantify the sentiment embedded within the language sample.

Sentiment Score. In general, sentiment refers to the emotion or feeling that is expressed through a word, phrase, or sentence; it is usually described as being positive, negative, or neutral. NLP software, such as Google Cloud Natural Language API, quantifies the sentiment score using a scale that ranges between -1.0 and +1.0, which corresponds with how negative or positive a particular word, phrase, or sentence is. For example, the sentence, “I do not like to eat chocolate,” has a negative sentiment and might have a score of -0.8, which is close to the absolute minimum score of -1. In contrast, the sentence, “I like to eat chocolate,” has a positive sentiment and might have a score of 0.8, which is close to the absolute maximum score of 1. From these examples, it can be understood that the closer a score is to 1, the more positive the sentiment, and the closer the score is to -1, the more negative the sentiment. For the purpose of analyzing sentiment from de-identified speech samples in the current study, Google Cloud Natural Language API software measured sentiment that was quantified as a sentiment score within the range of -1 to 1.

Sentiment Valence. Whereas sentiment scores range from +1.0 to -1.0, sentiment valence categorizes sentiment scores into three distinct levels: *positive sentiment* (1.0 and 0.3), *negative sentiment* (-0.3 and -1.0), and *neutral sentiment* (0.3 and -0.3). These cutoff scores for positive, negative, and neutral sentiment valence levels were originally defined by Liu (2015). However, Gutierrez et al. (2017) used the same cutoff scores in sentiment analysis algorithms that were used in conjunction with other linguistic measures to classify persons with schizophrenia using speech data. Likewise, the researcher in the current study used these empirically-supported sentiment score thresholds to transform sentiment scores into three distinct levels of sentiment valence: negative, positive, and neutral.

Sentiment Magnitude. Whereas sentiment valence refers to the positive or negative directionality of emotional content expressed through words and phrases, *sentiment magnitude* measures the strength or intensity of the expressed emotion or feeling regardless of positive or negative directionality. Recall the previous examples used to illustrate sentiment score and valence. Although the sentence, “I like to eat chocolate,” has positive sentiment, the sentiment magnitude is not very strong in comparison to the sentence, “I absolutely love eating chocolate!” Both sentences express positive sentiment when describing the experience of eating chocolate; however, the second example has a stronger magnitude because the emotion is much more intense. In the absence of positive or negative directionality, sentiment magnitude scores are theoretically greater than or equal to 0. Consistent with other NLP software, Google Cloud Natural Language API assigned sentiment magnitude scores that ranged between 0 and 5, in which 0 indicated no sentiment and 5 indicated the strongest possible sentiment.

Procedure

Archival recordings from 15 of the participant's psychotherapy sessions spanning the years 1993 to 2019 were available in audio cassette and digital formats. Older recordings on audio cassette tapes were converted to digital format using a handheld tape player connected to a Sony digital audio recorder using an auxiliary cord. The Sony digital audio recorder recorded digital audio from the cassette tapes to secure digital memory card storage. The recordings were then transferred to a secure encrypted hard drive. All digital recordings for the use of this project were stored and accessible via the encrypted external drive.

From the 15 audio recordings of 1-hour therapy sessions recorded between 1993 and 2019, transcripts were generated for three recordings by the principal investigator, research chair, and Luke Research Lab (LRL). The researcher chose to analyze three transcripts from therapy sessions that were recorded in 1996, 2004, and 2019. Transcripts from these years were selected for multiple reasons, although the primary reason was that two of these transcripts were previously analyzed by VanDerKlok (2017) in a longitudinal study of metaphact usage and immediate felt sense. The third transcript was selected because it was the most recent therapy recording with the participant. These transcripts were also selected because the original audio was the clearest, the audio recordings were roughly of the same length, the samples were recorded around the same months of the year, and there were significant intervals of time between the sessions.

Transcripts were examined for any identifiable data that were then removed from the coded transcripts to protect the participant's identity and confidentiality. Specific names, dates, and locations were removed from the transcripts. The de-identified

transcripts were then saved to the encrypted external drive. Another version of the de-identified transcripts was created to be used for sentiment analysis. First, each utterance from the participant was labeled with two numbers: the first number corresponded with the therapy session when the utterance was made (1 = 1996, 2 = 2004, 3 = 2019) and the second number corresponded with the order in which the utterance was made during the therapy session. The combinations of these two numbers functioned as identifiers for individual speech samples to assist in additional analyses of outliers and unique samples. After assigning identifiers to the participant's speech data samples, the therapist's remaining speech data were removed entirely from the transcripts and saved to the encrypted hard drive. The transcripts were then separated by utterance into separate text files and saved in folders that corresponded with the therapy session number. Speech samples were processed using the Sentiment Analysis feature of the Google Cloud Natural Language API in Python 3.10. The sentiment analysis returned values for sentiment score (-1 to 1) and sentiment magnitude (0 to 5) that corresponded with each speech sample. Afterwards, these sentiment values were imported into SPSS.

The transcripts were then analyzed using e2e-coref resolution software in Python 3.10, which identified all coreference clusters within the transcripts and included only references that had a clear referent. However, an additional process was required to identify any remaining pronouns that did not belong to a coreference cluster due to the lack of a clear referent. For that purpose, transcripts were processed using the Python 3.10 implementation of the NLTK, which tagged and coded all pronouns within the transcript. After combining e2e-coref and NLTK software outputs, all pronouns that did not belong to a coreference cluster were labeled as referential failures. Afterwards, each

of the transcripts were manually coded for referential failures by the principal investigator and another member of the LRL using the criteria described under the ambiguous reference measure. Both measures for referential failures and the corresponding text data were imported into SPSS and combined with the sentiment scores for further analysis.

To resolve discrepancies between referential failures measured by manual raters and the e2e-coref resolution software, values from both measures were analyzed for convergent validity. There was a positive correlation ($r = 0.77$) between the number of referential failures identified by raters and the e2e-coref software, which indicated very strong convergent validity between the two measures. Frequently, discrepancies in referential failure counts between the raters and coreference resolution software were due to raters having access to the therapist's speech data, which were not processed by the software. Specifically, when the participant made a reference to the therapist or content mentioned by the therapist, the software flagged these references as errors. Because these references were not errors in the context of the therapy session, they were coded as clear references instead.

The dataset was prepared for analysis of referential failures after removing all sample data that lacked references entirely, which included samples that had no clear or ambiguous references. The rationale for this decision was that in order to study the conditions for reference failures, there needed to be an opportunity to make a referential failure. In other words, speech samples needed to include at least one clear reference or a reference failure to be included in the analysis. Examples of speech samples removed from the dataset were those that generally included only three words, such as "Yes," "Not

sure,” and “Uh huh, yeah.” Most of these lines were the client confirming the therapist’s empathic understanding of the client’s internal frame of reference; these samples rarely contributed new information to the dialogue. Two speech samples were outlier datapoints that represented extreme values for referential failures, and therefore were removed from the data analysis. The researcher identified extreme values of referential failures to be greater than or equal to 7 due to the use of a single-participant design; however, these values may not be considered outliers with multiple participants and may contribute to an overall normal distribution of scores in larger studies.

Statistical analyses included descriptive statistics for the number of samples from each transcript and number of words per sample. Descriptive statistics were also calculated for referential failures and sentiment variables (i.e., score, valence, and magnitude) for individual sessions and all sessions combined. Although an ANOVA could have been used to analyze the large volume of linguistic quantitative data collected for this study, it would have been inappropriate to perform and analyze inferential statistics because the current study involved analyzing speech samples collected from only a single participant. Despite the utility of the current study for exploring trends and methodologies that will inform future research, significance levels could not be tested or generalized to larger populations. For this reason, the researcher analyzed trends that were observed within the data for sentiment variables and referential failures. Finally, a correlational analysis of sentiment magnitude and referential failures was completed for the entire dataset to explore the relationships between these variables; however, significance testing was not deployed during this pilot study.

Results

The current study was a pilot study that involved analyzing data from three therapy sessions with a single client. Due to the single-case design of the study, an analysis of inferential statistics would have been inappropriate as results cannot be generalized beyond the individual case. However, the results revealed trends that are intriguing and indicate a follow-up study involving multiple subjects might show similar trends that may be generalizable to other people diagnosed with a schizophrenic formal thought disorder.

Participant Demographics

The study included one participant ($N = 1$) who was analyzed based on his attendance to three client-centered therapy sessions during long-term therapy. The participant was a middle-age, single, White Caucasian male from the Midwest who was disabled and unemployed. The participant was a long-term psychotherapy client at a private practice. The participant received a diagnosis of schizophrenia in his early 20s prior to receiving psychotherapy. The participant met the *DSM-5* (American Psychiatric Association, 2013) criteria for schizophrenia in the absence of other psychiatric diagnoses over the last 30 years. Speech data were taken from three recordings of therapy sessions (session 1 = 1996, session 2 = 2004, and session 3 = 2019) that spanned 23 years.

Descriptive Statistics

The researcher analyzed samples of transcribed speech data of client utterances from three therapy sessions; each utterance was analyzed as a line of text. The study's sample ($N = 334$) from all three sessions had an average of 29.28 ($SD = 27.30$) words per speech sample and a range of 148 (minimum = 3, maximum = 151) words per line.

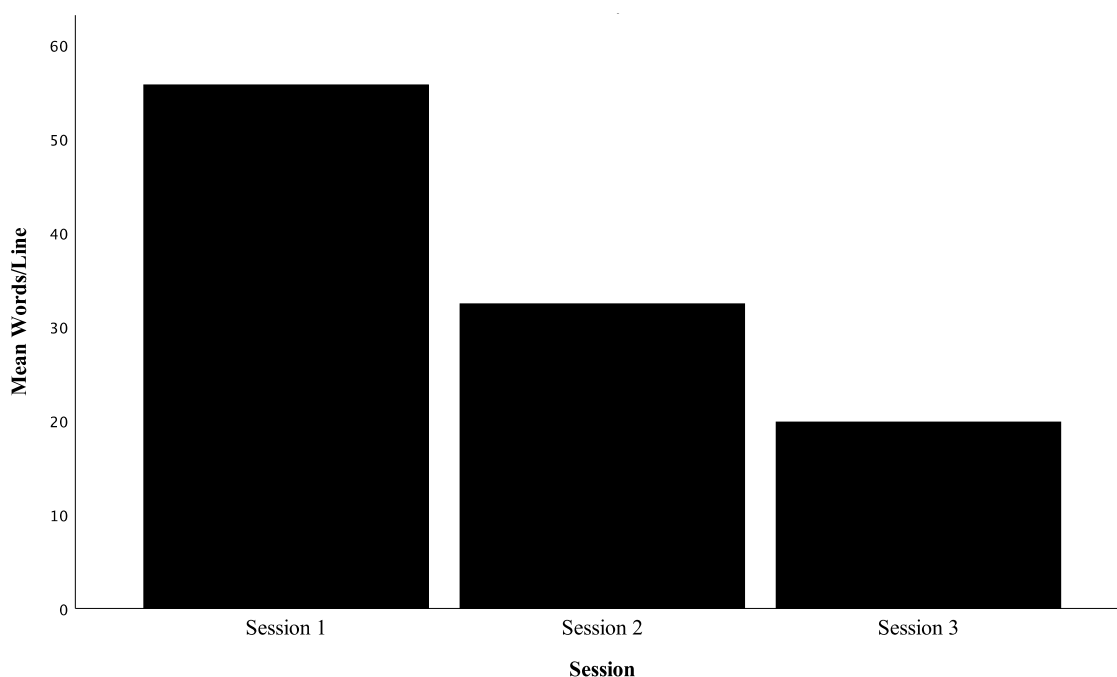
Session 1 ($n = 56$) had an average of 55.73 ($SD = 38.34$) and a range of 122 (minimum = 5, maximum = 127) words per line. Session 2 ($n = 91$) had an average of 32.42 ($SD = 30.10$) and a range of 148 (minimum = 3, maximum = 151) words per line. Session 3 ($n = 187$) had an average of 19.84 ($SD = 12.50$) and a range of 68 (minimum = 3, maximum = 71) words per line. There was a 62.5% increase in the number of lines between sessions 1 and 2, and another increase by 105% between sessions 2 and 3. In contrast, the average number of words per line decreased by 41.8% between sessions 1 and 2, and again by 38.8% between sessions 2 and 3. Though the number of lines per session increased from session 1 to 2 to 3, the number of words per line decreased correspondingly.

Consequently, the total number of words in each session was closer to constant with only an approximate 20% difference between the highest (session 3 = 3,710) and lowest (session 2 = 2,950) total word counts. See Table 1 for a summary of descriptive statistics for the number of lines, words, and words per line for each of the three sessions and the overall sample. See Figure 1 for a graphical representation of mean words per line by session.

Table 1

Descriptive Statistics for Words Per Line by Session

Words per line	n	M	SD	Min.	Max.	Sum
Session 1	56	55.73	38.34	5	127	3121
Session 2	91	32.42	30.10	3	151	2950
Session 3	187	19.84	12.50	3	71	3710
Overall	344	29.28	27.30	3	151	9781

Figure 1*Mean Words Per Line by Session*

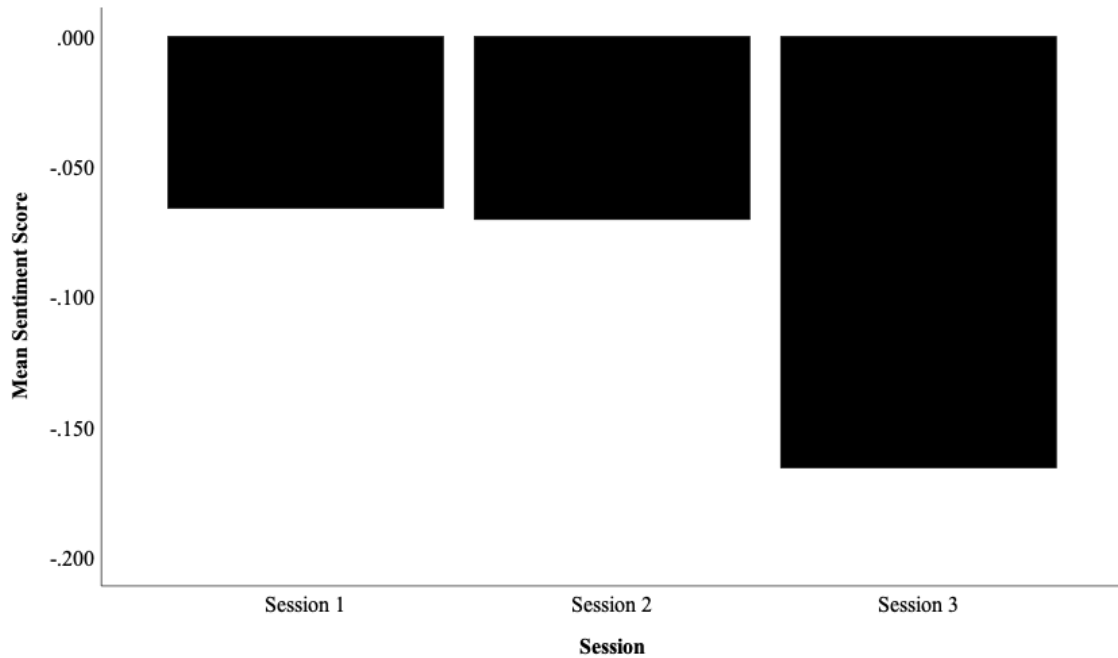
Sentiment scores were calculated for each line of speech data using Google Natural Language API software. Sentiment scores range from -1 to +1. Negative score values represent negative sentiment that become increasingly negative as they reach the maximum threshold of -1, whereas positive scores represent positive sentiment that approaches the most positive sentiment as the value approaches +1. Overall, the sample of lines from all three sessions combined ($N = 334$) had a mean sentiment score of -0.123 ($SD = 0.305$) and a range of 1.7 (minimum = -0.9, maximum = 0.8). Session 1 ($n = 56$) had a mean sentiment score of -0.066 ($SD = 0.230$) and a range of 1.2 (minimum = -0.6, maximum = 0.6). Session 2 ($n = 91$) had a mean sentiment score of -0.070 ($SD = 0.332$) and a range of 1.6 (minimum = -0.8, maximum = 0.8). Session 3 ($n = 187$) had a mean sentiment score of -0.166 ($SD = 0.305$) and a range of 1.7 (minimum = -0.9, maximum = 0.8). Overall, mean sentiment score values became more negative from session 1 to 2 to

3, although the mean sentiment score became more negative and decreased by 137% between sessions 2 and 3. Additionally, the minimum sentiment score values decreased consistently from session 1 to 2 to 3; the maximum sentiment score also increased correspondingly between session 1 and 2, although there were no changes between sessions 2 and 3. See Table 2 for a summary of the descriptive statistics for sentiment scores by session. Figure 3 is a graphic representation of the mean sentiment score values across the three sessions.

Table 2

Descriptive Statistics for Sentiment Score by Session

Sentiment score	<i>n</i>	<i>M</i>	<i>SD</i>	95% CI for Mean		Min.	Max.
				Lower	Upper		
Session 1	56	-.066	.230	-.128	-.004	-.6	.6
Session 2	91	-.070	.332	-.140	-.001	-.8	.8
Session 3	187	-.166	.305	-.210	-.122	-.9	.8
Total	334	-.123	.305	-.156	-.090	-.9	.8

Figure 2*Mean Sentiment Score by Session*

For the purpose of exploring the relationships between linguistic variables and sentiment valence, sentiment scores were transformed from a continuous variable to ordinal groups. Sentiment score values between 0.3 and 1.0 were labeled positive sentiment valence, scores between -1.0 and -0.3 were labeled negative sentiment valence, and scores that fell between -0.3 and 0.3 were labeled neutral sentiment valence.

Sentiment valence scores for the three sessions combined ($N = 334$) were 31.14% negative ($n = 104$), 58.68% neutral ($n = 196$), and 10.18% positive ($n = 34$). Sentiment valence in session 1 samples ($n = 56$) was 16.07% negative, 78.57% neutral, and 5.36% positive. Sentiment valence in session 2 samples ($n = 91$) was 26.37% negative, 57.14% neutral, and 16.48% positive. Sentiment valence in session 3 samples ($n = 187$) was 37.97% negative, 53.48% neutral, and 8.56% positive. Despite the overall increase in sample size from sessions 1 to 2 to 3, all three sessions had samples that were more than

50% neutral; each session also had more samples that were negative than positive. See Table 3 for a summary of samples for each level of sentiment valence by session. See Figure 3 for a visual representation of samples for all three sentiment valence groups by session.

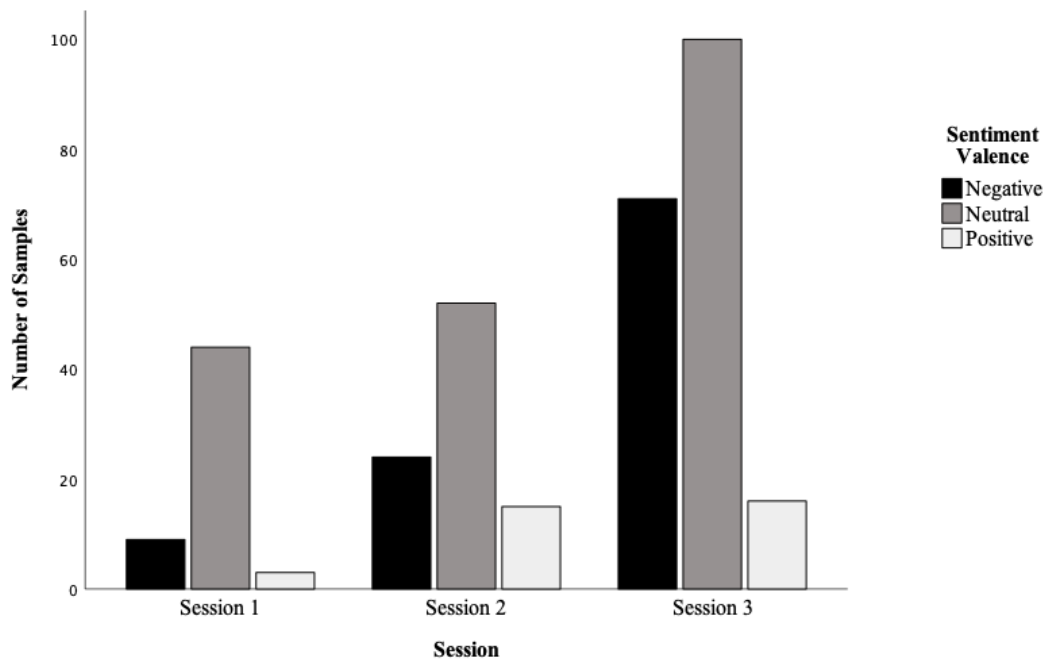
Table 3

Number of Samples for Sentiment Valence by Session

Sentiment valence	<i>N</i>	Negative	Neutral	Positive
Session 1	56	9	44	3
Session 2	91	24	52	15
Session 3	187	71	100	16
Total	334	104	196	34

Figure 3

Number of Samples for Levels of Sentiment Valence by Session



Hypothesis 1

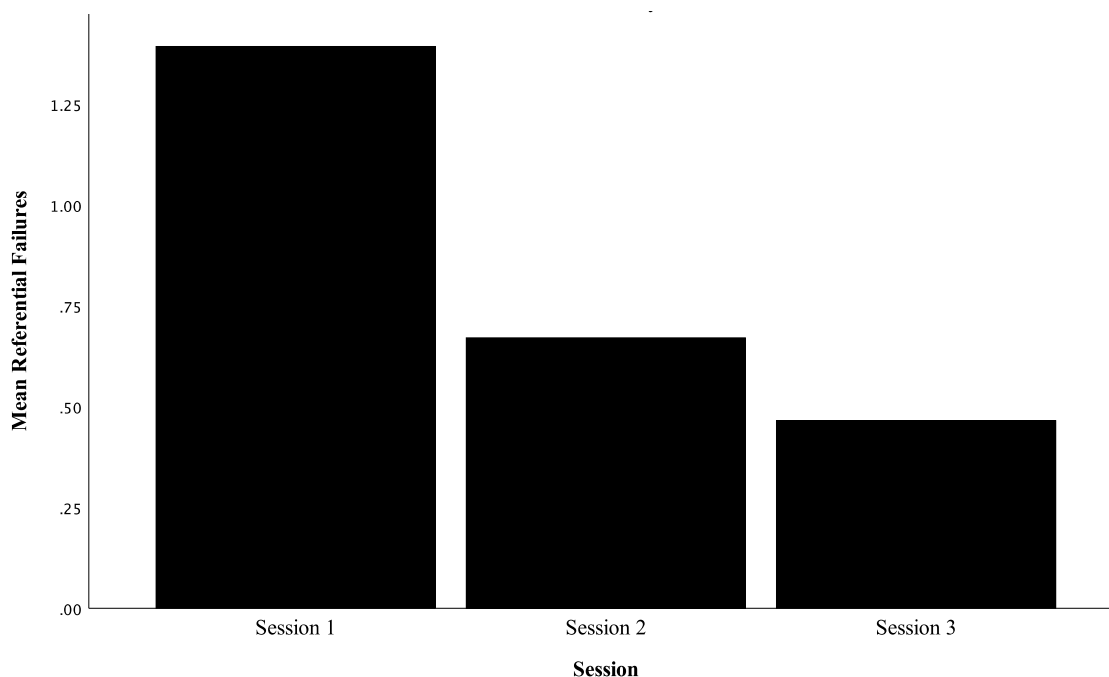
For the purposes of studying the stability of referential failures in schizophrenic speech over time, it was hypothesized that a longitudinal analysis of schizophrenic disordered speech data would reveal no differences across repeated measures of referential failures per utterance between three therapy session intervals.

Transcripts were analyzed to measure differences in referential failures per line between sessions 1, 2, and 3. Session 1 ($M = 1.39$, $SD = 1.522$) had more referential failures compared to session 2 ($M = 0.67$, $SD = 1.146$) and session 3 ($M = 0.47$, $SD = 0.778$). See Table 4 for descriptive statistics for referential failures by session. See Figure 4 for a visual representation of mean referential failures by session.

Table 4

Descriptive Statistics for Referential Failures by Session

Referential failures	<i>n</i>	<i>M</i>	<i>SD</i>	95% CI for Mean		Min.	Max.
				Lower	Upper		
Session 1	56	1.39	1.522	.99	1.80	0	6
Session 2	91	.67	1.146	.43	.91	0	5
Session 3	187	.47	.778	.35	.58	0	4
Total	334	.68	1.089	.56	.79	0	6

Figure 4*Mean Referential Failures by Session*

The number of referential failures per line in session 1 varied between zero and six. In contrast, session 2 had a maximum of five referential failures in a single line and session 3 had a maximum of four. Additionally, the percentage of lines with no referential failures increased two-fold between session 1 and session 2 from 30.30% to 64.84%. The percentage of lines without referential failures actually remained relatively stable between session 2 and session 3. Comparisons of referential failure rates were analyzed using percentages of total lines per session due to the dramatic differences between the total number of lines per session. Specifically, there was an increase in the number of lines from session 1 to 2 to 3, and there was a decrease in the number of words per line from session 1 to 2 to 3, which equated to a relatively stable total number of words per transcript. See Table 5 for frequencies of referential failures per line for each of the three sessions.

Table 5*Sessions by Count of Lines with Referential Failures (RF)*

	0 RF	1 RF	2 RF	3 RF	4 RF	5 RF	6 RF
Session 1	17	21	7	7	1	0	3
Percent	30.30%	37.50%	12.50%	12.50%	1.79%	0.00%	5.36%
Session 2	59	17	6	5	3	1	0
Percent	64.84%	18.68%	6.59%	5.49%	3.30%	1.10%	0.00%
Session 3	123	49	9	4	2	0	0
Percent	65.78%	26.20%	4.81%	2.14%	1.07%	0.00%	0.00%

Hypothesis 2

It was hypothesized that there would be a significant difference in referential failures across positive, neutral, and negative levels of sentiment valence within speech samples from single sessions and all three sessions combined. It was hypothesized that negative sentiment speech data would contain significantly more referential failures than neutral sentiment and positive sentiment, although there would be no significant difference in referential disturbance between positive and neutral sentiments.

An analysis of samples from all three sessions ($N = 334$) revealed referential failures were more frequent in negative sentiment ($M = 0.82$, $SD = 1.237$) compared to neutral sentiment ($M = 0.64$, $SD = 1.035$), and neutral sentiment had more referential failures than positive sentiment ($M = 0.44$, $SD = 0.860$). The minimum number of referential failures was zero for all three levels of sentiment valence; however, negative and neutral sentiment had a greater range (maximum = 6) of referential failures than positive sentiment (maximum = 4). Overall, reference failures were highest in speech that carried a negative valence and lowest in speech that carried a positive valence. See Table 6 for descriptive statistics of referential failures by sentiment valence for the entire

sample of speech data. See Figure 5 for a visual representation of mean referential failures by sentiment valence levels.

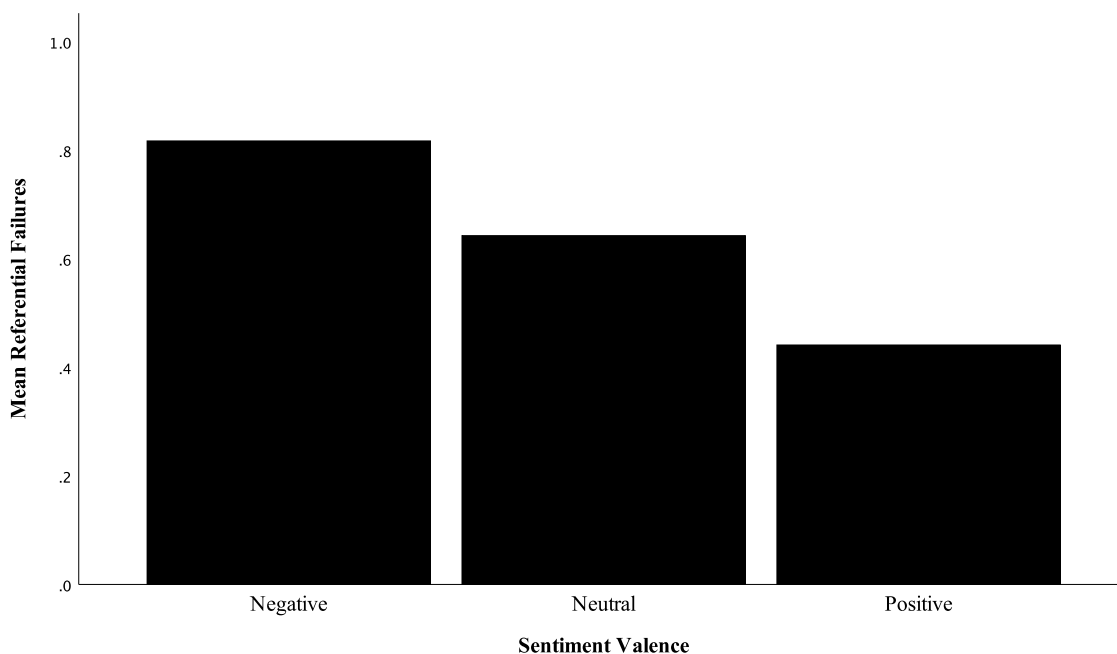
Table 6

Descriptive Statistics for Referential Failures by Sentiment Valence

	<i>n</i>	<i>M</i>	<i>SD</i>	95% CI for Mean		Min.	Max.
				Lower	Upper		
Negative	104	.82	1.237	.58	1.06	0	6
Neutral	196	.64	1.035	.50	.79	0	6
Positive	34	.44	.860	.14	.74	0	4
Total	334	.68	1.089	.56	.79	0	6

Figure 5

Mean Referential Failures by Sentiment Valence



An analysis of samples from session 1 ($n = 56$) revealed referential failures were more frequent in negative sentiment ($M = 2.44$, $SD = 2.242$) compared to neutral sentiment ($M = 1.23$, $SD = 1.292$), and neutral sentiment had more referential failures

than positive sentiment ($M = 0.67$, $SD = 1.155$). An analysis of samples from session 2 ($n = 91$) revealed referential failures were more frequent in negative sentiment ($M = 0.83$, $SD = 1.204$) compared to neutral sentiment ($M = 0.67$, $SD = 1.150$), and neutral sentiment had more referential failures than positive sentiment ($M = 0.40$, $SD = 1.056$). An analysis of samples from session 3 ($n = 187$) revealed referential failures were more frequent in negative sentiment ($M = 0.61$, $SD = 0.902$) compared to positive sentiment ($M = 0.47$, $SD = 0.629$), and positive sentiment had more referential failures than neutral sentiment ($M = 0.37$, $SD = 0.691$). Although mean referential failures were consistently more frequent in negative sentiment than in neutral or positive sentiment, the mean referential failures for negative sentiment decreased from session 1 to 2 to 3. Likewise, mean referential failures in neutral sentiment decreased from session 1 to 2 to 3. However, mean referential failures in positive sentiment decreased from session 1 to 2 and then slightly increased from session 2 to 3. See Table 7 for a summary of descriptive statistics for referential failures and sentiment valence by session. See Figure 6 for a visual representation of mean referential failures for negative, neutral, and positive sentiment valence by session.

Table 7

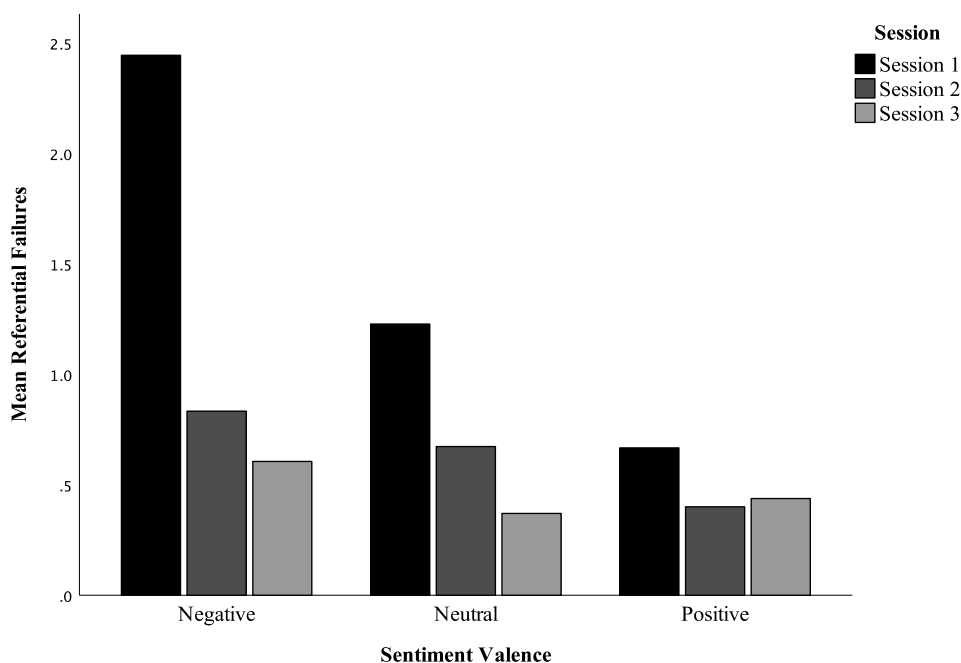
Descriptive Statistics for Referential Failures by Sentiment Valence and Session

Session		<i>n</i>	<i>M</i>	<i>SD</i>	95% CI for Mean		Min.	Max.
					Lower	Upper		
Session 1	Negative	9	2.44	2.242	.72	4.17	0	6
	Neutral	44	1.23	1.292	.83	1.62	0	6
	Positive	3	.67	1.155	-2.20	3.54	0	2
	Total	56	1.39	1.522	.99	1.80	0	6
Session 2	Negative	24	.83	1.204	.32	1.34	0	4
	Neutral	52	.67	1.150	.35	.99	0	5

Session	<i>n</i>	<i>M</i>	<i>SD</i>	95% CI for Mean		Min.	Max.	
				Lower	Upper			
	Positive	15	.40	1.056	-.18	.98	0	4
	Total	91	.67	1.146	.43	.91	0	5
Session 3	Negative	71	.61	.902	.39	.82	0	4
	Neutral	100	.37	.691	.23	.51	0	4
	Positive	16	.44	.629	.10	.77	0	2

Figure 6

Mean Referential Failure by Sentiment Valence and Session



Hypothesis 3

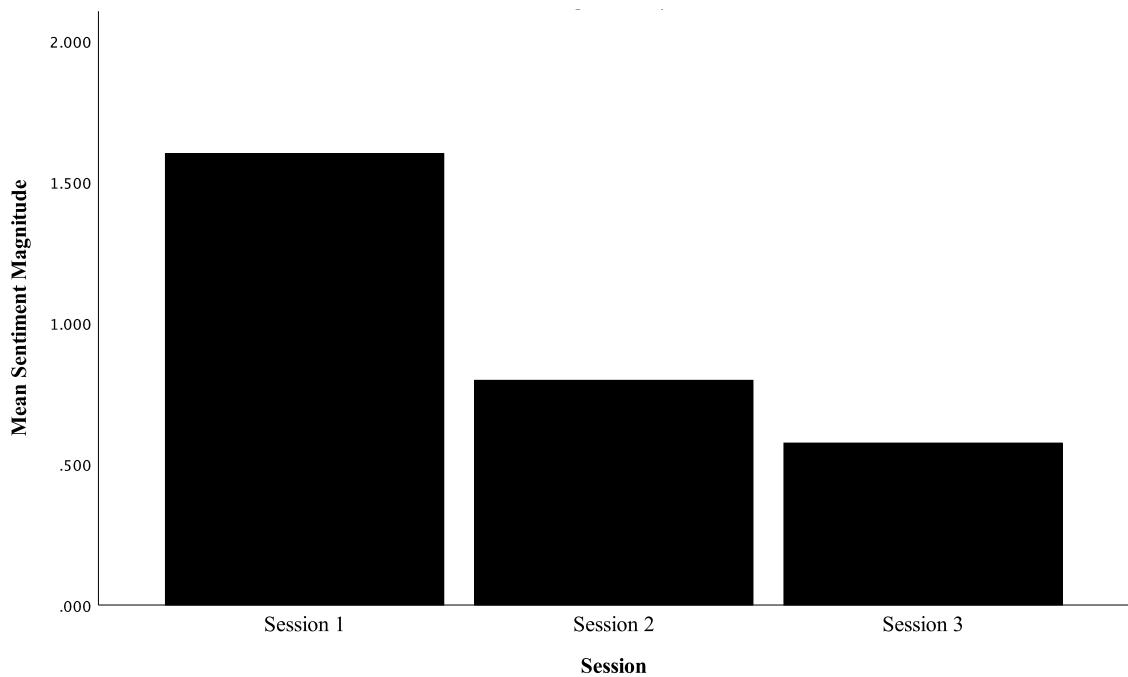
It was hypothesized that intra-individual variability in schizophrenic disordered speech during single sessions and all sessions combined would demonstrate a positive correlation between sentiment magnitude and referential failures, meaning any observed increases in sentiment magnitude would occur with similar increases in referential failures.

Sentiment magnitude is a measure of the intensity or weight of sentiment within a line of text. Regarding samples from all three sessions ($N = 334$), the mean sentiment magnitude score was 0.807 ($SD = 0.715$) with a range between 0 and 4.9. A comparison of all three sessions revealed greater sentiment magnitude in session 1 ($M = 1.600$, $SD = 1.009$) than session 2 ($M = 0.797$, $SD = 0.574$), and session 2 had greater sentiment magnitude than session 3 ($M = 0.574$, $SD = 0.458$). Results revealed a trend of decreased sentiment magnitude from session 1 to 2 to 3. See Table 8 for descriptive statistics for sentiment magnitude by session. See Figure 7 for a visual representation of mean sentiment magnitude by session.

Table 8

Descriptive Statistics for Sentiment Magnitude by Session

	<i>N</i>	<i>M</i>	<i>SD</i>	95% CI for Mean		Min.	Max.
				Lower	Upper		
Session 1	56	1.600	1.009	1.330	1.87	0	4.9
Session 2	91	.797	.574	.677	.916	0	2.9
Session 3	187	.574	.458	.508	.640	0	2.6
Total	334	.807	.715	.730	.884	0	4.9

Figure 7*Mean Sentiment Magnitude by Session*

An analysis of the association between referential failures ($M = 0.68$, $SD = 1.089$) and sentiment magnitude ($M = 0.807$, $SD = 0.715$) revealed a positive correlation ($r = 0.357$), indicating a moderate association between the two variables. The 95% confidence interval for the correlation coefficient was 0.260 and 0.447, indicating repeating the same analysis using data from multiple subjects might reveal a correlation within this range. See Table 9 for a summary of correlation results for referential failures and sentiment magnitude.

Table 9*Summary of Correlation for Referential Failures and Sentiment Magnitude*

	<i>N</i>	<i>M</i>	<i>SD</i>	Pearson correlation	Sig. (2-tailed)	95% CI (2-tailed)	
						Lower	Upper
Referential failures	334	.68	1.089	.357	<.001	.260	.447
Sentiment magnitude	334	.807	.715				

Discussion

Summary of Findings

Because this pilot study involved a single case and lacked a true experimental design, findings do not explain the cause of the changes in referential failures rates over time nor can they be generalized to others with schizophrenia. However, possible explanations of trends in the data are discussed.

Hypothesis 1

An analysis of speech samples from three transcripts in this single-case pilot study revealed that, over time, there was a decrease in the average number of referential failures among the three therapy sessions. These findings do not support the study's hypothesis that the rate of referential failures would be relatively stable over time. Furthermore, there was a two-fold increase in the percentage of samples without referential failures between session 1 and session 2. It is likely the dramatic increase from 30.30% to 64.84% of client utterances without referential failures would be experienced by the therapist as clearer communication from the client over time. The observed reduction in referential failure rate over time during therapy sessions is inconsistent with previous research studies that found stable or worsening referential disturbance and other linguistic features in schizophrenic language over time (Alonso-Sánchez et al., 2022; Docherty et al., 2003; Docherty et al., 2003; Docherty et al., 1994; Mota et al., 2018).

One explanation for the observed improvement in referential failure rates over time might be that referential failures become less frequent over the course of the disease with time. Alternatively, given the nature of the study's single-case design, it is possible that the findings are not representative of the clinical population. However, it is also

worth considering that the participant's improvement in referential failures over time may be attributed to the treatment intervention in which the client received client-centered psychotherapy twice a week. The findings warrant further investigation of psychotherapy as an intervention for schizophrenia to improve referential disturbance in communication.

Hypothesis 2

Schizophrenia is characterized by increased language disturbance, especially when discussing emotionally negative topics as compared to positive or neutral topics. The meaning communicated by individuals with schizophrenia has been found to be less clear and precise when emotions are involved. This phenomenon is referred to as *affective reactivity of speech*, which describes the deterioration of communication under emotionally negative conditions. The induction of unpleasant emotions by negative subject matter is believed to be the primary factor contributing to this phenomenon. The present study was designed to explore whether speech data from a longitudinal design would reveal the affective reactivity of speech to be stable over time.

Results from the present study showed there were more frequent referential failures in speech that expressed negative emotions than in speech that expressed neutral or positive emotions. The findings supported the study's hypothesis that negative sentiment valence would be associated with more frequent referential failures than either neutral or positive sentiment valence within single therapy sessions and all therapy sessions combined. These findings upheld the empirically supported phenomenon of affective reactivity of speech in schizophrenia, which suggests that negative valence may hinder cognitive-linguistic processes in language for persons with schizophrenia. Despite this overall trend, the mean frequency of referential failures in negative sentiment

decreased from session 1 to 2 to 3, as did the mean frequency of referential failures in neutral sentiment. However, in positive sentiment, the mean frequency of referential failures decreased from session 1 to 2 and then slightly increased from session 2 to 3.

These results indicate the participant's referential failures improved over time, although the results also indicate valence of expressed emotions may still influence referential failures to some extent. The findings from this single-case study were consistent with strong empirical support for the affective reactivity of speech in persons with schizophrenia (Burbridge et al., 2005; Cohen & Docherty, 2004; Docherty & Grillon, 1995; Docherty & Hebert, 1997; Docherty, Hall, & Gordinier, 1998; Docherty, Rhinewine, et al., 1998; Docherty et al., 1994; Seghers & Docherty, 2009). However, the present study observed a reduced frequency of referential failures in negative valence over time, which is inconsistent with previous studies that found stable or worsening referential disturbance over time (Docherty et al., 2003; Docherty et al., 1994). The discrepancy between the results from the present study and previous research findings highlights the potential benefits of psychotherapy for improving referential disturbance. These findings indicate referential disturbance may not be as stable over time as previously considered; therefore, future research on schizophrenia should consider the emotional context of communications when investigating referential disturbance and other linguistic features as a diagnostic biomarker for the disorder.

Hypothesis 3

The results indicate there was a significant decrease in the average strength of emotions expressed during therapy sessions between session 1 and 2, as well as between session 2 and 3. This decline in emotional intensity was also observed in the maximum

strength of emotions expressed during each session. Overall, the reduction in both the maximum and average emotional intensity expressed during therapy sessions over time supports a general decrease in the intensity of the participant's emotional experience during therapy.

Additionally, the study's analysis revealed a moderate positive correlation ($r = 0.357$) between changes in sentiment magnitude and referential failures, with increases or decreases in sentiment magnitude corresponding to similar changes in referential failures in the same direction. In other words, if sentiment magnitude increased, there was an increase in referential failures, and if sentiment magnitude decreased, there was a decrease in referential failures. These results indicate the emotional intensity expressed by the participant during therapy sessions was linked to the frequency of his referential communication. These results were consistent with previous research on intense emotional experiences and the affective reactivity of speech and other psychotic experiences within schizophrenia (Ciompi, 1997; Docherty et al., 2009; Minor et al., 2016; Myin-Germeys & van Os, 2007).

Because changes in sentiment magnitude were positively correlated with changes in the frequency of referential failures, results indicate the ability to modulate the intensity of expressed emotion may have played a role in the frequency of referential failures. Findings from the current study are also consistent with research on the treatment of schizophrenia and psychotic process in client-centered and person-centered psychotherapies that showed significant improvement in emotional functioning (Gendlin, 1970; Pearce, 2012; Prouty, 1986, 1991, 1994, 1998, 2000a, 2000b, 2001, 2007, 2008; Prouty et al., 2005; Rogers et al., 1967; Simmons, 2013; Tomlinson, 1967; Trytten, 2002;

VanDerKlok, 2017; Warner, 2002a, 2002b, 2013a, 2013b; Warner & Trytten, 2008; Williams, 2013). The findings support that additional research is needed to explore the effect of classical, client-centered psychotherapy and other experiential and process-oriented psychotherapies in the treatment of schizophrenia. Additionally, sentiment analysis of therapy recordings, such as that used in the current study, may be an appropriate outcome measure in future research of emotion regulation in the treatment of schizophrenia for person-centered therapies because sentiment analysis measures provide quantifiable data for standardized research design methodologies.

In summary, despite previously mentioned observed increases in the range of expressed emotions over time, the analysis revealed a substantial decrease in both the average and maximum emotional intensity expressed during therapy sessions, as well as a reduction in the frequency of referential failures over time. Additionally, the moderate positive correlation ($r = 0.357$) between changes in sentiment magnitude and referential failure rate indicates the participant's ability to modulate the intensity of expressed emotion may have played a role in the frequency of referential failures in his speech. Taken together, these findings support that over time as the participant modulated the intensity of his emotional experiences, he made fewer referential failures and expressed a wider range of emotions.

The overall improvement in the emotional functioning and communication of the participant indicates the observed changes may have occurred for two reasons. It is conceivable that the change in referential failures and affective reactivity may be attributed to spontaneous improvement over time, although the observable differences would be inconsistent with previous research studies that found these traits to be

relatively stable or worsen over time (Docherty et al., 2003; Docherty et al., 2003; Docherty et al., 1994). However, the alternative explanation is that the observed changes in referential failures and affective reactivity of speech may have been related to the effect of the participant receiving nondirective client-centered psychotherapy over time. The results are consistent with the previously mentioned studies of person-centered psychotherapies as treatment for schizophrenia and psychotic process that observed positive outcomes. For this reason, it is recommended that future research explore the effects of nondirective person-centered psychotherapy on schizophrenia using NLP measures for sentiment analysis of therapy recordings to measure changes in affective reactivity and emotion regulation.

Implications

Theory

As previously discussed in the results and summary of findings, trends from the therapy recordings of one participant with schizophrenia indicated that over time as the participant modulated the intensity of his emotional experiences, he made fewer referential failures and expressed a wider range of emotions. In the context of person-centered therapy, these findings could be understood through multiple conceptualizations.

Difficult Process. In the context of Warner's (2013a) difficult process theory, the participant's earlier emotional experiences may be characterized as intense while having difficulties attending to these emotional experiences. The participant appeared to demonstrate these difficulties during the first session as observed in the highly elevated maximum sentiment magnitude despite relatively narrow and neutral range of expressed sentiment scores. This intensity could be described as difficult process due to the

overwhelming quality of these emotional experiences. However, over time the participant developed the *processing capacities* for naming a greater breadth of emotional experiences and modulating their intensity. It can therefore be understood that during psychotherapy treatment, the participant developed a relationship with his therapist that was similar to that of an early attachment relationship or holding environment, which had the effect of restarting or fostering the development of his processing capacities.

In essence, the therapeutic relationship provided a safe holding environment for the participant to process his emotions and modulate their intensity, which reduced the frequency of overwhelming emotional experiences driven by panic as well as subsequent referential failures. This difficult process theoretical conceptualization provides one potential explanation for the observed improvement in the participant's affective reactivity of speech in schizophrenia using a person-centered theoretical framework.

Metaphact Theory. Warner (2002a, 2002b) described Luke's idiosyncratic use of metaphors that are a combination of ordinary metaphors and facts, which she termed metaphacts, that have been quite stable feature in the participant's speech during therapy. Since Warner started recognizing metaphacts in the participant's speech, she described herself as developing a better empathic understanding of participant's internal frame of reference. By using metaphacts conceptually to improve her empathic understanding of the participant's communications, it is possible that the participant felt more deeply and consistently understood by his therapist, which contributed to his overall improvement in referential failures and emotion regulation. Metaphact theory provides an explanation of how the therapist understood and responded to the participant during therapy, which, in

turn, may have enhanced his experience of the therapist maintaining the core attitude conditions of genuine, empathic, and prizing.

Felt Sense. Previous studies (Warner & Trytten, 2008) suggested that Luke's use of idiosyncratic speech, which include referential failures and metaphacts, to process *felt sense* experiences that were not yet clear was productive therapeutically and demonstrated outcomes that would be expected of normative clients without idiosyncratic speech. Therefore, the present study's findings of improvement in the participant's emotion regulation and referential failures could be understood as a result of the participant attending to *felt sense* experiences, which underwent subsequent changes and moved him in the direction of his actualizing tendency.

Finally, during a phone conversation, the therapist described Luke as being able to use idiosyncratic language in ways that are more complex and effective over time, suggesting he is able to describe his emotional experiences more fully (M. Warner, personal communication, February 1, 2023). Results from the study indicate the participant has developed an ability to express himself using a broader range of sentiment, which supports the therapist's intuition.

Linguistic Biomarker for Schizophrenia

The study's findings have the potential for substantial benefit to future scientific investigations and clinical application settings. A validated linguistic measure for schizophrenic disordered speech may prove efficient in the diagnosis of schizophrenia and the measurement of symptom changes. In response to the NIMH's (2014) call for "Biomarker Development and Validation: Establishing Standards of Evidence for their Context of Use in Clinical Trials," the researcher in the current pilot study proposes a

method and design for evaluating the effect of sentiment on referential failures should this linguistic measure become a biomarker for schizophrenia. If the study were replicated with a larger sample size, the findings could contribute to the validation of linguistic biomarkers for schizophrenia that would have major implications for future diagnostic criteria.

Additionally, the present study's findings indicate more research is needed to evaluate whether linguistic features such as referential failures are stable over time. Though the results of the current study showed that over time referential failures continued to be present in the speech of one person with schizophrenia, the average referential failures rate decreased over time as well. The observed changes could be attributed to time or psychotherapy; however, these changes warrant further exploration before a diagnostic biomarker can be validated as a stable feature. Should future studies implement the methods used in the present single-case study with a larger sample size, the results could lead to validation of a biomarker for psychosis prodrome and schizophrenia spectrum disorders, which is a priority area based on unmet medical need. Should future research observe an overall decline in referential failures over time, these findings would contribute to the current literature on the disease course process of schizophrenia.

Despite the limitations of single-case pilot studies, the present study contributes to the very large, though still incomplete, body of research validating the use of these linguistic biomarkers for schizophrenic disordered language, which might become invaluable to future schizophrenia research spanning the functional domains of cognition, social communication, language, and emotional regulation. Finally, the present single-

case study's measures may be implemented by clinicians in the future to evaluate therapeutic interventions and monitor clinically meaningful change in real-time outcomes and function.

Limitations

It should be noted that the findings of this single-case pilot study may not be generalizable to other individuals or populations. Further research with larger sample sizes is needed to determine the extent to which these findings can be replicated. Though efforts were made to control for extraneous variables that could have affected the results, individual differences in personality or behavior may still have influenced the findings of this study. Future research should consider these factors and take steps to minimize their impact on the results.

The small sample size in this single-case pilot study limited the statistical power of the analysis, making it difficult to draw firm conclusions. Future research with larger sample sizes and more appropriate statistical tests may provide more definitive results. The complexity of the affective reactivity of referential failures within schizophrenia under investigation may not have been fully captured by this single-case pilot study. Future research using more comprehensive methods, such as multiple-case studies or longitudinal designs, may provide a more complete understanding of the phenomenon.

Though this single-case pilot study provided valuable insight into affective reactivity and referential failures in schizophrenia, it is important to acknowledge its limitations when interpreting the results. Future research should build upon these findings and address the limitations of this study to further advance our understanding of the phenomenon.

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