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The Silent Treatment? Changes in patient emotional expression after silence

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Abstract

Psychotherapy can be an emotionally laden conversation, where both verbal and nonverbal interventions may impact the therapeutic process. Prior research has postulated mixed results regarding how clients emotionally react following a silence after the therapist is finished talking, potentially due to studying a limited range of silences with primarily qualitative and self-report methodologies. A quantitative exploration may illuminate new findings. Utilising research and automatic data processing from the field of linguistics, we analysed the full range of silence lengths (0.2–24.01 s), and measures of emotional expression—vocally encoded arousal and emotional valence from the works spoken—of 84 audio recordings of Motivational Interviewing sessions. We hypothesised that both the level and the variance of client emotional expression would change as a function of silence length; however, due to the mixed results in the literature, the direction of emotional change was unclear. We conducted a multilevel linear regression to examine how the level of client emotional expression changed across silence length, and an ANOVA to examine the variability of client emotional expression across silence lengths. Results of both analyses indicated that as silence length increased, emotional expression largely remained the same. Broadly, we demonstrated a weak connection between silence length and emotional expression, indicating no persuasive evidence that silence leads to client emotional processing and expression.

KEYWORDS
emotional process, psychotherapy research, linguistics, vocal features, silence

1 | INTRODUCTION

> 'Silence can exist without speech, but speech cannot exist without silence'. Max Picard (1952).

Psychotherapy is essentially a health-promoting conversation between a therapist and a client (Frank, 1961). Though the words themselves represent the primary vehicle for therapeutic interventions (Lambert & Bergen, 2004), silence may play an integral part in the therapeutic process (Levitt, 2001a; Levitt, 2002; Frankel et al., 2006; Hill et al., 2003; Daniel et al., 2018; Hill et al., 2019). Silence is not merely a by-product of the conversation (Johannesen, 1974; Levitt, 2002), but a potentially important nonverbal intervention (e.g. Gladstein, 1974).

Psychotherapy researchers have investigated the perceived function and outcome of silences during therapy. Qualitative studies

indicate therapists report using silence to personally reflect on therapeutic content (Hill et al., 2003), as well as a therapeutic intervention (e.g. psychoanalysis, see Freud, 1912; psychodynamic, for a review, see Lane et al., 2002; Hill et al., 2003; Gale & Sanchez, 2005). Silence may be used by the therapist to promote components of the therapeutic relationship, such as rapport building (Sharpley et al., 2005; Daniel et al., 2018), collaboration (Hill et al., 2019; Cuttler et al., 2019) and empathy (Matarazzo & Wiens, 1977; Hill et al., 2003; Ladany et al., 2004). Clients may similarly utilise silence intentionally to formulate their next thought and to reflect on therapeutic content (Levitt, 2001a; Hill et al., 2003). Clients have reported improved attachment to their therapist and decreased feelings of distress after the therapist's use of silence as a therapeutic intervention (Daniel et al., 2018). However, client silences have also been perceived as resistance (e.g. Freud, 1912; Lane et al., 2002). Frequent silences from clients may also be an attempt to disengage with the therapy process, potentially compounding existing insecure attachment and poorer alliance with their therapists (Daniel et al., 2018). As a therapeutic process component, silence may have many uses and consequences depending on contextual factors.

Therapists may specifically use silence in an attempt to facilitate therapeutic tasks, such as processing emotions (Ladany et al., 2004; see Greenberg & Safran, 1989, for a review on emotions in therapy). Silence might correspond with changes in client emotional expression throughout a session (Levitt, 2001b). Qualitative research has indicated therapists use silence to create a space for their clients to experience a particular emotion (Hill et al., 2003). Clients, in turn, have reported using silence to sit and process their emotions (Levitt, 2001b). Silences the client perceives to be helpful could contribute to decreased feelings of overall distress (Frankel et al., 2006) and facilitate an understanding of self or insight into personal experiences (Hill et al., 2019; Levitt, 2001a). Emotion processing is a critical component of psychotherapy process (Greenberg & Safran, 1989) and outcome, including, but not limited to, forming the therapeutic alliance (e.g. Safran & Muran, 2000), client decision-making (Bar-On et al., 2004; Isen, 2008) and physiological changes such as pupil dilation (Lang & Bradley, 2010), heart rate increases (e.g. Helm et al., 2014) and changes in the immune system (e.g. Ackerman et al., 1998; Kiecolt-Glaser et al., 2005).

In addition to silence supporting clients engaging emotionally in therapy, clients have also reported using silence to deliberately disengage from their emotions (Frankel & Levitt, 2009), potentially increasing feelings of depression and negative self-evaluation (Stringer et al., 2010). The client may feel unsafe during a silence and avoid reporting feelings to their therapist (Levitt, 2001a). In sum, the current literature has produced varied results; silence in psychotherapy may facilitate processing of emotions or may be a strategy for clients to avoid emotional experiences. Although the psychotherapy research literature provides some information about how a client may respond emotionally to silence, there are distinct limitations to the extant literature. First, many studies arbitrarily restricted the minimum length of coded silences to between three (Frankel et al., 2006; Levitt, 2001b) and five seconds (e.g. Cuttler et al., 2019; Sharpley et al., 2005; Daniel et al., 2018; Cook, 1964), or to 'a silent event' perceived by the therapist (Hill et al., 2003, p. 515). Therapy studies have included initial interviews (Sharpley et al., 2005), psychodynamic therapy (Hill et al., 2003), psychoanalysis (Daniel et al., 2018), general psychotherapy at a college counselling centre (Cook, 1964) and therapists providing cognitive behavioural therapy, humanistic and psychodynamic therapy (Cuttler et al., 2019). However, according to linguistics researchers, the majority of silences in everyday conversation range from 0.1 to 0.3 s (Heldner & Edlund, 2010; Xiao et al., 2015; Levinson & Torreira, 2015; see Nagaoka et al., 2013, for a counterexample due to variations in language, culture and conversational norms). Silences lasting more than 3 s are considered rare (see Holler et al., 2016). As such, many psychotherapy studies are likely not studying the full range of silences, and how therapeutic processes are changing from smaller silences, less than a second, to longer silences. Psychotherapy research has relied heavily on extracting silences with human coding (e.g. Pausing Inventory Categorization System—PICS—see Levitt, 2001b; Frankel et al., 2006; Daniel et al., 2018; Cuttler et al., 2019; Stringer et al., 2010; Cook, 1964), qualitative analysis (e.g. Levitt, 2001a, 2001b; Frankel & Levitt, 2009) and self-report (Hill et al., 2003; Frankel & Levitt, 2009). Although these methodologies provide some understanding of client and therapist experience of silence, they are much less temporally sensitive and likely exclude much actual inter-speaker silence that likely occurs during psychotherapy. It is possible that shorter silences also include a variety of information about the emotional nature of a session.

In addition to the restricted range of silence lengths, limited studies have examined the temporal aspect of silence and its relation to psychotherapy processes, and have produced mixed results. Cuttler et al. (2019) indicated that therapists perceived silences that facilitated emotional engagement and reflectivity as longer than silences where the client seemed disengaged, tense or confused. An analysis

Implications for Practice and Policy

- Psychotherapy research is sparse on quantitative investigations of silence that include all lengths of silence during a session.
- Linguistics research theory and automated data processing techniques provide an innovative perspective to study silence in psychotherapy.
- This paper utilised theory from linguistics and automated data processing techniques to extract the full range of silences initiated by the therapist and model the client's emotion reaction in a way that has not previously been done.
- This research could help therapists understand the impact of silence and potentially contribute to training and supervision of additional therapeutic variables that impact the therapeutic process.

of covariance in the same study also revealed that an increase in silence length corresponded to increased therapeutic collaboration. A qualitative study from Levitt (2001a) found contradictory evidence, demonstrating that clients chose to remain silent longer if they felt the therapist said something disconcerting or unpleasant. These studies show a contradiction between longer silences both indicating client disengagement and feeling unsafe, but also collaboration. These results continue to present mixed conclusions about how the length of silence is contributing to the therapeutic process. By examining only a small portion of silences, it is difficult to conclude how much silence length contributes to therapy. Alternative methodologies may be necessary to capture and study the full range of silences, and how they relate to important therapeutic processes, such as emotions.

For linguistics researchers, the study of silence fits into the larger quest for understanding how people facilitate conversation (Sacks et al., 1974; Heldner & Edlund, 2010; Levinson & Torreira, 2015). This includes how people decide who talks when (i.e. turn taking), when there are pauses in the conversation (i.e. gaps), and how individuals formulate what they are going to say (i.e. projection and reaction theory; Sacks et al., 1974; Duncan, 1972). For instance, during conversation people often anticipate when others are finished speaking and have also constructed most of what they are planning to say before their partner finishes speaking, in addition to anticipating when their partner will finish speaking (i.e. projection theory; Sacks et al., 1974; Heldner & Edlund, 2010). Speakers will use cues such as fundamental frequency (Prieto et al., 1996) to predict when their partner will finish talking. The typical distribution of silences is positively skewed, indicating that most gaps in conversation are small and that there is limited processing time post conversation exchange (for a review, see Heldner & Edlund, 2010). Using linguistics research as a model to study psychotherapy may provide additional information about how all types of silence length are related to psychological processes. For instance, Silber-Varod and Lerner (2017) compared silences ranging from 0.2 to 10 s from four colloquial conversations and four therapy sessions. Results indicated that the number of between-speaker silences—one speaker stops talking, there is silence and the other speaker starts talking—was significantly different across colloquial and therapeutic conversation. Although Silber-Varod and Lerner (2017) began to explore how silence length relates to psychotherapy process, quantitative research is sparse and has yet to investigate the connections between silence length and emotional expression. Given the additional importance of emotional processing during psychotherapy (Greenberg & Safran, 1989) and the contradictory evidence regarding silence length and client emotion (Levitt, 2001a; Cuttler et al., 2019), a deeper quantitative study of all silence lengths and client emotional expression could be crucial to further understanding psychotherapy processes.

The current study presents a quantitative exploration of the silence between when the therapist stops speaking and the client starts speaking (i.e. therapist-initiated silence) during 84 psychotherapy sessions. We investigated how client emotional expression varied as therapist-initiated silences increased in length. We extracted 2744 instances of therapist-initiated silence of at least 0.02 s (Sacks et al., 1974). Emotional expression was measured via vocally encoded arousal and the emotional valence derived from semantic content (see Posner et al., 2005). Vocally encoded arousal is measured via the vocal features in the voice (see below for a further description), which are one of the most robust and minimally invasive measures of emotional activation (see Juslin & Scherer, 2005). Additionally, emotional expression from the words spoken in therapy is a thriving field of psychotherapy research and provides a minimally invasive method of extracting emotional expression (see Tanana et al., 2016; Tanana et al., 2021). We examined how both the level of client emotional expression and the variability of emotional expression related to changes in the length of silence before the client starts speaking. Given the importance that psychotherapy theorists and researchers have placed on silence, we expected that both the level and variability of client emotional expression (arousal and emotional valence) would be significantly related to silence length. However, with the variety of results in the psychotherapy literature, we were unsure as to whether emotional expression would significantly increase, potentially indicating emotional activation via emotional processing or defensiveness, or decrease, possibly indicating withdrawal or relaxing after a silence.

2 | METHODS

2.1 | Data source

For this study, we utilised a sample of 84 sessions[1] obtained from five Motivational Interviewing (MI) dissemination trials (Baer et al., 2009; Lee et al., 2014; Roy-Byrne et al., 2014; Neighbors et al., 2012; Tollison et al., 2008). At its Rogerian-based theoretical core, MI emphasises the therapist's ability to accurately understand, or make efforts to understand, a client's experience, that is, have empathy, and specifies that the therapist uses reflective statements and open questions focused on eliciting client-motivated change. Originally developed to treat individuals primarily struggling with substance use issues, MI has been expanded for use with a variety of populations (e.g. weight loss; Armstrong et al., 2011), and in many different settings (e.g. mental health, primary care; Lundahl et al., 2010). Client verbal statements about their planned, desired or actual behaviour changes (i.e. change talk) are theorised to motivate further behaviour change (see self-determination theory; Miller & Rollnick, 2012). Additionally, MI theory encourages many qualities that are considered to be therapeutically beneficial across therapies, for instance, promoting the therapeutic bond (e.g. Bordin, 1979).

Those who participated in the study were promised that no identifying information outside the recorded session would be collected. As such, there is no demographic information for the sample.

However, according to the United States Census at the time of data collection (2000), five million Washington state residents reported their race as White (84.9%), Black or African American (4%), Asian (6.7%), American Indian and Alaska Native (2.7%), Native Hawaiian and Other Pacific Islander (0.7%) or indicated another race (4.9%); in a separate measure, 7.5% indicated Hispanic or Latino ethnicity (Evans et al., 2001). Census data collected gender identification only for the gender binary (i.e. male and female) and did not include data about non-binary and transgender individuals. Given this limitation, the Census Bureau reported that 50.2% of Washington residents identified as female and 49.8% as male. Participants across studies were 18 years and older, either in a primary care setting or on a college campus.

Data from 58 therapists were utilised, all of whom conducted single-session therapy with at least one client ($M = 1.48$, $SD = 1.01$). Most therapists saw one client ($n = 44$), with three therapists seeing a maximum of five clients. The studies included therapists who completed training and received weekly supervision (Lee et al., 2013; Neighbors et al., 2012; Tollison et al., 2008), therapists who received initial training and were notified of drift from MI protocol (Roy-Byrne et al., 2014) and therapists who had received training without any continued supervision (Baer et al., 2009). In one study, primary care providers conducted either brief alcohol and drug interventions or enhanced care (Roy-Byrne et al., 2014). In three of the studies, providers targeted alcohol and marijuana use in college students (Lee et al., 2014; Neighbors et al., 2012; Tollison et al., 2008). In the last study, providers were conducting therapy in community-based primary care clinics, in which patients may have been using many types of drugs at one time (Baer et al., 2009). The primary treatment modality in each study was MI, an evidence-based treatment that emphasises empathy and specifies that the therapist uses a specific type of language (e.g. reflective statements), focused on eliciting verbal statements regarding change in a behaviour from clients (Miller & Rollnick, 2012). The trials were conducted in the Pacific-Northwest and were approved through a local institution's review board.

2.2 | Measures

2.2.1 | Silence

The definition of silence used in this research was guided by the linguistics literature, where it is established that humans can discern a pause in conversation at between 0.15 and 0.25 s (Heldner & Edlund, 2010; Levinson & Torreira, 2015), with the average being approximately 0.2 s (Campione & Véronis, 2002; Heldner & Edlund, 2010; Holler et al., 2016). Thus, we chose a silence threshold of 0.2 s; we did not restrict the maximum silence length (see Sharpley et al., 2005). Gaps of less than 0.2 s were considered 'no silence'.

The silences, as defined above, were extracted from sessions that had been manually transcribed and time stamped. This allowed for alignment between transcriptions and audio recordings, using an Automatic Speech Recognizer (ASR) customised to the data (see Xiao et al., 2015, for further technical explanations). Sessions where alignment was not possible were discarded. An acoustic model then combed the audio data and placed timestamps when a specific phoneme was uttered. Sequences of phonemes create words, and then, words form utterances. Thus, the model composes a beginning and end of each sequence of words, and silence was defined as the space between the end of an utterance and the beginning of the next one. Transitions from one speaker to another were set at a lower threshold of 0.01 s—that is, the smallest gap in speech processed automatically where there were no overlaps (see Heldner & Edlund, 2010).

2.2.2 | Vocally encoded arousal

The first indicator of client emotional expression was arousal, measured via vocal acoustics. Vocal acoustics assist individuals to distinguish affect in social situations, which promotes effective social communication (Lima et al., 2013), and can impact the quality of social relationships, medical care and communication generally (Laukka et al., 2008). Vocal acoustics can be garnered from audio data in a variety of ways. We chose to use *Kaldi Toolkit*, a free, open-source software used for speech recognition research (available on SourceForge—http://kaldi.sf.net/; see Povey et al., 2011). *Kaldi* relies on two open source modelling packages, OpenFST (Allauzen et al., 2007) and two numerical algebra libraries (http://www.netlib.org/blas/; http://www.netlib.org/lapack/), in order to properly run the software. *Kaldi* first works to recognise who is speaking during a particular utterance based on unique vocal characteristics. Next, *Kaldi* transcribes a given audio file by utilising prior lexical and phonetic definitions of sounds, context of the transcript (e.g. psychotherapy data) and probability models to predict which words are likely to appear in utterances. After transcription, *Kaldi* can extract estimates of various vocal features in the audio recording (Povey et al., 2011). Using *Kaldi*, we extracted estimates of vocally encoded emotional arousal (mean *f0;* fundamental frequency) from audio recordings of the sessions (see Juslin & Scherer, 2005; Weusthoff et al., 2013; Imel et al., 2014), every 0.025 s, with a 0.01 s gap between each estimate. Each set of mean *f0* values was assigned a speaker label (therapist or client) and put into a vector of all values for each speaker. Speaker assignment was checked by matching sections from the manually transcribed sessions to the calculated *f0* values. The median *f0* was then computed for each utterance to establish the typical arousal level for each speaker. Lastly, the median *f0* for each utterance was compared to the vector of all values, and the number of mean *f0* estimates larger than the median *f0* divided by the total number of mean *f0* estimates in a particular utterance. The resulting estimate ranged from 0 to 1. With 0.5 indicating speaker-specific average arousal, estimates greater than or equal to 0.5 indicated a higher arousal level, and estimates below 0.5 indicated a lower arousal (see Bone et al., 2014, for further technical explanation).

2.2.3 | Emotional valence

We measured positive and negative emotional expression from a metric derived from the words spoken (i.e. semantic content) by the client, which produces a continuous measure (ranging from very negative to very positive) of emotion extracted from text (Malandrakis & Narayanan, 2015). First, a dictionary of valenced words was created, and each word was weighted, known as a norm value, according to the positive and negative associations with the word (i.e. Psycholinguistic Norming). For example, the word 'happy' would have a positive valence (Turney & Littman, 2003). The basic assumption is that other words with similar meanings will have similar norm values (Malandrakis et al., 2013). The initial dictionary used was the Affective Norms for English Words (ANEW), where each word in this dictionary had a corresponding, continuous value corresponding to the magnitude (see Malandrakis & Narayanan, 2015). The weights were input into a previously researched model, which was specifically trained on psychotherapy data, and correlated with human coded words ($r = 0.87$; see Malandrakis et al., 2013). The model then computed values, ranging from −1 to 1, on each utterance. Note that a zero-valence measure is neutral.

2.3 | Analysis

As discussed earlier, qualitative and self-report psychotherapy research has indicated limited evidence for the effects of how long a client is silent until they speak on their emotional expression, as well as evidence for variability in a client's emotional response to therapist-initiated silences. However, prior research represents only a small portion of the total silence data. We examined the changes in client emotional expression following all lengths of therapist-initiated silence with two analyses: (a) the level of emotional expression (vocally encoded arousal and emotional valence) related to silence length, and (b) variability of emotional expression in both vocally encoded arousal and emotional valence related to the length of silence.

For the analysis of level, we used a multilevel linear regression to examine the relationship between emotional expression and length of silence, with observations of silence nested within session. Silence was log transformed for the regression analysis (see Campione & Véronis, 2002). To understand variability in emotional expression, we chose to utilise an analysis of variance due to the test's methodological specificity in comparing the variance across groups. In order to create groups to compare the variance, we binned emotion into six categories to determine whether the variability in emotional expression was related to the length of silence: no silence (0–0.2 s) and silences of 0.2–0.5 s, 0.5–1 s, 1–2 s, 2–5 s and greater than 5 s. We first compared the six groups for mean differences in vocally encoded arousal and emotional valence with an analysis of variance (ANOVA).[2] We then conducted tests of variance for significant differences in vocally encoded arousal and emotional valence among the six different lengths of silence. Bartlett's test, a type of *F*-test, was utilised to compare variances among multiple groups (Bartlett, 1937). Levene's test, a more robust type of *F*-test, was used to analyse valence due to the data skew (Schultz, 1985).

R statistical software, version 3.3.2, was used to conduct the analyses and construct the figures. Regression analysis was conducted using the *lme4* package (Bates et al., 2014). Analysis of variance and Bartlett's tests were completed with the *stats* package (Chambers et al., 2017), and Levene's test using the *car* package (Fox & Weisberg, 2019). Figures were generated with the *ggplot2* package (Wickham et al., 2019). Figures 1, 2 and 3 are density plots, generated by a kernel density estimate, which are essentially a smoothed version of a histogram.

3 | RESULTS

3.1 | Silence

As shown in Figure 1, the length of silences in this sample of psychotherapy sessions was negatively skewed, as expected (see Heldner & Edlund, 2010, Figure 3, p. 562). The mean silence was 0.96 s ($SD = 1.25$). Silences ranged between 0.2 and 24.01 s, with a median of 0.61 s and a mode of 0.23 s. On average, sessions contained 32.67 therapist-initiated silences ($SD = 21.01$) and 31.4 total s of silences ($SD = 23.6$); 98.6% of silences were under 5 s, 70.7% were under 1 s, and 41.4% were under 0.5 s. The means, standard deviations and analytical findings for both vocally encoded arousal and emotional valence are shown in Table 1.

3.2 | Vocally Encoded Arousal

The mean client arousal across sessions was 0.56 ($SD = 0.22$). From the regression analysis, there was no significant effect of therapist-initiated silence on vocally encoded arousal ($\beta_1 = -0.01$, $t(83) = -1.71$, $p = 0.09$, 95% CI [−0.01, 0.001]).

Figure 2 shows the density of arousal across the six groups of silence lengths. There was a significant main effect of length of silence on mean arousal, $F(5, 4039) = 3.19$, $p < 0.01$. When examining the means in Table 1, and the plots in Figure 2, there was a decrease in mean arousal for silences greater than 5 s. The effect size was small ($\eta^2 = 0.004$). Bartlett's test indicated no significant differences of arousal variance across lengths of silence ($T[5] = 1.3$, $p = 0.94$).

3.3 | Emotional Valence

The mean client valence was 0.32 ($SD = 0.13$). There was a significant effect of therapist-initiated silence on emotional valence ($\beta_1 = 0.004$, $t(83) = 2.05$, $p < 0.05$, 95% CI [0, 0.01]). As silence increased by 1 s, emotional valence also increased by 0.004 units. Demonstrated in Figure 3, there were diminished neutral and negative responses, indicating valence became more positive as silence increased.

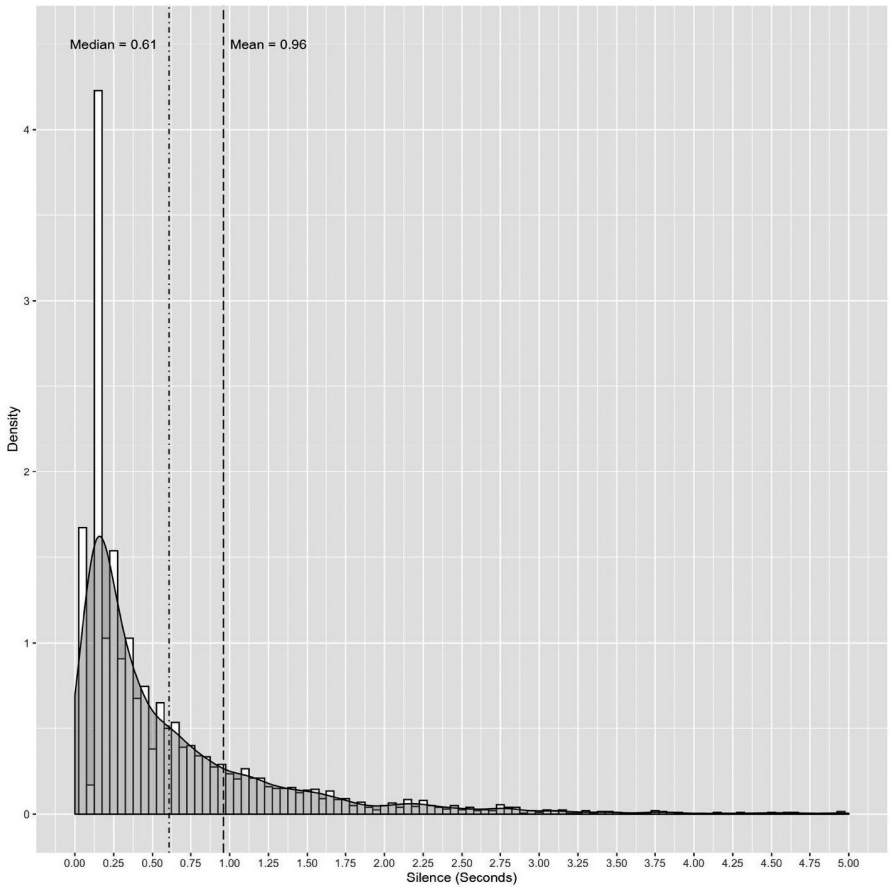

FIGURE 1 Density plot of silences <5 s. Given that 98.6% of silences were 5 s or less, 5 s was chosen to best demonstrate the density of silence values. The number of observations greater than 5 s was 39

Figure 3 shows the density of valence across the six groups of silence lengths. There was no significant main effect of length of silence in sentiment content ($F(5, 4039) = 0.39$, $p = 0.86$). Levene's test demonstrated a significant difference in variance across silences of different lengths ($F[4, 4040] = 2.72$, $p < 0.05$). When examining Figure 3, there was a decrease in variance only for silences greater than 5 s.

4 | DISCUSSION

This study aimed to provide a large-scale temporal quantitative analysis of client emotional expression after therapist-initiated silences. Psychotherapy research has indicated a connection between silence and client emotional expression. However, prior studies have only examined longer silences, considered rare by linguistics researchers, and have produced consistently mixed results. To contribute to the existing literature, we investigated the relationship between client emotional expression and the full range of silence lengths utilising quantitative methods. Broadly, our results demonstrate a weak connection between silence length and emotional expression, indicating no persuasive evidence that silence leads to client emotional processing and expression.

To start, descriptive measures demonstrated both consistencies and discrepancies with prior linguistic and psychotherapy literatures. Consistent with linguistics findings, our results demonstrated that the lengths of silence in psychotherapy were negatively skewed, with a modal length of silence of 0.23 s (see Heldner & Edlund, 2010). Descriptive measures indicated the vast majority (98.6%) of silences were under 5 s, consistent with prior findings that longer silences in psychotherapy are rare (Holler et al., 2016), and that many qualitative and self-report studies have explored only a small portion of silences. Cumulative statistics also indicated about 70% of silences were under 1 s, and about 40% were under 0.5 s, whereas, on average, 75% of conversational pauses are typically under 0.5 seconds (Levinson & Torreira, 2015) and between 82% and 95% are less than 1 s (Heldner & Edlund, 2010). As such, therapists may pause more often than a speaker engaged in typical colloquial conversation (see Silber-Varod & Lerner, 2017), supporting prior claims that therapists may try to be more intentional about using silence to observe the client, process therapeutic content and demonstrate their interest in the client (Hill et al., 2003).

Our hypothesis that the variance of client emotional expression would change as a function of silence length was confirmed for vocally encoded arousal; however, the effects were minimal. The ANOVA comparing arousal across groups of silence lengths indicated significant changes, but the effect size was very small. There was no significant trend in the regression analysis of arousal level changing across continuously increasing silence length. One possibility for the lack of large effects for vocally encoded arousal is our use of single-session MI data. The therapist and client are beginning to develop rapport, and not necessarily engaging in more

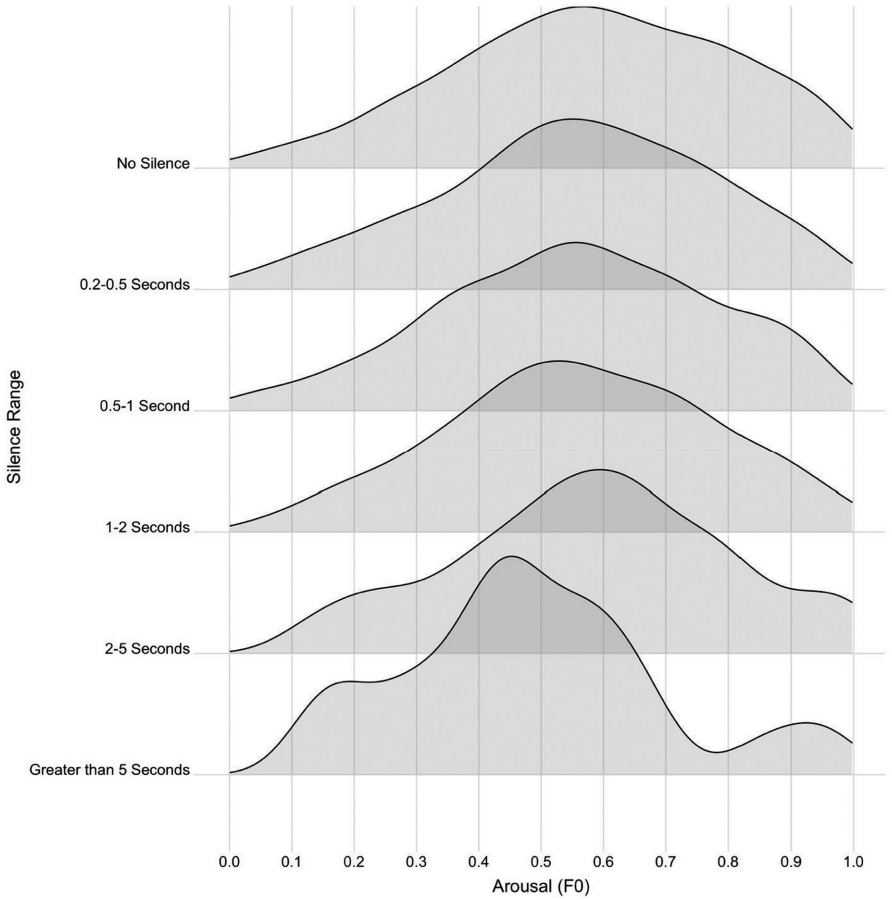

FIGURE 2 Emotionally encoded arousal and therapist-initiated silence

emotionally laden therapeutic material. Previous research has studied specified sessions in a series of psychotherapy (Daniel et al., 2018), as well as comparing initial and ending future sessions (Cook, 1964). Prior studies indicating emotionality and reflectivity in silence (Levitt 2001b; Hill et al., 2003) may be a product of longer and more developed therapeutic relationships (Hill et al., 2019). The current study thus provides a quantitative understanding of silence in the early phases of therapy, and in particular, the first session of therapy. Daniel et al. (2018) indicated most productive silences occurred halfway through treatment, which may indicate that client emotional expression may occur in later sessions. As such, further study may analyse longitudinal data and could explore how silence changes over time as the therapeutic relationship changes.

Our hypothesis of changing emotional valence across silence length was also confirmed, but again, the effects were weak. Regression analysis demonstrated that emotional valence significantly increased as silence length increased; however, the effect size was, again, very small. When examining Figure 3, we saw that for silences greater than 5 s, there were diminished neutral and negative responses. MI was the treatment modality, and as such, therapist goals during MI are to elicit client statements of desired change (i.e. change talk) and are discouraged from discussing statements indicating resistance to behaviour change (i.e. sustain talk) in order to promote actual behaviour change (see meta-analysis by Magill et al., 2018). It is possible that MI therapists may avoid times whereby the client is defending their behaviours, potentially eliciting strong negative emotional reactions, leaving the existing therapeutic content to be more neutral or positive. Further research is necessary to understand how silence influences client emotional expression in other therapeutic settings.

As a quantitative and interdisciplinary study of silence, our findings are an important contribution to the psychotherapy process literature and may have some implications for clinical practice. Linguistics and computer science research provided a theoretical framework and methodology to automatically extract thousands of silences, and continuous measures of emotional expression. In addition to providing a methodology to explore the full range of silences available during a therapy session, this study also provides a method for quantitatively modelling silence and how it relates to emotional expression. Further research can expand these findings to explore how silence relates to other psychotherapy processes, as well as to address some of the study's limitations. Within a clinical context, therapists pausing more frequently than is typical in colloquial conversation supports the notion that therapy is a special type of conversation, in which traditional conversational rules and paradigms may not exist. Though clients may not necessarily be utilising silence for emotional processing, silence may create space for the client to focus on therapeutic content at their own pace (Levitt, 2002; Hill et al., 2019).

One limitation is that the study examined only therapist-initiated silences and the client's emotional response to those silences. However, pauses within a speaker's speech, as well as client-initiated

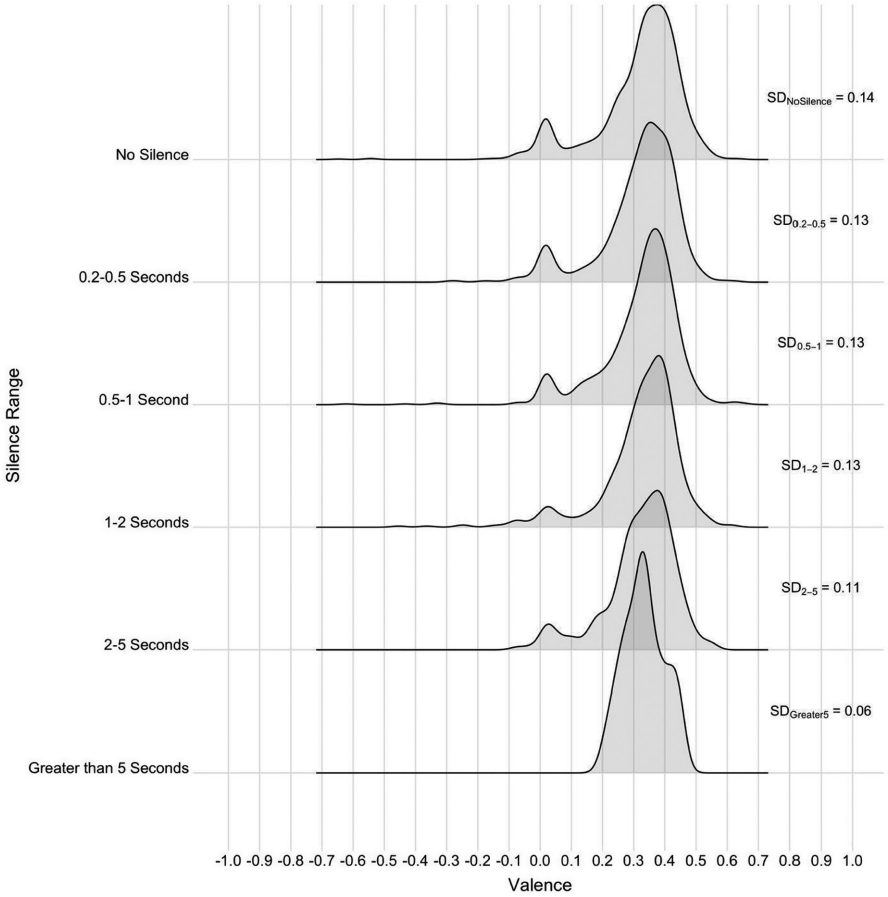

FIGURE 3 Semantic content across different lengths of silence

TABLE 1 Vocally encoded arousal and emotional valence analysis results

	Vocally encoded arousal	Emotional valence
Descriptives	**Mean (*SD*)**	**Mean (*SD*)**
Overall mean	0.56 (0.22)	0.32 (0.13)
Groups of silence		
No silence	0.58 (0.22)	0.31 (0.14)
0.2–0.5 s	0.55 (0.22)	0.31 (0.13)
0.5–1 s	0.56 (0.22)	0.32 (0.13)
1–2 s	0.56 (0.21)	0.32 (0.13)
2–5 s	0.58 (0.22)	0.32 (0.11)
Greater than 5 s	0.48 (0.21)	0.33 (0.06)
Regression analysis	Estimate (SE)	Estimate (SE)
Intercept	0.57 (0.01)	0.32 (0.004)
Silence coefficient (β_1)	−0.01 (0.003)	0.004 (0.002)*
95% CI	[−0.01, 0.001]	[0, 0.01]
ANOVA	$F(5, 4039) = 3.19$**	$F(5, 4039) = 0.39$
Test of variance	*Bartlett's test*	*Levene's test*
	$T(5) = 1.3$	$F(4, 4040) = 2.72$*

Note: Significance codes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

silences, are still relevant to explore quantitatively. Additionally, modelling the therapist's emotional expression with silence may contribute to understanding therapist-specific emotional processes, such as countertransference (see Hill et al., 1996), or client attachment style (Daniel et al., 2018). However, in terms of understanding silence as a therapist intervention in therapy, studying therapist-initiated silence may be most ideal for understanding the client's immediate emotional reaction. Future research should explore the therapist behaviours that precede silences. For instance, MI emotion process research has found that MI-inconsistent behaviours have correlated with client sustain talk (Magill et al., 2014; Pace et al., 2017; Magill et al., 2018) and that positive emotional experiences have correlated with MI-adherent behaviours (Moyers et al., 2005). However, MI process research is lacking in many ways, and, in particular, lacking research on client emotional experiences (Wagner & Ingersoll, 2008).

The current data also lack demographic information to better understand the relationship between individuals' identities and silence (e.g. gender; Ramakrishna et al., 2015), and a broader relationship of silence, cultural norms (Nagaoka et al., 2013) and relational power dynamics. Studies have primarily examined silences in the context of European countries and the mainland and continental United States (Heldner & Edlund, 2010). Future research could benefit from including demographic variables, therapeutic process

variables and therapy outcomes. Even with these limitations, the study provides a strong basis for quantitative and interdisciplinary research on silence during psychotherapy and contributes to the understanding of how smaller exchanges between therapist and client contribute to larger psychotherapy processes.

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ENDNOTES

[1] The full data set included both real and standardised patients. We included only real patients in this sample. Additionally, the 84 sessions were able to be processed for silence with our data processing procedure. Due to the nature of community mental health, the quality of some audio recordings was not conducive to extracting silence with our methodology.

[2] Due to the nested nature of psychotherapy data, ANOVA and tests of variance compared the entire data set, as well as a random sample of data containing one client per therapist to control for nesting. Results were consistent in both sets of tests.

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