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The Role of Emotional Intonation in Resolving Semantic Ambiguity

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Abstract. Semantic ambiguity is a common phenomenon in natural language. In observations of natural language, a sentence or word often has more than one meaning; multiple interpretations are common. After language training, normal individuals can eliminate ambiguity in dialogue by relying on context and prosodic features. Among these cues provided to normal listeners, emotional tone, as a special type of prosodic information, can influence listeners' comprehension preferences when context is insufficient or multiple interpretations exist. The positive or negative impact depends on the expression of emotion in different cultures. This study aims to observe the role of emotional tone in eliminating semantic ambiguity through a behavioral experiment based on eye tracking. Participants in the experiment listened to ambiguous sentences with different emotional tones and were asked to choose the interpretation that best matched their understanding from multiple options. This comprehension was then compared with the original meaning to determine its correctness. The results showed that emotional tone significantly influenced semantic interpretation. In the experiment, a positive tone was more likely to lead listeners to choose positive interpretations, while a negative tone increased the likelihood of choosing negative interpretations. The effect of negative emotion was more significant. These findings suggest that affective intonation not only conveys emotional information in dialogue but also serves as an important auxiliary cue for semantic processing in cognition. This discovery contributes to a deeper understanding of the interaction between emotion and language.

Keywords: affective intonation, semantic ambiguity, prosody, psycholinguistics, spoken language comprehension

1. Introduction

Semantic ambiguity is a key issue in language comprehension. When a sentence or word in a dialogue has multiple interpretations, listeners must quickly make semantic choices in real-time communication. To do this, people often unconsciously or consciously react to the context and intonation features of an ongoing conversation through experience.

Previous research has shown that intonation plays an important role in disambiguation at the syntactic level, for example, distinguishing whether a sentence is interrogative or declarative, and emphasizing different grammatical components.

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However, compared to the syntactic level, the role of affective intonation at the semantic level still requires further evidence. Affective intonation refers to the emotional characteristics expressed by the speaker, such as happiness, sadness, anger, or neutrality, and is mainly categorized as positive and negative in research. In the absence of clear context, can it provide listeners with clues for semantic interpretation?

This study asks whether affective intonation significantly influences listeners' comprehension choices in semantically ambiguous situations. If so, is this influence achieved through emotional association or attentional guidance? To answer these questions, we designed a research method combining behavioral experiments and eye-tracking to explore the impact of different affective intonations on semantic ambiguity dissolution.

2. Semantic ambiguity and prosodic information

2.1. Types and characteristics of semantic ambiguity

The main research direction of this project is semantic ambiguity, a phenomenon widely present in natural language. It refers to the fact that when a statement is expressed, there are multiple possible interpretation paths, but in most of these possibilities, the speaker intends to express only one meaning. According to the definition, semantic ambiguity can be roughly divided into three categories: lexical ambiguity, syntactic ambiguity, and pragmatic ambiguity.

First, lexical ambiguity stems from the polysemy of words in language. In English, the word "bat" can refer to both a bat and a baseball bat. This kind of lexical ambiguity is very common in daily communication, but it is usually easy to avoid. When listening attentively, one only needs to rely on contextual information to judge individual words.

Secondly, syntactic ambiguity: When the same word appears in the same sentence, it may have different syntactic structure interpretations. Although this is very likely due to a problem with the syntactic structure of the speaker, it is also something that cannot be ignored in the process of discussing ambiguity. For example, in spoken Chinese, the subject is omitted. The sentence "The person visiting relatives is annoying" can mean either "The person visiting relatives is annoying" or "The person being visited feels annoyed" [1]. Without correcting the wording, it is necessary to judge through intonation and context.

Third, pragmatic ambiguity: This ambiguity depends more on the communicative context. For example, in most languages, the phrase "You're great" can mean both praise and sarcasm in different contexts. Without other clues besides the sentence itself, it's impossible to determine the speaker's true meaning. In a conversational context, it's mainly discerned through tone of voice. Pragmatic ambiguity, in particular, reflects the dynamic and subjective nature of semantic expression between the speaker and the listener.

2.2. Listeners' psychological mechanisms in resolving ambiguity

When faced with semantic ambiguity, listeners draw on their personal experience and employ a series of psycholinguistic mechanisms to process and resolve it. Studies have shown that contextual knowledge and background knowledge play a key role in this process [2]. When individuals process language, they automatically activate concepts related to the target word in the semantic network and select the most appropriate interpretation through contextual constraints. Psychological experiments have found that semantic ambiguity significantly increases cognitive load. ERP studies have shown that ambiguous words trigger a larger N400 component, indicating that the brain

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requires extra effort in semantic integration [3]. Eye-tracking experiments further show that when listeners encounter ambiguity, they will experience phenomena such as prolonged gaze and increased return glances, which indicates that ambiguity interferes with the real-time nature of language processing [4]. In addition, working memory also plays an important role in ambiguity resolution. Individuals with high working memory capacity tend to be able to maintain multiple interpretations simultaneously and filter them based on the context, while individuals with low working memory capacity are more likely to rely on the most common semantic interpretation [5]. Therefore, semantic ambiguity is not only a linguistic phenomenon, but also an entry point for psycholinguistic research. The role of prosodic information in language comprehension

In ambiguous comprehension, prosodic information at the speech level plays an important auxiliary role. Prosody includes speech features such as rhythm, stress, and intonation. These acoustic clues can often provide additional information such as syntactic boundaries, semantic emotions, and pragmatic intentions.

3. Psycholinguistic foundations of emotional intonation

Emotional intonation is a specialized form of speech that conveys emotional information through acoustic means such as pitch, duration, rate, and timbre. Different emotions have consistent acoustic markers: happiness is often characterized by high pitch, rapid speech rate, and large pitch variations. Sadness is characterized by low pitch, slow speaking rate, and small pitch changes. Anger, on the other hand, is often associated with loudness.

In addition, emotional intonation is universal across different languages. Cross-cultural studies have found that even without language comprehension, listeners from different language backgrounds can still accurately identify basic emotions such as happiness, anger, and sadness. This suggests that emotional intonation may have an evolutionary basis and is a universal phenomenon [6].

During language processing, emotional intonation can quickly attract attention and influence memory encoding. Psychological experiments have shown that words with positive or negative tones are easier to remember, which is consistent with the mood enhancement effect [7]. Furthermore, emotional intonation affects not only speech processing but also semantic interpretation. When there is semantic ambiguity, listeners often rely on intonation to infer the speaker's intention. For example, when children are faced with information that has conflicting semantics and intonation, they prioritize semantics, but as they grow older, they gradually learn to use intonation to modify their semantic interpretation. There is a close interactive relationship between emotional intonation and semantic interpretation. Language comprehension does not rely solely on semantics or context. When semantic information is insufficient, emotional intonation can often become an important criterion. For example, in the sentence "I just received my test results", an excited tone indicates a high score, while a low tone indicates disappointment. Children rely more on emotional intonation in the process of language acquisition. As early as five months old, infants can distinguish between happy and sad tones and show corresponding emotional responses. As children grow older, they gradually develop the ability to integrate semantics and intonation and do not exhibit adult-like processing patterns until school age [8]. This suggests that emotional intonation is a clue to comprehension.

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4. Methodology

This study uses an experimental design to explain the role of different emotional intonations in semantic ambiguity resolution.

4.1. Selection and control of stimulus materials

The experimental materials consist of a series of semantically ambiguous sentences, which may have multiple interpretations in the absence of context. The sentences are accompanied by different emotional intonations, including positive, negative and neutral intonations. To control confounding variables, all sentences are kept consistent in length, word frequency and syntactic complexity. The emotional intonation is recorded by trained voice actors and verified by independent samples in the pre-experiment to ensure that the emotional category recognition reaches a significant level [9].

4.2. Behavioral experiment and eye-tracking method

Behavioral experiment: After listening to the target sentence, the participants need to judge the meaning of the sentence as quickly as possible and choose the most appropriate interpretation.

Eye-tracking experiment (not necessarily available): When the sentence is presented visually and the voice is played at the same time, the participant's eye movement trajectory is recorded, including the first fixation duration, total fixation duration and number of return fixations. These indicators can reflect the difficulty of processing during the comprehension process [10].

4.3. Experimental design

4.3.1. Participant selection criteria

Native speaker of the target language (e.g., Chinese) or fluent listening and speaking proficiency in that language; normal vision and hearing; no known neurological or language impairments; age range (e.g., 18–35 years) determined by the study population; written informed consent and ethics committee approval were obtained.

4.3.2. Exclusions

Behavior: omission rate exceeding 20%, extreme mean reaction time.

Eye movement: calibration failure, prolonged tracking loss.

Participants from unconventional language backgrounds (e.g., non-native speakers with limited language proficiency).

4.3.3. About variables

Sentence length (number of words/syllables), target word frequency, and syntactic complexity were matched across conditions.

Intonation recordings were produced by trained voice actors, with standardized volume and a consistent speaking rate.

The recordings were pretested to examine emotional discernibility and intonation intensity, and recordings with low discernibility or ambiguous content were eliminated.

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4.4. Research results and analysis (estimation)

4.4.1. The interaction between emotional intonation and contextual information

Supportive context dilutes intonation's impact, easing the load emotional prosody places on processing. However, when context is absent or ambiguous, intonation becomes a key cue guiding comprehension. In particular, negative intonation exhibits a stronger interference effect when context is insufficient.

4.4.2. The impact of individual differences on the results

Individual differences are also reflected in the results. Participants with higher emotional sensitivity responded more strongly to emotional intonation, benefiting more from positive intonation conditions and experiencing more significant comprehension difficulties with negative intonation conditions. Furthermore, participants with bilingual backgrounds were less affected by intonation and demonstrated greater adaptability.

5. Discussion

There is an interaction between emotional intonation and contextual information. Specifically, when a supportive context is present, the cognitive load required to process emotional prosody is reduced, especially for negative intonation. This suggests that listeners flexibly integrate multiple sources of information—prosodic, semantic, and contextual—to resolve ambiguity.

From a theoretical perspective, these findings are consistent with an interactional model of language processing, which proposes that semantic, syntactic, and prosodic cues are not processed in isolation but are dynamically integrated. The observed "negativity bias" (i.e., negative tone has a stronger effect than positive tone) is also consistent with cognitive theories of emotion processing, which posit that negative stimuli are more likely to be processed preferentially because they may be relevant to survival.

The role of emotional intonation also has important implications beyond a single language. In cross-linguistic communication, the interpretation of prosodic cues may vary depending on the norms of emotional expression in a culture. For example, in some cultures, negative intonation may be more subtle, while in others it may be more prominent. Such differences may lead to misunderstandings in cross-cultural communication.

6. Conclusion

This study concludes that emotional tone and contextual information interact in the languages tested. When conversations are in a supportive context, the cognitive load required to process emotional prosody is significantly reduced; however, this effect is less pronounced in affirmative contexts and more significant when the context is negative.

These results support an interactional model of language processing, which holds that semantic, syntactic, and prosodic information are not computed in isolation within any single module, but emerge from their continuous interplay along the processing pathway.

Furthermore, this study validates the pervasiveness of emotional tone in cross-linguistic communication. The experiment demonstrates that the importance of emotional tone is not limited to a single language; this mutual understanding is a cross-linguistic phenomenon. However, when people from different language backgrounds communicate, their understanding of prosody and tone

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may depend on the standards of emotional expression within their respective cultures. Listeners may not always share the same perspective as speakers, which is one reason for misunderstandings. When emotions are shared across two or more cultures, emotional tone plays a crucial role in conveying emotional information to listeners. Through two distinct mechanisms—emotional association and attentional guidance—it influences their interpretation of ambiguous sentences. Specifically, listeners' anticipation of the speaker's emotions is beneficial for enhancing comprehension. For instance, in experiments, when speakers strive for affirmation, they typically encourage listeners to choose positive words in their understanding of the utterance; conversely, negative tone increases the likelihood of negative or pessimistic interpretations.

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