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Consistency in verbal expression of death row criminals: concluding life with emotions

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Introduction: There is a lack of both data and, more significantly, computational analyses of the linguistic behavior near an individual's final moments of life. The present study is aimed to reduce human bias and save time in psycholinguistic studies by providing data-backed insights.

Methods: A novel machine learning based pipeline proposed, using elements of semantic similarity (BERT and transformers) and emotion extraction in collaboration, to analyze the final statements of death row inmates to understand the consistency in their verbal expression moments before their death. A new method of analysis was proposed in this study to explore the notions inherent in the statements. A large database of 466 final statements from death row inmates in Texas was utilized in this study. Manual notion analysis was validated by a computational method of notion inferencing.

Results: Basic emotions of Anger and Fear majorly dominated the statements, constituting 54% of the whole, while 21% of all statements were of emotional states of Happiness and Serenity.

Discussion: The outcomes of this study are expected to contribute to psychological analyses of humans, moments before death, and provide insights to criminology researchers to formulate better strategies of rehabilitation and debate the death penalty.

KEYWORDS

computational psycholinguistics, emotion classification, death sentence, natural language processing, BERT

1 Introduction

> *I am sorry for what happened and that it was because of me that they are gone. If there were any way I could change things and bring them back I would. But I can't. Because of what I caused to happen many people were affected and I am very sorry that I did.*
>
> *Last statement of a death row inmate, 2003*

The mantle of analyzing human minds through various modes of expressions used to be worn by philosophers and psychologists. Nowadays, verbal expressions of mental experiences are generally analyzed through the lens of computational psycholinguistics (Xu, 2021; Ghosh and Anwar, 2021). The computational analyses of data collected during or near to such experiences provide objective insights into the human mind and generic human tendencies. However, the experience of moments of and near to death, that is a certainty, is generally and understandably associated with negative connotations

in the human mind. As a result, though there are numerous studies that collect and computationally analyze linguistic data pertaining to other behaviors and situations (Lyons et al., 2018; Bogolyubova et al., 2018; Markowitz, 2023; Guiller and Durndell, 2007; Kaplan, 2020; Chelmis and Rahman, 2023; Anshul et al., 2023), some work have been done over detecting suicidal tendencies using computational analysis (Xu, 2021; Naseem et al., 2022) yet there is a dearth of data and more importantly, computational analyses of the verbal behavior of and near to the final moments of life. Hence, this study is focused on the final statements of criminals on death row. It uses techniques of emotion modeling and natural language processing on these verbal expressions, and further proposes methods to analyze such data to get novel psychological behavioral insights. The proposed analysis is intended to provide data-backed insights into the human mind that may be used to evolve existing modes of punishment for criminals and venture into the computational psychology of death.

1.1 Thematic consistency in final statements

Studies have shown that the final words of death row inmates can provide valuable insights into their emotional experiences and attempts at meaning-making in the face of imminent death. A focused review of use of language preceding death by execution revealed that the most prevalent themes in these final acts of verbal communication were spiritual references, emotional positivity, and messages to relevant social others (Hirschmüller and Egloff, 2018). This is surprising given that executions are generally assumed to be maximally anxiety-provoking. The same study found that the final statements of executed Texas death row inmates contained a higher percentage of positive emotion words than negative ones. Over 80% of these inmates spoke more positive than negative emotion words, suggesting a strong predominance of emotional positivity in their final moments. The proportion of positive emotion words was significantly related to the greater use of first-person singular self-references, words reflecting social orientation, and present-tense verbs. A qualitative text analysis reported in Heflick (2005) identified prevalent content themes in these statements, such as love/appreciation, forgiveness, claims of innocence, belief in an afterlife, and activism. These themes were found to be consistent across different time periods and studies, indicating a common pattern in the last words of death row inmates. Interestingly, a study in Goranson et al. (2017) reported that the affective experiences and meaning-making attempts in the last words of executed prisoners were found to differ from those expressed by people imagining death and dying. Last words of the executed prisoners contained significantly more expressions of positive affect and fewer expressions of negative affect than people's simulated written last statements when asked to imagine what it would be like to face execution the next day. A surprising amount of emotional positivity and a focus on aspects such as social connections and religion that make life and death meaningful, provide a unique perspective on the human experience of death and dying, and have significant implications for the understanding of end-of-life communication needs and themes. According to the study in Kelly and Foley (2013), the final statements made by prisoners awaiting execution commonly revolved around themes of love, spirituality, and remorse. Psychological factors that frequently emerged and consistently persisted over time included indirect expressions, overwhelming psychological pain, identification-egression, and rejection-aggression. The similarity between the themes and psychological patterns observed in the last statements of death row inmates and those found in suicide notes suggested a potential convergence of concerns as life approaches its end, irrespective of the circumstances of death. The study reported in James (2022) revealed prevalent themes of defiance in the final statements, characterized by expressions asserting innocence, criticism toward the death penalty, and concerns regarding the fairness of the judicial proceedings. The case study discussed in Frigo (2022) explored two distinct methodologies for analyzing linguistic data of final statements to examine and identify various linguistic themes present in them, specifically focusing on the rhetoric surrounding the death penalty and expressions of apology and forgiveness. Findings of the research reported in van Baak et al. (2023) suggest that a minority (25%) of individuals convicted of homicide provide justifications for their actions when confronted with the prospect of execution. However, it is common for them to simultaneously express sentiments of guilt and gratitude. Another study (Hirschmüller and Egloff, 2016) shows that emotional positivity in last statements correlated with an increased usage of language that indicated self-references, a focus on social interactions, and orientation toward the present moment. Additionally, it was associated with a lower frequency of cognitive processing, references to the past, and the use of words related to death.

1.2 Mental state of death row criminals

In addition to fulfilling basic bodily needs like sleeping, eating, and engaging in natural functions, death row inmates allocate a significant portion of their time to deep contemplation. Through an examination of letters and various writings penned by inmates awaiting execution, the study in Shneidman (1995) determined that they engage in profound introspection regarding their own existence and the experience of death. The awareness of impending death leads individuals to intensely focus on themselves to the extent that they begin to mourn or grieve for their own loss. While it is possible that the selection of final statements in Shneidman (1995) may not represent the entirety of death row inmates, many of the letters exhibit a remarkable nobility of sentiment and genuine concern for others in the face of mortality. Consequently, the execution-related correspondence scrutinized in Shneidman (1995) unveils a compassion for loved ones and a sense of tranquility as life nears its end. It is also common for numerous death row inmates to develop strong religious convictions and beliefs in concepts such as reincarnation or alternative forms of an afterlife. The research conducted in Cunningham and Vigen (2002) revealed a prevalence of elevated psychological disorder rates among death row inmates. It was observed that the conditions of confinement seemed to play a role in triggering or exacerbating these disorders. A study of death row inmates in Pakistan (Ali et al., 2023) unveiled several

prominent themes, encompassing the mental health of the inmates, their inclination toward criminal behavior, the psychological and physical transformations experienced following the imposition of the death sentence, their social and interpersonal encounters, coping mechanisms employed, as well as their perceptions of themselves, others, and the world. The study in Jackson (2023) demonstrates how inmates leverage their final statements as a means to exert control and shape their situations, ultimately positioning themselves as the "masters of ceremonies."

For the current study, a computational ML-based analysis was conducted to understand notional, emotional, and semantic consistency in the final statements of death row inmates. The intent of the application of these computational algorithms was to reduce human bias and time consumed in psycholinguistic studies to a great extent and highlight pure data-backed insights.

2 Materials and methods

2.1 Data

In Texas, inmates on death row are given the opportunity to make a final statement before their execution. These statements are typically made in the execution chamber, immediately prior to the administration of lethal injection. The content of these last statements varies widely, ranging from expressions of remorse and apologies to proclamations of innocence and condemnations of the criminal justice system. Some inmates choose to speak directly to their victims' families or to their own loved ones, while others use the platform to make political or social statements. According to the Texas Department of Criminal Justice, the last statements of inmates on death row are considered public information and are typically released to the media following the execution. The current study uses the dataset of final statements made by criminals since approximately the last 30 years (Texas Department of Criminal Justice, 1976). Such a dataset provides the opportunity to analyze final statements with the intent of understanding the most prominent notions conveyed by criminals, their outlook toward life in the final moments, and their varying ways of self-representation in their final moments. The data was collected using beautifulsoup4 (Richardson, 2023) based web scraper. Out of a total of 575 criminals who were executed in the concerned duration, 109 inmates declined to make a statement. The remaining final statements (466) were used for analyses. Additionally, the dataset was de-identified by removing all the personal details of the criminals from the scraped data.

Furthermore, the data was preprocessed prior to the analyses by removing punctuations and stop words using NLTK (Bird et al., 2009). The specific experimental details for the analyses have been explained in the upcoming subsections.

2.2 Procedure

This section describes the methodology of analyses that were carried out to derive insights from the dataset to final statements. The overall analysis is done by conducting three different experiments. After the preprocessing, for the first experiment, a bag of relevant words was created for word frequency-based analysis. Next, basic emotions were extracted from the statements, which were further translated into valence and arousal coordinates, for emotion based analysis. Finally, all the sentences in each statement were classified into one of the four relevant notions for further notion based analysis. This summary view of the analyses is shown in Figure 1.

2.2.1 Word frequency analysis

Post data preprocessing, the dataset was combined to form a bag of words. A frequency analysis was done on the bag of words using word-clouds to understand the content and themes. Furthermore, it provided insights into the emotional state of the inmates and their attitudes toward their impending execution.

2.2.2 Emotion analysis

A novel method comprising two phases was used for this analysis. The analysis was performed by extracting the most dominant emotion present in each final statement and mapping it on a two-dimensional VA (Valence-Arousal) plane (Russell, 1980)

2.2.2.1 Weight calculation phase

In the first phase of this analysis (Figure 2), a pre-trained BERT model (Devlin et al., 2018) was used to obtain the semantic embeddings of each final statement and each of the N words that form the final statement. The embedding of each statement was compared with the embeddings of the N words of that statement using cosine similarity. The resulting values were saved in a list of size N, where each value at a particular index describes how well the word at that index in the statement semantically represents the complete statement. Furthermore, the embedding of each word was compared with the embeddings of the rest of the words using cosine similarity to create an $N \times N$ matrix. The list of size N and the $N \times N$ matrix were used to calculate the weight of each word per statement that quantitatively signifies how well the word represents the statement. These weights were further passed to the next phase for emotion extraction.

2.2.2.2 Emotion extraction and mapping phase

Whole statements were analyzed in this phase by deriving the emotions present in them (Figure 3). The intensities of basic emotions were first extracted and then they were converted to coordinates of the VA plane (Posner et al., 2005; Russell, 1980; Russell and Barrett, 1999). Two libraries, namely *NRCLex* (Mohammad and Turney, 2013) and *Text2Emotion* (Gupta, 2020), were used to obtain word-based and sentence-based emotion intensities. The *NRCLex* library uses a large affect dictionary containing approximately 27,000 words and is based on the affect lexicon of National Research Council (NRC) and the *WordNet* synonym sets of the *NLTK* library. It was used to predict intensity of eight emotions namely, *Happiness, Sadness, Anger, Fear, Surprise, Excitement, Serenity, and Disgust.* On the other hand, the Text2Emotion library works on sentences by individually assessing the emotions associated with the words of the sentence. This library uses an affect dictionary of 8,666 words and infers five emotions *(Happiness, Sadness, Anger, Fear, and Surprise)*. However,

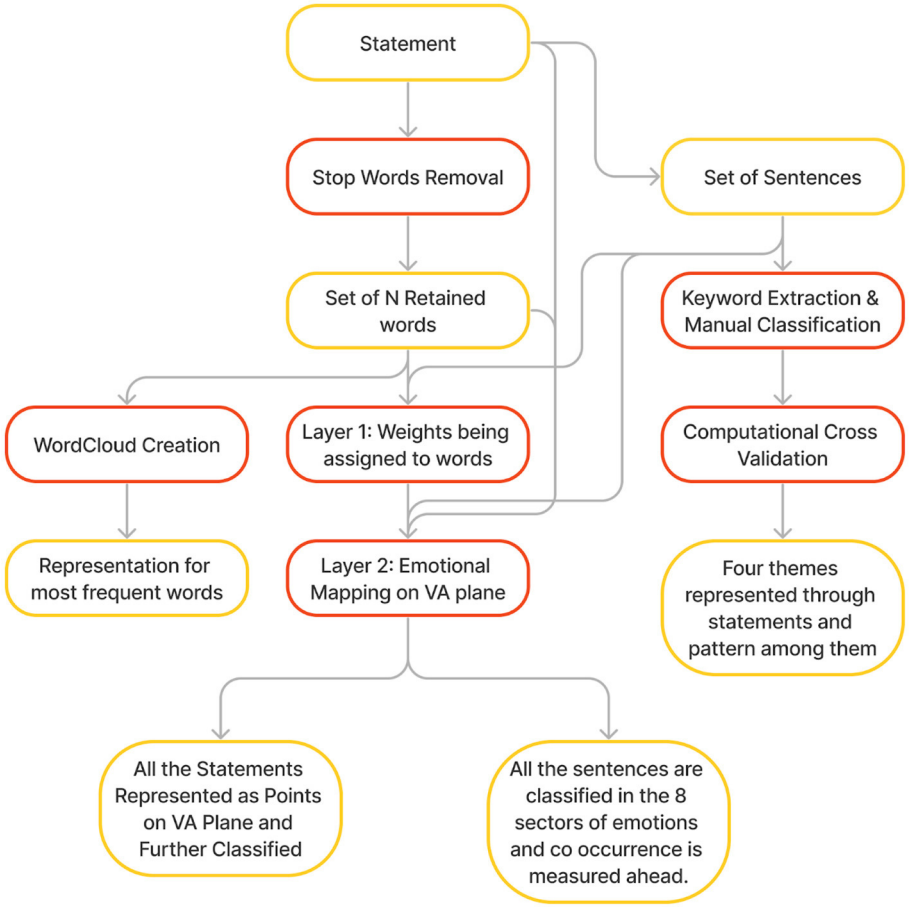

FIGURE 1
Summary of the analysis techniques.

the emotions it infers are all present in the first two quadrants of the VA plane (Figure 4) and therefore, the library is biased toward positive arousal. Since each of the library methods had its own advantage, both were used for emotion inference in the proposed technique of emotion analysis.

Since 8 emotions were inferred for each of the N words using *NRCLex*, an N X 8 matrix was created. Each row of this matrix is multiplied by the corresponding weight calculated in the previous phase. The values of each of the columns of the resultant matrix were added to obtain the intensities of eight basic emotions for the whole sentence. These intensities are further combined with the intensities of five emotions for each sentence derived by the *TextToEmotion* library. The intensities of the five emotions that are common in both the libraries were averaged. The rest of the intensities were considered as they were.

2.2.2.3 Conversion of emotion intensities to VA coordinates

Since the emotion intensities were in the range of 0 to 100, a circle of radius 100 was used on the VA plane for mapping the emotions as defined in Russell (1980). As shown in Figure 4, the circle is divided into 8 sectors, namely *Happiness, Anger, Fear, Sadness, Gloominess, Tired, Calmness, and Serenity*. To map each vector of emotion intensity corresponding to a final statement on this VA plane, one can start from the origin (center of the circle) and move in the direction of each of the emotions present in the vector as per the respective emotion intensities. The position on the 2D plane where this process ends is the point considered as the VA coordinate for the statement. The VA coordinate, and the respective statement were classified based on the sector in which the coordinate lies.

2.2.3 Co-occurrence of emotions

Emotions in the final statements of death row inmates are complex and possibly interconnected. For instance, the co-occurrence of anger and sadness in a final statement could suggest a notion of injustice or betrayal, while the co-occurrence of gratitude and regret could indicate a complex mix of emotions related to a person's past actions and relationships. The objective of this analysis was to observe the co-occurrence of emotions in final statements. An 8×8 co-occurrence matrix of emotions was used for this purpose. The statements were divided sentence-wise, and their emotions were extracted, as described in the previous sections. The classified emotions

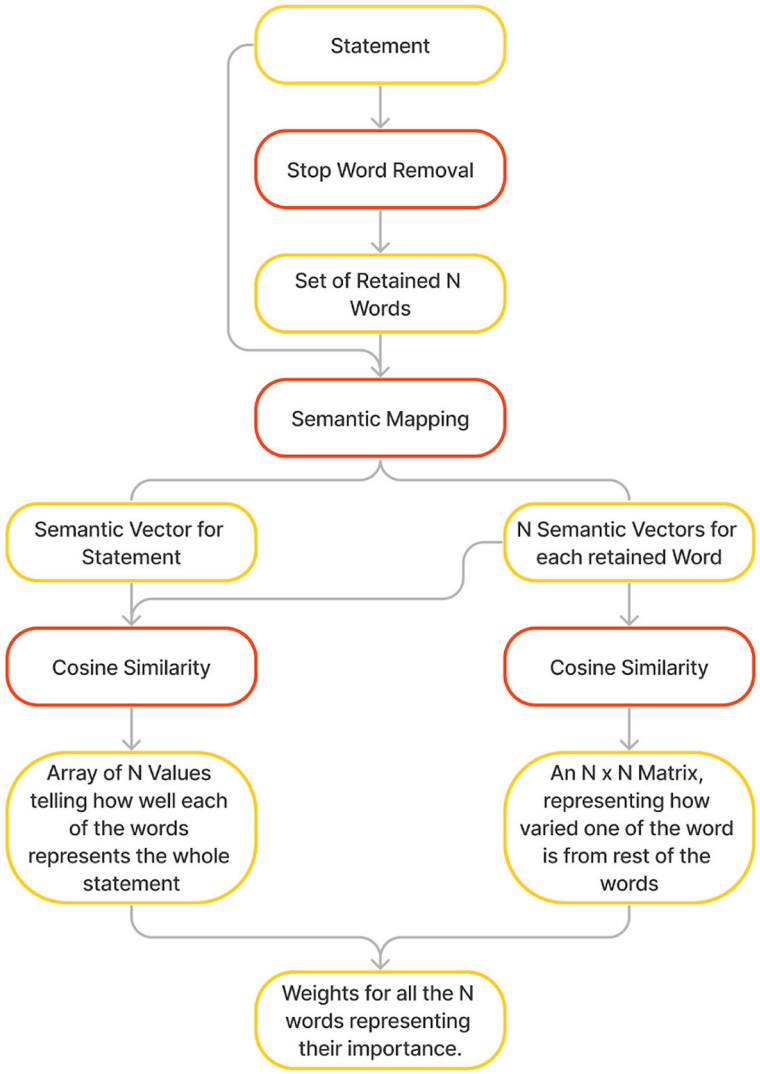

FIGURE 2
Weight calculation phase.

were used to calculate the co-occurrence values of two classes in the same statement as overall percentages. These percentages were used to create the co-occurrence matrix using a color map.

2.2.4 Notion extraction

The final statements were broken down into sentences and such keywords were identified for each of them that best represented the sentence using the methodology of weight calculation described in Section 2.2.2. These words were then manually classified into four classes, namely *Guilt, Gratitude, Affection, and Faith* (Eaton and Theuer, 2009; Vollum and Longmire, 2009; Arriens, 2005; Upton et al., 2017). This classification was validated by calculating the cosine similarity between the semantic embedding of each of the sentences and the names of the four classes. The overview of the process of notion extraction is shown in Figure 5.

3 Results and analysis

3.1 Results

3.1.1 Word frequency analysis

The word-cloud representation is shown in Figure 6.

Given that the statements are made by criminals moments before their execution, it was expected that the word-cloud would be grief or anger-driven. However, to the contrary, the most frequent word was "love." Additionally, most of the words reflected in the word-cloud have a positive tone, such as "thank," "family," "mom," "sister," and "friend," which likely represent the theme of gratitude among the final statements. There are words such as "sorry," "mercy," "forgive," "apologize," "peace," and "victim family," which represent the attempts made by the criminals during their final statements to ask for forgiveness. Another set of words includes "Lord," "God," "Jesus," "hope," and "heaven," representing the highly spiritual and probable afterlife beliefs of the criminals in

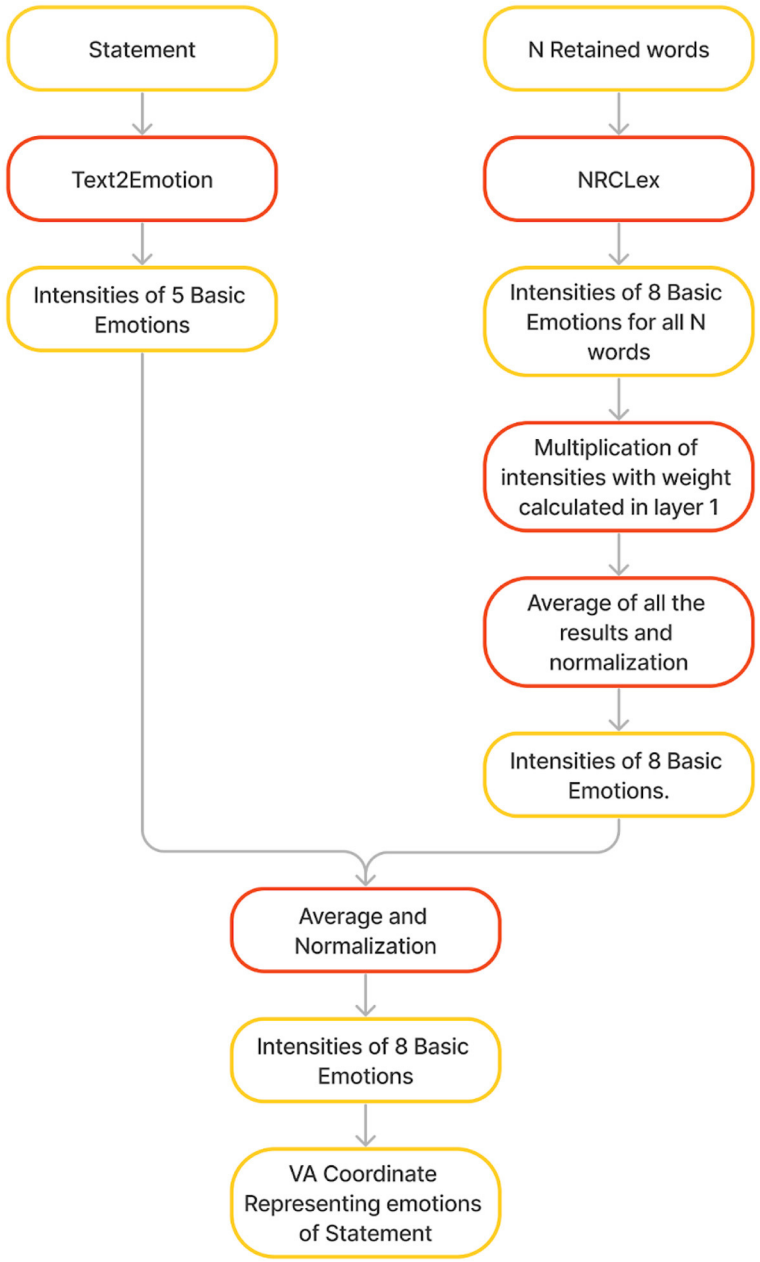

FIGURE 3
Emotion extraction and mapping phase.

their final moments. On the one hand, these words may indicate a very positive attitude toward death as a conclusive part of life, but at the same time, it can be viewed as a terror management strategy (Solomon et al., 1991, 2004) adapted by humans after realizing that death is inevitable. The word-cloud also contains words such as "innocent," "wrong," "justice," "stop," and "please." These words may represent the section of criminals who still deny the decision of their death penalty. Even in their final moments, they choose to portray themselves as "not guilty" and indicate that the decision was incorrect. Furthermore, the phrase "inmate declined" represents all the criminals who chose not to make any statement before their execution.

It is noteworthy that most of the words that represent the themes or emotional significance of the respective final statements fall within the word categories described above. It can be inferred that even though these statements are made over a long course of thirty years, they still represent similar themes and topics.

3.1.2 Emotion extraction and classification

The mapping of emotion coordinates on the VA plane is shown in Figure 7. The figure represents the levels of valence on the x-axis and the levels of arousal on the y-axis. Upon examining the

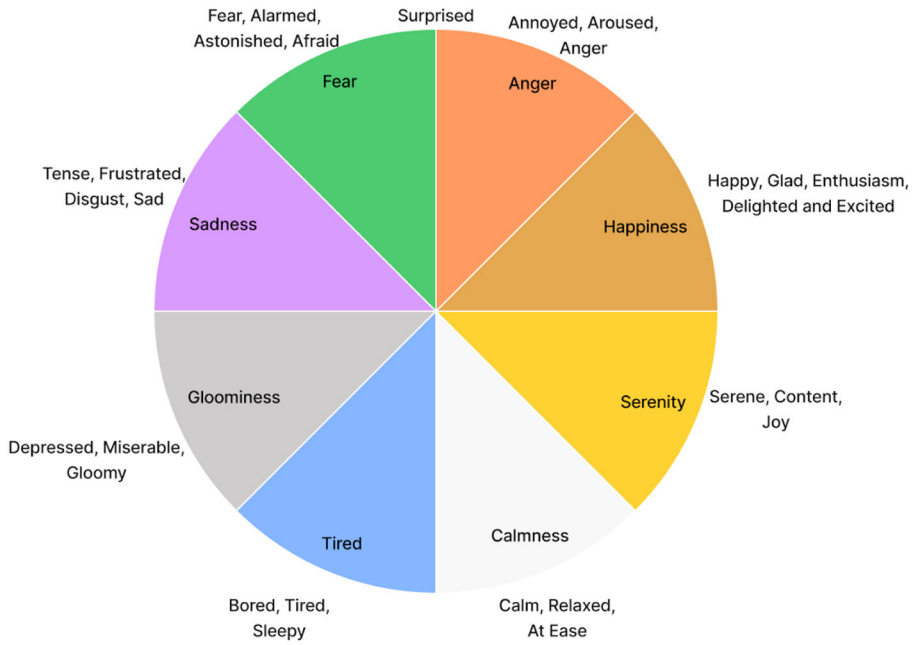

FIGURE 4
Circle of eight emotion sectors on the VA plane.

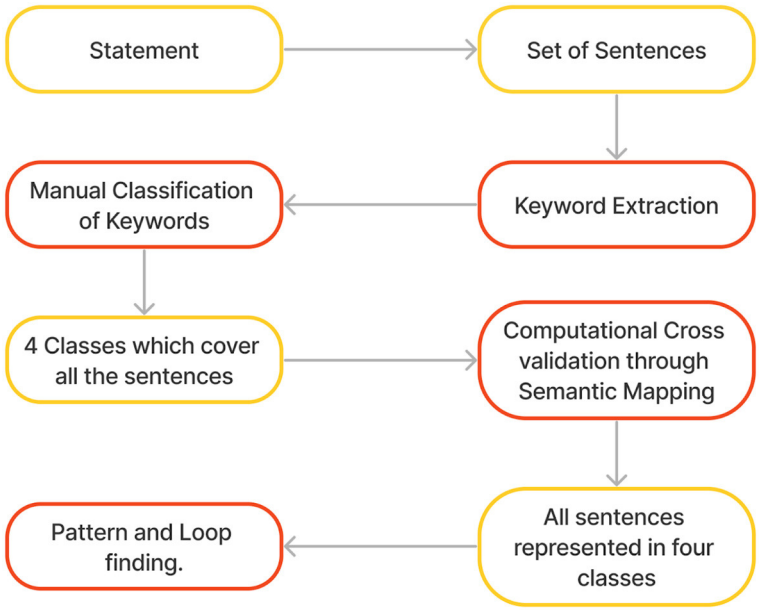

FIGURE 5
Analysis using notion extraction.

x-coordinate values of the points, it is evident that most of the criminals, while making their final statements, experienced mixed emotions, as most of the points lie between −50 and 50. The values of the y-coordinates of points demonstrate that the whole set of points is predominantly deviated toward higher positive arousal, with most of the points ranging from 20 to 80. This indicates the highly active state of mind of all the criminals while making their final statements and the prominently visible emotion of surprise among these statements. However, there are exceptions, with some points not following the trends discussed above, primarily observed at the extremes of the x-axis. These points were further classified into the eight emotion sectors described earlier. Figure 8 shows the distribution of final statements according to the most prominent emotions present in them.

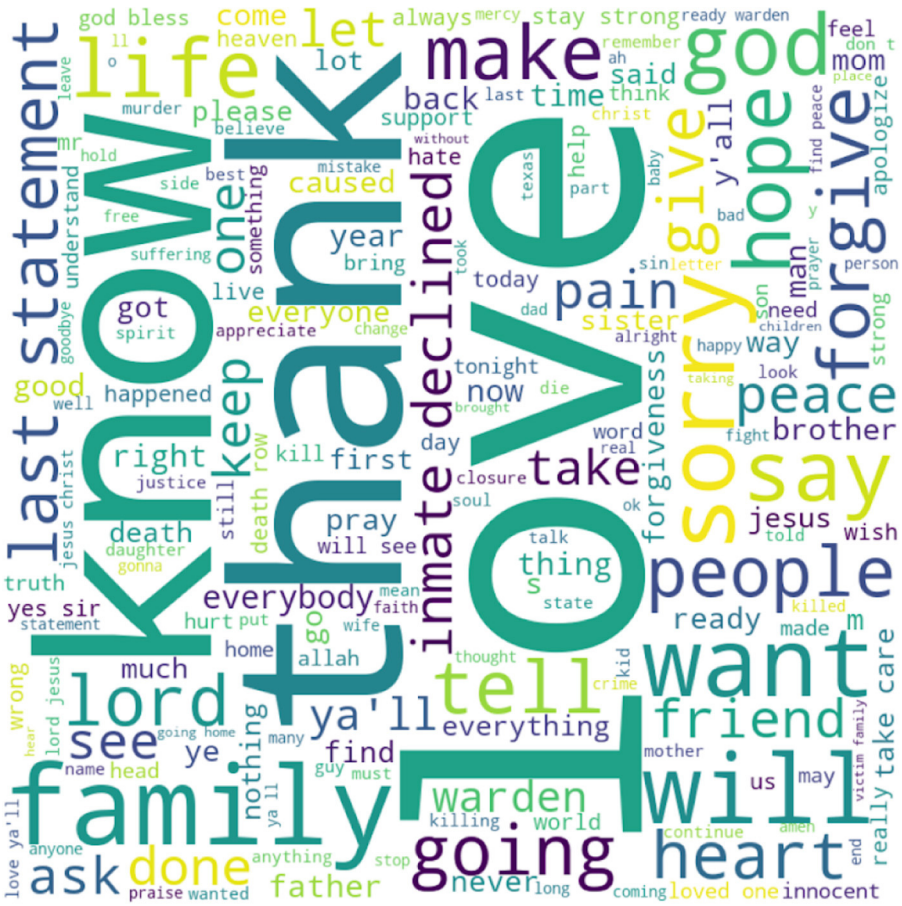

FIGURE 6
Word-cloud of all the final statements of Texas death row criminals.

In contrast to the results of the word-cloud analysis, the pie chart in Figure 8 is dominated by the emotions of *Anger and Fear*, accounting for 54% of the entire dataset. Some criminals also made predominantly positive statements that fell under the emotional states of *Happiness and Serenity*, which accounted for 21% of the entire dataset.

3.1.3 Co-occurrence of emotions

The co-occurrence matrix for emotions in final statements is shown in Figure 9. It can be seen from the figure that no sentence of any statement lies in the class of tiredness or calmness. Furthermore, it can be observed that gloomy emotion mostly co-occurs with other emotions. On the other hand, *sadness* is the least co-occurring class.

3.1.4 Analysis of notions

The four notion classes of *Guilt*, *Gratitude*, *Faith*, and *Affection* were used for manual classification of sentences in final statements. Word-clouds for these notions are shown in Figure 10. These word clouds are presented to give reader a holistic view and understanding of what the notions actually interpret and consist of. Further an overview of emotional state while expressing the mentioned notions can be estimated through the provided wordcloud.

3.1.4.1 Notion class validation

A BERT model was used to quantitatively validate the four notion classes. The notion class of each sentence of each statement was predicted by the BERT model and compared with the manually assigned class. The percentage of the total number of sentences for which the manually predicted notions coincided with the computationally predicted notions was 93.74%. For notion-wise analysis, the computationally predicted notions were considered in the cases when the inferred notions were conflicting with the manually assigned notions.

3.1.4.2 Notion-notion transition probabilities

Given a notion of a sentence in a statement, the probability of the next occurring notion was calculated based on the notion of the next sentence across the dataset. The notion-notion probability for 2 neighboring sentences is shown as a colormap matrix in Figure 11.

As shown in the figure, *Gratitude follows Guilt* with the highest probability. Similarly, *Affection follows Gratitude* with a considerably high probability. *Faith* follows the notion of *Gratitude and Guilt* follows the notion of *Faith* with a high probability. The percentages of statements that contain notion-notion transitions

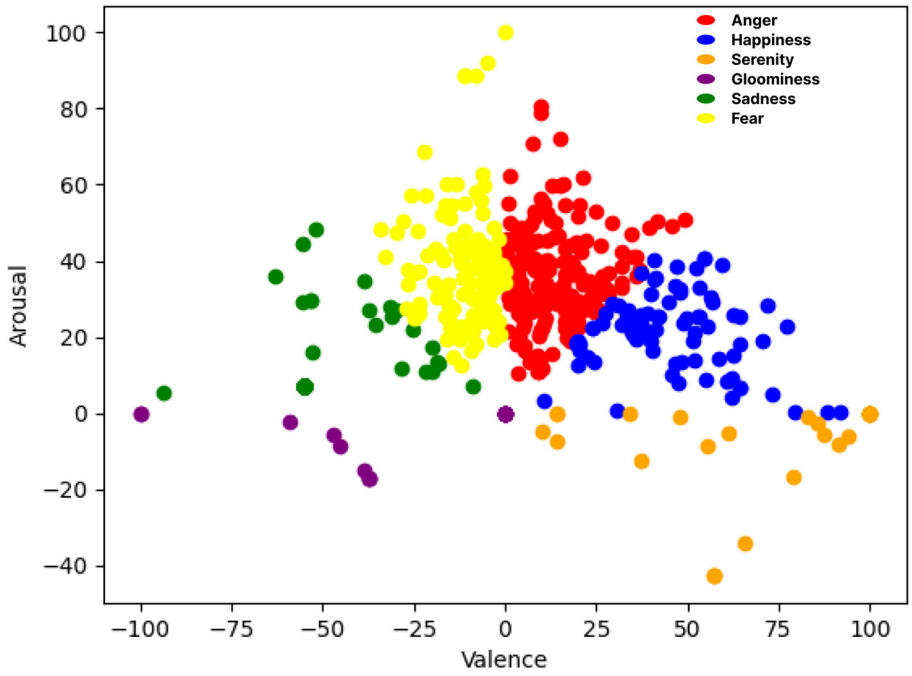

FIGURE 7
Emotion coordinates of final statements mapped on the VA plane.

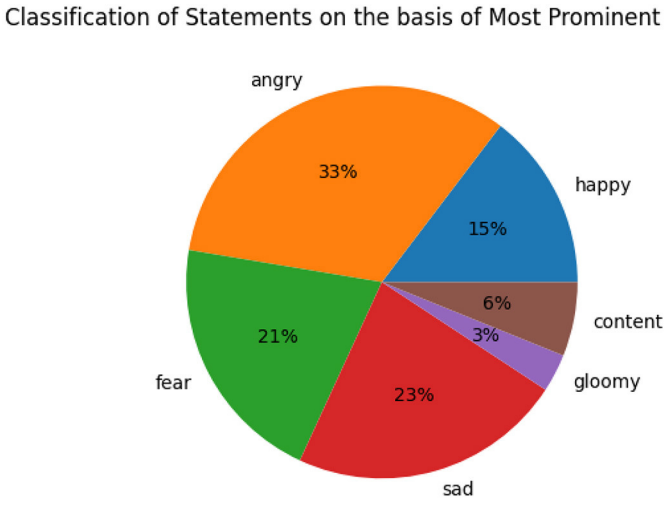

FIGURE 8
Most prominent emotion-wise distribution of final statements.

of two, three, four, and five (cycle of four) neighboring notions are shown in Figure 12. In the figures, G1 represents *Guilt*, G2 represents *Gratitude*, A represents *Affection*, and F represents *Faith*.

3.2 Analysis

It is noteworthy that words, their direct semantics, and their representative emotions are related but different things (Johnson-Laird and Oatley, 1989). It is possible that one can use words having semantics belonging to some theme that does not align with the emotions the person is trying to convey or going through. Thus, in the discussion ahead, the attempt is to understand the results from both perspectives: what was conveyed through the statements and what could be the possible intent.

3.2.1 Contradiction in criminal behavior and positive notions

The analysis of the word-clouds of the final statements made by death row criminals makes it evident that positive notions such as *Love, Gratitude, Faith,* and *Forgiveness* have the highest

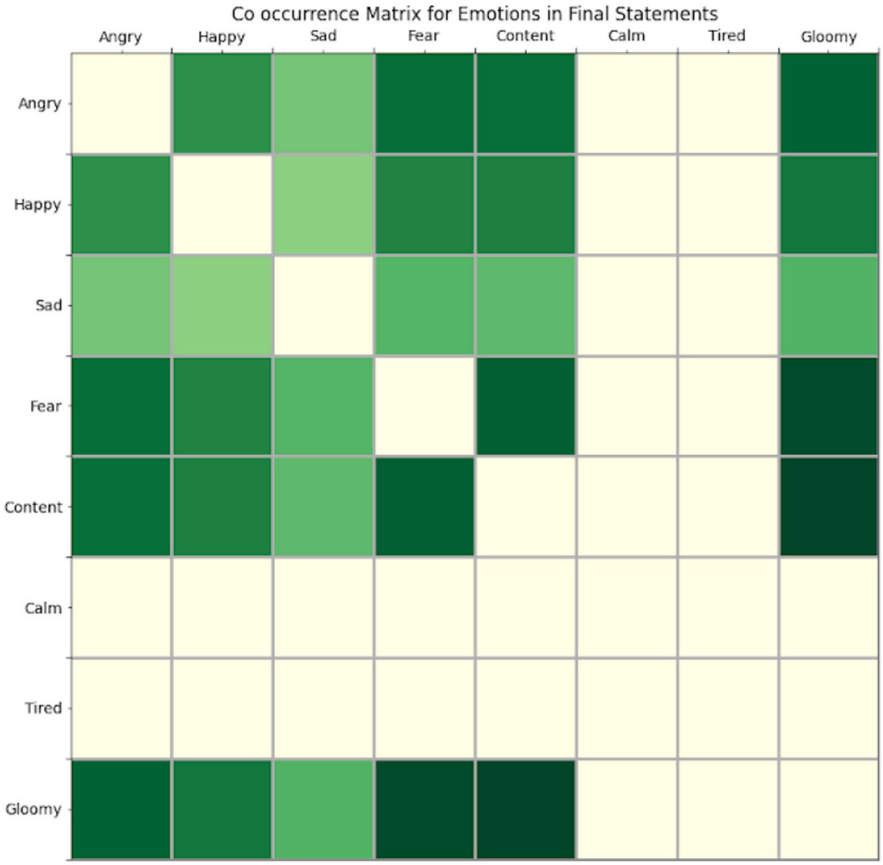

FIGURE 9
Co-occurrence matrix for eight classes of emotions.

frequency. This is surprising considering that these statements are made by individuals facing the most severe and inhumane form of punishment—execution (Steiker and Steiker, 1995). This raises questions about the humanity and moral character of those who committed heinous crimes, yet express positive notions in their final moments such as the following.

> *I would like to thank my Jesus Christ my Lord and Savior. I would like to thank all these people in my life and that aided me in this journey. I would also like to thank the Texas Department of Criminal Justice inmate Field Minister program True Foster and Garcia for aiding me in my journey. To Ms. Walker's family I pray my death will bring you peace.*
>
> *Last statement, 2022*

The presence of positive notions expressed in the final statements of death row inmates is a complex issue that requires further psychological investigation. Some researchers suggest that positive emotions could be used as a coping mechanism to deal with the stress and anxiety of facing imminent death (Elder, 2019). Others argue that the positive emotions expressed could be a form of manipulation, as death row inmates may hope to appeal to the emotions of the public and officials to spare their lives (Devins et al., 2002).

3.2.2 Religiosity and afterlife beliefs

The word frequency analysis reveals a high occurrence of words related to religion, such as *Lord, God, Jesus, Hope, and Heaven*, indicating that many final statements revolved around this theme. This observation is consistent with the findings of the study in Heflick (2005), that identified a specific class representing afterlife beliefs among the six classes of final statements. The theme of afterlife beliefs has contributed to the high frequency of the positive notions discussed in the previous subsection. The study in Cooney and Phillips (2013) had also noted that the more a victim references God in their final statement, the more likely they are to ask for forgiveness. The results in the present study demonstrate that the element of religiosity can significantly influence the overall tone of the statement, as illustrated by the following example.

> *Lastly to God himself... Thank you being a gracious friend to me. I love you with all my heart, mind, strength, in Jesus name.. stay strong and faithful to God... May the Lord God almighty in heaven, Jesus Christ see my spirit. Amen.*
>
> *Last statement, 2014*

The study in Jong (2020) discussed the relationship between afterlife beliefs and Terror Management Theory (TMT) (Vail et al., 2010) in detail. According to this perspective, statements that

FIGURE 10
Word clouds for 4 major notions observed. **(A)** Word-cloud for Guilt. **(B)** Word-cloud for Gratitude. **(C)** Word-cloud for Faith. **(D)** Word-cloud for Affection.

portray afterlife beliefs can be viewed as an adaptation of TMT, where individuals hold a belief that death is not the end and that there is something to look forward to after death.

3.2.3 Role of self-representation

It is important to consider that the final statements made by death row criminals represent their first and only opportunity to speak publicly since the decision of their execution. These statements carry a significant weight and severity, as they are intended to be their final words to the media, the families of victims, their own family, friends, and supporters. Many death row inmates even seek the help of supporters or acquaintances to prepare a script for their final statement, which emphasizes the effort exerted in the preparation of the statement. This aligns with the psychological theory of attempt for positive self-representation and may explain the prevalence of positive notions such as love, gratitude, faith, and forgiveness in the word-cloud. Additionally, some statements may attempt to create a positive image of the inmate in the eyes of the listeners or plead their innocence even in their final moments.

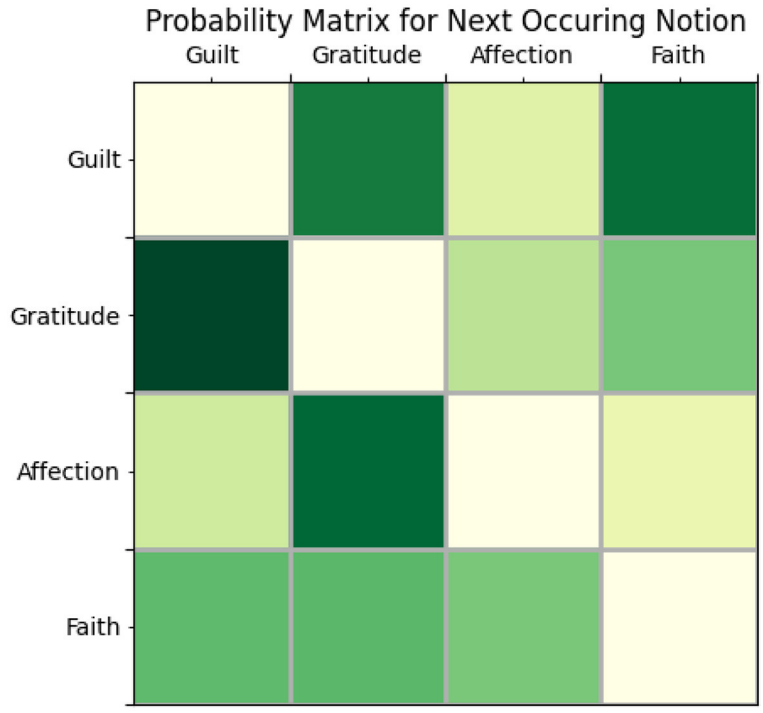

FIGURE 11
Notion-notion probability matrix for 2 neighboring sentences (X-axis denotes the current sentence notion; Y-axis denotes the next sentence notion).

3.2.4 Reflection of life

Another observable aspect of the analysis done for this study is the criminals' attempt to reflect on significant events and people in their lives. The word-cloud clearly shows references to family, friends, important memories, the crime that led to their death, and the victims. This theme is also extended as they express gratitude and hope for a better life ahead for their loved ones, even though such expressions are sometimes motivated by guilt, as demonstrated in the following example.

> *I ask for forgiveness to the Thomas Family for my past choices I made. Carol did not deserve for what I've done. I've asked God to forgive me. Please find it in your hearts to forgive me. I'm sorry it has been bothering me for a long time. So I now pray and I will keep you all in my prayers. I hope you find it in your heart to forgive me. I'm sorry. To my supporters Daniel, brother Charlie, Steve and all who stood by me, thank you. By no means am I happy for what I've done. I have asked the Lord to forgive me. Please tell everyone I'm certain I left off some names. Tell my kids I'm sorry for being a disappointment. Thank you. God bless.*
>
> *An excerpt from last statement, 2018*

3.2.5 Activism and voice against injustice

As previously discussed, there was an underlying motive of positive self-representation in the final statements made by death row criminals, with an attempt to declare their innocence. This is further reflected in some statements where they declare the decision of execution as an injustice and blame the system for their situation. These themes are represented in the word-cloud with words like *Fight, Justice, Innocent, Death row,* etc. Additionally, expressions of activism can be associated with TMT as discussed in Hayes et al. (2010), as an attempt to find a bigger-than-life purpose in their own death. The following sample statement exemplifies these characteristics.

> *I'm not only saddened, but disappointed that a system that is supposed to protect and uphold what is just and right can be so much like me when I made the same shameful mistake. If someone tried to dispose of everyone here for participating in this killing, I'd scream a resounding, "No." I'd tell them to give them all the gift that they would not give me . . . and that's to give them all a second chance.*
>
> *An excerpt from last statement, 2002*

3.2.6 Emotional mapping of final statements

3.2.6.1 Valence values

The analysis of the emotions expressed in the final statements was conducted using a two-dimensional VA plane. Most of the statements fell within a range of −50 to 50 on the valence axis, where 100 represents pure happiness and −100 represents pure sadness. It is evident that most of the criminals expressed mixed emotions, with positive and negative instances, throughout their statements, placing them in the central region of the valence spectrum. This indicates that, while reminiscing, they reflected on both happy and sad memories, with intensities significant enough to balance each

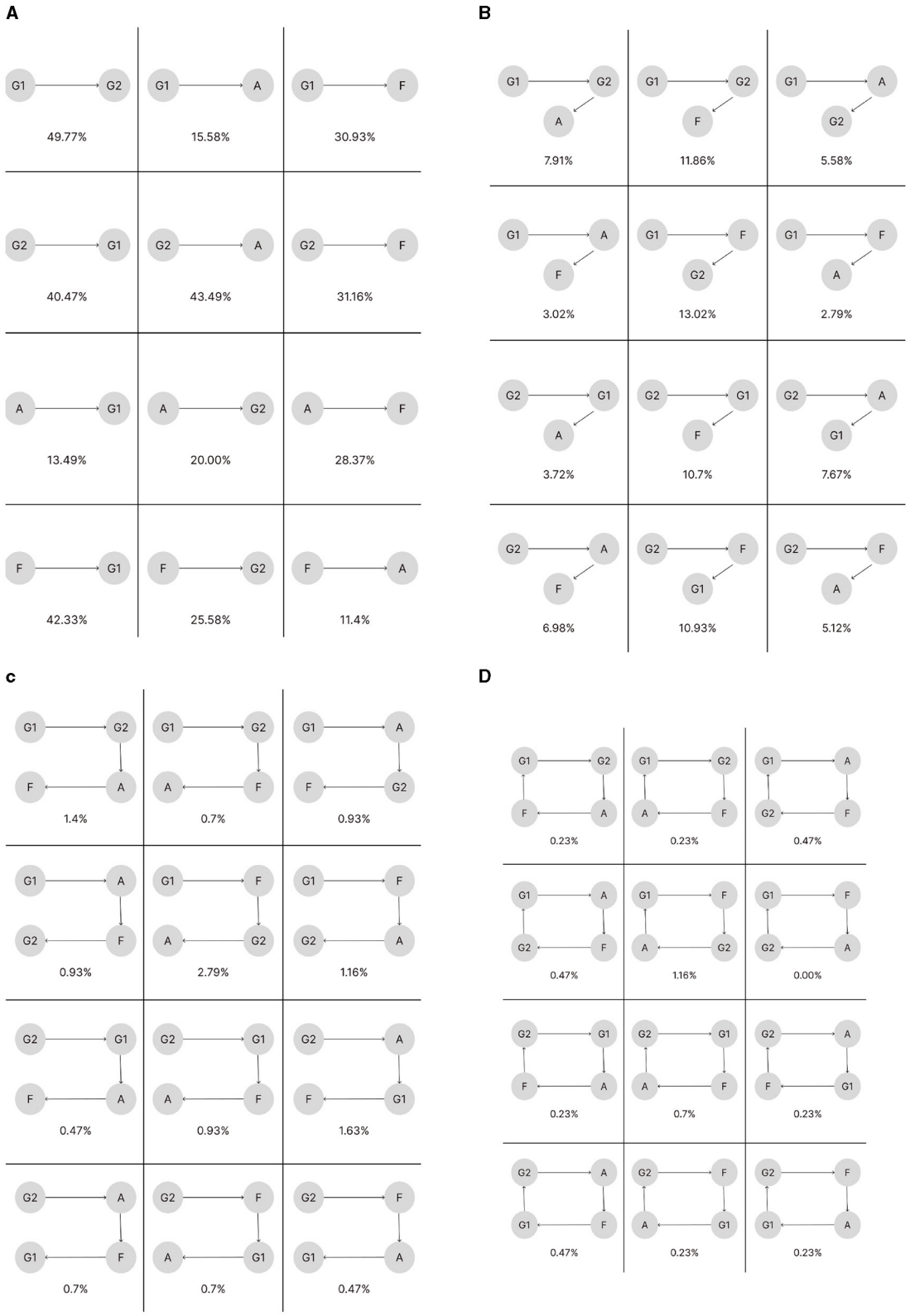

FIGURE 12
Percentage of instances of notion-notion transitions. **(A)** For 2 neighboring sentences across the dataset. **(B)** For 3 neighboring sentences across the dataset. **(C)** For 4 neighboring sentences across the dataset. **(D)** For 5 neighboring sentences across the dataset. In the figures, G1 represents *Guilt*, G2 represents *Gratitude*, A represents *Affection*, and F represents *Faith*.

other out and maintain a neutral valence. Thus, it can be concluded that the emotions expressed in the statements were sufficiently intense to place them in the central region of the valence scale.

3.2.6.2 Arousal values

Upon analyzing the mapping of these statements, it is evident that most of the criminals were highly aroused during their final statements, with most points having an arousal value >20. This indicates that they were more surprised than tired or calm in the moments leading up to their death. This finding aligns with the idea presented by Terror Management Theory (TMT) that the thought of one's own death can be terrorizing, as supported by previous studies (Solomon et al., 1991, 2004). In fact, 21% of all the statements analyzed in this study belong to the sector of Fear, which is located directly to the left of the coordinate of *Surprise* on the VA plane.

The sector on the right side of the *Surprise* coordinate on the VA plane corresponds to the emotion of *Anger*, and contains the highest number of final statements, post classification. About 33% of the statements fall into this sector. The emotions of surprise and anger in the statements may stem from various motivations, such as reflecting on the tragedy of their lives or expressing thoughts of activism.

3.2.6.3 Explanation of exceptions

Although there is a consistent pattern in the emotional expression of most criminals in their final statements, there are exceptions that provide insights. One such exception is shown in Figure 7, where points with valence values between −100 to −75 or between 75 to 100 tend to have a lower level of arousal. Most of these points have an arousal value lower than 0, indicating that if a subject is at the extreme end of the valence spectrum, they will be more toward the "sleepy" end of the arousal spectrum than the "surprised" end. This suggests that criminals who were mostly happy in their final moments tended to be calmer when facing death. They were content with what they had made of their lives and could accept whatever had happened in their past. While the scope of this work does not include an in-depth understanding of this behavior, it is an area that merits further investigation.

3.2.6.4 Sector-wise classification of statements into emotions

An examination of the pie chart in Figure 8 reveals that most of the points lie in the *Anger* sector (33%), which could be directed toward the corresponding criminal's own life or the justice system that deprived the criminals of their right to live. This suggests that they may have felt like victims and believed that injustice had been done to them. The sector of *Sadness* had the second-highest number of points (23%), which could be linked to their guilt over causing pain to their loved ones or the loved ones of the victim. The *Fear* sector accounted for 21% of all points, which is a generic emotion and could be due to the uncertainty associated with facing death. Surprisingly, the *Happiness* sector had 15% of criminals, which could be combined with 6% of points in the *Serenity* sector, resulting in a total of 21% of points. This is an unusual representation of emotions, particularly for someone about to face execution. The happiness element could be linked to the acceptance of their past and the hope for a better afterlife or for the future of their loved ones. Faith, in the garb of the afterlife, could be the driving force behind this representation of happiness and serenity.

3.2.7 Co-occurrence of emotions

In Figure 9, a matrix displaying the co-occurrence of various sectors of emotions in each statement is presented. The matrix suggests that no single emotion sector is dominating the entire plane. Even though a statement may dominantly belong to one of the eight sectors classified in Figure 8, it is typically a mixture of different sentences belonging to different sectors of emotions. Although the sector of *Anger* is the most dominant with 33% of total statements belonging to it, it was observed that *Gloomy* was the most commonly co-occurring emotion, even if only in one sentence of a statement.

3.2.8 Notion consistency in final statements

Each sentence in all the statements was analyzed and classified into four notions: *Guilt, Gratitude, Faith, and Affection.* Initially, these notions were identified manually and later verified through a computational model with a performance metric of 93.74%, which demonstrated consistent results and validated manual classification. The probability of the next possible notion based on the notion of the current sentence was determined and displayed in a matrix in Figure 11. The analysis revealed that if the current sentence reflects the notion of guilt, the next sentence most likely represents the notion of gratitude, followed by faith and affection. Similarly, if the current sentence reflects the notion of gratitude, the next sentence most likely represents the notion of affection, followed by gratitude and finally faith. Next, if the current sentence reflects the notion of affection, the next sentence most probably represents the notion of faith, followed by gratitude and guilt. Finally, if the current sentence reflects the notion of faith, the next sentence most likely represents the notion of guilt, followed by gratitude and affection. Additionally, paths were identified between all combinations of notions in sets of two, three, and four, along with the percentage of statements in which they appeared as portrayed in Figure 12. *Guilt* to *Gratitude* was the most frequently observed path between any two notions, appearing in 49.77% of all statements. In contrast, the path from *Faith* to *Affection* was the least observed among any two notions, appearing in only 11.4% of statements. Among paths of any three notions, the path from *Guilt* to *Faith* to *Gratitude* was the most observed, appearing in 13.02% of all final statements. On the other hand, the path from *Gratitude* to *Faith* to *Affection* was the least followed, appearing in only 2.79% of statements. Continuing the trend of paths among three notions, the addition of *Affection* to the end of the most observed path of three notions *(Guilt, Faith, and Gratitude)* resulted in the most observed path among four notions, appearing in 2.79% of all statements. There were many paths in the category of least observed among any order of the four notions, with all of them appearing in only 0.47% of the total statements.

Furthermore, the loops among all four notions were also observed. Out of 24 possible loops, only 19 were found in the data. Among them, 12 loops were found in only 0.23% of all the statements, while 5 loops were found in 0.47% of the final

statements. The loop from *gratitude* to *grief* to *faith* to *affection* and back to *gratitude* was found in 0.7% of final statements. However, the loop from *guilt* to *faith* to *gratitude* to *affection* and back to *guilt* was the most observed, found in 1.16% of final statements. This figure is exceptionally high when compared to the percentages of other loops. This loop is simply an extension of the most followed path of *guilt* to *faith* to *gratitude* to *affection* among all the paths made with four notions. This is a recurring result that, if studied further, could potentially lead to significant breakthroughs in enhancing our understanding of the human state of mind in the moments before death and criminal characteristics. This transition through different notions in the statements of death row inmates not only justifies the theories of narrative psychology (Murray et al., 2015), but further the transition from *Guilt*, toward positive notions like *Faith*, *Gratitude*, and *Affection*, also supports the self concept and identity theory (Alsaker and Kroger, 2020), suggesting an attempt from the end of inmates to reshape the definition of their life in a more positive light.

4 Conclusion

While analyzing the final statements of death row inmates in Texas provides some significant insights into human and criminal behavior moments before death, it is important to consider the following limitations of the study and the potential biases that may be present.

4.1 Limited generalizability

The study is only applicable to death row inmates in Texas and may not be representative of the larger population of individuals facing death. The sample may not be representative of all death row inmates, as those who choose to make a final statement may be different from those who do not. Country based and cultural bias could be in the results and further, it should be kept in mind that the final statements in consideration were collected over the time frame of more than 30 years. At the same time, the data of the final statements of death row inmates isn't publicly available in most of the cases, and collecting that data was out of the scope of our work. Also, the number of death row inmates is declining around the globe and Texas is having 3rd highest number of death row inmates among all the states in the USA.

4.2 Self-report bias

The final statements are self-reported and may not accurately reflect the individual's true thoughts and emotions, rather might reflect how the individual likes to represent themselves. Considering these to be the final statement of the individuals, many have been reported to prepare for it for some time, thus it might not be exactly what they had felt in the moment and others might also have helped in writing the statements.

4.3 Lack of control group

There is no comparison group to determine whether the final statements of death row inmates are different from those of individuals who are not facing imminent death. This study can be further used to build a basis for comparison of final statements across different states or countries. Conducting a comparative analysis of final statements made by death row inmates in different states or countries could reveal interesting differences in cultural or legal norms, or in the ways that people cope with the prospect of their own mortality. Since the current study is completely identified and the corresponding demographic information is ignored, it cannot correlate other factors, such as age, gender, race, or socioeconomic status, with the analysis outcomes. In future studies, interesting insights can be gained by such correlations. Furthermore, psychological profiles of death row inmates can be used along with the results of this study to gain a deeper understanding of the evolution of criminal behavior.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

Ethical review and approval was not required for the study of human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants or participants legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

VM: Conceptualization, Methodology, Visualization, Writing – original draft. US: Conceptualization, Methodology, Visualization, Writing – original draft. NA: Conceptualization, Methodology, Validation, Writing – review & editing. AP: Validation, Writing – review & editing. GS: Conceptualization, Writing – review & editing, Validation. SS: Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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