Amplifying Truth? Vocal Volume and Speakers' Self-Perceived Truthfulness

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Abstract

This study was the first to examine whether the volume of one's voice serves as an embodied cue for assessing information credibility. Eighty U.S. undergraduate students were randomly assigned to one of three conditions: loud, soft, or control. They read aloud in their assigned loudness condition while rating the truthfulness of trivia statements, followed by silently rating additional statements. The results revealed no significant effect of voice loudness on truthfulness ratings. When examining confidence levels reflected in the ratings, an interaction effect between reading status and loudness condition emerged. Participants who controlled their volume (either loud or soft) rated statements with higher confidence compared to when rating statements silently. These findings suggest that speakers do not associate their own voice loudness with the truthfulness of information.

Keywords: loudness; embodied cognition; truth judgment

Introduction

"Make oneself heard." "Speak up." "Action speaks louder than words." These idioms all imply a loud message may be taken more seriously. It is known that feelings play a significant role in forming judgments about truth (Brashier & Marsh, 2020). This research explored whether the loudness of information can influence the speakers' own perception of its truthfulness.

Listeners process not only the information itself but also its paralinguistic cues. The processing of nonverbal information seems to occur spontaneously and does not demand task involvement or cognitive capacity (Reinhard & Sporer, 2008). The processing of vocal cues is also reflected by brain responses (Jiang & Pell, 2015, 2016). Voice loudness has been used to extract much information such as emotion (Guyer et al., 2021; Kamiloğlu et al., 2020; Murray & Arnott, 1993). Across different languages, people consistently discriminate loudness levels and use them to distinguish different emotions (Bänziger et al., 2014). Loudness is also associated with listeners' perception of dominance or hierarchical rank of a speaker (Burgoon et al., 2021; Dunbar & Burgoon, 2005; Ko et al., 2015; see a review, Hall et al., 2005).

Most studies on voice loudness and truth judgments have focused on the listeners' perspective. Listeners are less likely to perceive loud voices as deceptive (Goupil et al., 2021) and tend to associate them with greater confidence (Scherer et al., 1973). Political speech research has consistently shown that loudness positively correlates with perceived credibility (Rodero et al., 2014) and charisma (Rosenberg & Hirschberg, 2009). Interestingly, participants rated that voice volume did not influence their assessments of credibility (Rodero et al., 2014), despite contrary evidence, suggesting a disconnect between perceived and actual vocal influence. Sex may modulate perception, with female listeners potentially being more sensitive to confidence levels reflected in statements compared to male listeners (Jiang & Pell, 2016). Notably, specific loudness measurements matter: loudness, but not its variation, was associated with perceptions of certainty and honesty (Goupil et al., 2021).

Studies from the speaker's perspective have been mainly conducted in persuasion studies. The association of voice loudness and truth judgments is extensively supported by evidence in persuasion studies (Ketrow, 1990). Speakers spontaneously raise their voice in an attempt to persuade, which is a successful strategy (Van Zant & Berger, 2020). For instance, debt collectors' louder voices were associated with shorter delinquent times (Huang et al., 2022). Louder phone interviewers had lower refusal rates, likely due to perceived positive personal characteristics (Oksenberg et al., 1986; Sharf & Lehman, 1984). When recorded counselors' statements were rated for persuasiveness, high-persuasive statements were found to be louder than low-persuasive ones (Packwood, 1974). Advertisement loudness was associated with different ratings of pleasantness and intelligibility (Chebat et al., 2007).

Beyond persuasion studies, research examining the relationship between voice loudness and truth judgments from the speaker's perspective is limited. The most relevant evidence comes from a study on eyewitness testimony for an emotional event, where accurate statements were produced louder than inaccurate statements (Gustafsson et al., 2023). In other words, speakers tended to raise their voices when perceiving the statements as accurate than not. Other related studies mainly demonstrate the link between voice loudness and speaker confidence. As information senders, individuals speak more loudly when expressing higher confidence ratings across various tasks, including word recognition (Goupil & Aucouturier, 2021), answering trivia questions (Kimble & Seidel, 1991), and reading text with different confidence levels (Scherer et al., 1973). Interestingly, when phrases signaling varying confidence levels were prefixed to sentences, speakers spontaneously increased their voice volume for high-confidence phrases even though the

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sentences were given to them rather than self-generated (Jiang & Pell, 2017). This suggests that the association between vocal loudness and confidence may be independent of the actual quality or truthfulness of the information. This spontaneous tendency to increase volume under confident conditions has been observed across different languages (Ji et al., 2022). Sex differences emerge again. The difference in acoustic characteristics may be more pronounced among male speakers than female speakers (Jiang & Pell, 2016).

The association between loudness and perceived speaker confidence is not limited to the perceptual level but extends to the explicit conceptual level. Speakers of different languages report that someone who is certain will speak with a louder volume (Goupil et al., 2021). Researchers also stated that voice intensity indicates high confidence (Cramer et al., 2009).

Studies from both the listener's and speaker's perspectives have shown that louder speech is associated with higher confidence. However, the underlying mechanisms remain unclear. Possible explanations include merely improved perceived speaker credibility or enhanced information quality. While studies from listeners' perspectives make differentiating these mechanisms challenging, examining from speakers' perspectives, where their own credibility can be held constant, may directly examine loudness's association with perceived information quality.

Bodily experiences shape cognitive processes (Barsalou, 2008). According to grounded cognition, the states of initial experiences are reenacted and integrated into knowledge representations of the initial experiences. The embodiment effect is supported by neural foundations of metacognitive ability (Fleming & Dolan, 2012) and is not simply a result of demand characteristics (Coles et al., 2023).

Grounded cognition suggests a potential reciprocal relationship between bodily expression of information quality and perceived information quality. Adopting confident but not doubtful postures enhances self-generated thought impact (Briñol et al., 2009). When accompanied by body movements typically associated with positive evaluations such as nodding, giving a thumbs up, and holding an up and expansive posture, stimuli being processed are evaluated more positively (Chandler & Schwarz, 2009; Tom et al., 1991; Van Cappellen et al., 2022; Wells & Petty, 1980). Conversely, when accompanied by body movements typically associated with negative evaluations, such as head-shaking, stimuli are evaluated more negatively (Tom et al., 1991; Wells & Petty, 1980).

When individuals reenact body movements associated with specific associations, their behavior tends to align with those associated meanings. For instance, posing postures associated with lower power leads participants to indicate a lower level of power (see Elkjær et al., 2022 for a review). Firm muscles, typically associated with exerting willpower, have been found to be associated with increased willpower (Hung & Labroo, 2011). Putting a hand on one's heart is commonly linked to honesty, effectively discouraging participants from cheating or telling a white lie (Parzuchowski & Wojciszke, 2014). As reviewed previously, voice volume control reflects subjective feelings of confidence. Therefore, it is possible that vocal control, similar to body movement, can also exert such an influence.

Studies have already shown the embodiment of oral muscle movement. Speaking at a lower pitch correlates with increased feelings of power and a higher level of abstract thinking (Stel et al., 2012). Words with vowels such as /o:/, which inhibit smiling during articulation, are more associated with negative valence compared to words with vowels such as /i:/, which involve muscle movements similar to smiling (Körner & Rummer, 2022; Rummer & Schweppe, 2019).

The hypothesis that loud verbal inputs are associated with increased perceived credibility of information by speakers has received support from previous studies examining mood-congruent voices (Flack, 2006; Siegman et al., 1990). In these studies, participants engaged in verbal tasks such as reading a word list (Flack, 2006) and speaking about personal experiences (Siegman et al., 1990) while following specific instructions regarding the loudness of their voices. They then rated their feelings. The researchers presumed that loudness would elicit feelings of anger, while softness would elicit feelings of sadness. Participants rated the congruent emotions higher after following the given instructions. Sex differences were observed again. In Siegman et al., (1990), male but not female participants rated anger much higher after speaking about neutral experiences in loud voices compared to soft or normal voices. If the loudness-linked emotion can be experienced in a consistent manner, then the loudness-linked confidence levels may also be experienced by the speakers.

Purpose of the Present Study

This study was preregistered (https://osf.io/x2a9j/). This study examined whether one's own voice volume serves as an internal cue for assessing information credibility, specifically, whether content read loudly appears more credible than content read softly. If the effect were to be found, we would also examine the potential moderators. The first moderator to consider would be the need for cognition (Cacioppo & Petty, 1982), the tendency to engage in and enjoy cognitive endeavors. Individuals with lower need for cognition tend to rely more on peripheral information when processing information (Cacioppo et al., 1996). Therefore, individuals with a lower need for cognition may exhibit a stronger association between loudness and information credibility.

The second potential moderator is the individuals' lay theory of the relationship between confidence and loudness. Several studies on the embodiment effect have suggested that the perceived meaning of body movements holds more significance than the movements themselves (Smith et al., 2013; Streicher & Estes, 2016; see a review, Briñol et al., 2017). Consequently, individuals who strongly believe in the correlation between confidence and loudness are more likely to display a heightened anticipated effect.

Method

Participants

The research used a mixed research design with three groups (loud, soft, and control) as the between-subject variable and two measurements (read-aloud and silent) as the within-subject variable. We determined the sample size by a priori power analysis using G*Power (Faul et al., 2007) with the power of .80, and the minimum effect size of $f = .19$ reported in an embodied cognition study on vocal characteristic of pitch (Stel et al., 2012). The minimum sample size obtained is 72. We recruited 80 students (71% women, 75% White American, $M_{age} = 20.74$, $SD_{age} = 4.49$) from a small liberal arts college in the United States in exchange for partial course credit. There were 25 in the soft condition, 28 in the control condition, and 27 in the loud condition.

Procedure

Adult participants were recruited for a "voice recording" study for extra points in psychology courses. After providing consent, participants were informed that the goal of the study was to have them read the materials aloud while their reading was recorded for use in a future study. They were provided with a list of 40 trivial statements to prepare for the upcoming recording.

The trivia statements were selected from the materials used by Lev-Ari and Keysar (2010), which originally included 45 statements. Word counts, syllable counts, and reading durations by Office Read Aloud were recorded for these statements, and 40 of them were chosen for this study. The 40 statements were divided into two groups, each consisting of half true and half false statements. The two groups were equivalent in their word count, syllable count, and reading durations. Within each group, the true and false statements were also matched in these measures.

Participants informed the experimenter when they were ready. They were asked to read a list of 20 trivia statements, one of the two versions. They were instructed to read clearly and at a good pace. Participants were shown how Office Read Aloud read one statement, which is originally from Lev-Ari and Keysar (2010).

There are three experimental conditions: loud, soft, and control. With two versions of the survey alternating the statements for the experiment and control statements, there are six possible groups. Participants were randomly assigned to one of the six groups. Participants in the loud condition were told to read as loudly as possible whereas those in the soft condition were told to read as quietly as possible ("as quietly as possible, just at a volume that ensures that your reading is accurately captured in the recording"). Participants in the control condition did not receive any instructions about the voice loudness. Participants practiced by reading another statement aloud and received corresponding feedback before their recording. The statement again was from Lev-Ari and Keysar (2010). Participants' readings were recorded on a laptop.

After reading each statement, participants rated the truthfulness of each statement from 1 (definitely false) to 7 (definitely true). Participants also had the option to check if they had previously known if a statement was true or false. If a statement was indicated to be previously known, it was excluded from the data analyses. After reading and rating 20 statements, participants answered three questions related to ego-depletion ("I had to exert an effort in the task of ratings," "The task of ratings made me feel tired," "I felt like I was fighting an urge while doing the task of ratings"; 1 = strongly disagree, 7 = strongly agree), modified from items previously used in Mok and De Cremer (2018), $\alpha = .67$.

Participants then rated the truthfulness of another 20 statements without reading them aloud, followed by the three ego-depletion questions, $\alpha = .74$. Average ratings for truthfulness and ego-depletion were calculated for those that have been read aloud or not, separately.

Next, participants completed the need for cognition scale (Cacioppo et al., 1984) and reported their age, sex, and ethnicity. To align with other measurements in the study and facilitate ease of completion, the scale was adapted from a 9-point format to a 7-point format (1 = extremely uncharacteristic of me, 7 = extremely characteristic of me). Average ratings for the need for cognition scale were calculated after reverse coding where necessary, $\alpha = .86$.

Participants were prompted to guess the purpose of the study. One participant from the control condition guessed that it involved reading aloud and truth judgment, but their data were retained for analysis.

Last, participants responded to a volume-theory question (1 = people speak louder to feel confident about the content of their message; 7 = people speak louder when they feel confident about the content of their message; Labroo et al., 2014). Participants were debriefed afterwards.

Results

Preliminary analyses examined but found no sex differences across variables. The durations of recordings did not vary across conditions, $F(4, 154) = 1.23$, $p = .30$.

Participants overall viewed volume as a consequence of confidence rather than its cause, $M = 5.62$, $SD = 1.78$, $t(77) = 8.04$, $p < .001$, $d = 1.29$. While reading aloud, participants' truth judgments for the statements did not significantly differ from 4, the midpoint of the scale, indicating a neutral stance, $M = 4.07$, $SD = 0.74$, $t(79) = 0.86$, $p = .39$, $d = 0.14$. In contrast, when judging silently, participants were more likely to perceive the statements as true, $M = 4.15$, $SD = 0.61$, $t(79) = 2.20$, $p = .03$, $d = 0.35$.

We ran a mixed-measures ANOVA with groups (loud, soft, and control) as the between-subject variable and measurements (read-aloud, silent) as the within-subject variable on truthfulness ratings. None of the main effects or interaction effect was statistically significant, Fs < 2.11, $p > .12$, $\eta_p^2 < .06$ (see Table 1).

Table 1: Means and standard deviations for truthfulness ratings by conditions.

Condition	Read-aloud Statements		Silent Statements	
	M	*SD*	*M*	*SD*
Soft	4.04	0.76	3.99	0.36
Control	3.99	0.72	4.03	0.77
Loud	4.19	0.76	4.41	0.52

We calculated the truthfulness rating differences between read-aloud and silent statements, with positive scores indicating higher ratings for the read-aloud condition. We performed a moderation analysis with truthfulness rating differences as the outcome variable, experiment condition as the predictor (soft = 0, control = 1, loud = 2) and need for cognition as the moderator. The overall model was not statistically significant, F (3, 76) = 1.21, p = .31, R^2 = .05. A moderation analysis with volume-theory as the moderator also yielded a non-significant result, F (3, 74) = 1.76, p = .16, R^2 = .07.

We calculated confidence scores as the absolute differences from the midpoint of 4, with higher scores indicating greater confidence in the rating, regardless of truth judgment. We conducted another mixed-measures ANOVA on these confidence ratings. While the interaction effect between reading status and condition was statistically significant, F (2, 77) = 4.43, p = .02, η_p^2 = .10, the main effects of reading status, F (1, 77) = 0.80, p = .37, η_p^2 = .01, and condition, F (2, 77) = 0.23, p = .79, η_p^2 = .006 were not. Bonferroni pairwise comparisons, however, found no significant group differences. The graph suggested a similar pattern across the two experimental conditions (Figure 1). Consequently, we performed a post-hoc analysis by combining the two experimental groups and rerunning the mixed-measures ANOVA with group (experimental vs. control) as the between-subject variable. The interaction effect between reading status and condition remained statistically significant, F (1, 78) = 8.82, p = .002, η_p^2 = .10, with main effects remaining non-significant, Fs < .47, ps < .50. Bonferroni pairwise comparisons revealed that participants in the control condition demonstrated no change in confidence between read-aloud (M = 1.49, SD = 0.40) and silent evaluations (M = 1.69, SD = 0.37), p = .06. In contrast, participants in the experimental conditions responded more confidently when evaluating statements read aloud (M = 1.54, SD = 0.37) compared to silent evaluations (M = 1.43, SD = 0.39), M_D = 0.11, p = .02, 95% CI = [0.02, 0.19].

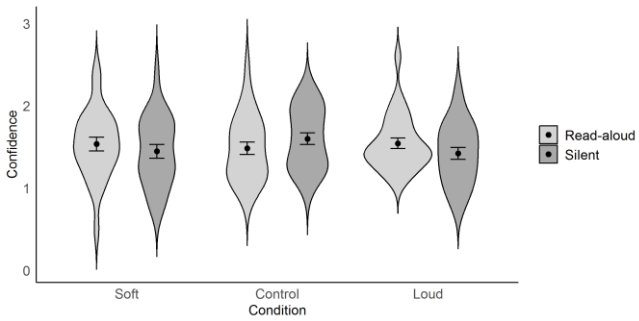

Figure 1: Confidence (absolute difference between truthfulness ratings and 4) by reading status and conditions. (Error bars show standard errors.)

The mixed-ANOVA for ego-depletion showed participants reported lower ego-depletion for silent statements (M = 2.13, SD = 1.17) than read-aloud statements (M = 2.76, SD = 1.28), F (1, 77) = 29.03, p < .001, η_p^2 = .27. The interaction between condition and reading status was statistically significant, F (2, 77) = 3.70, p = .03, η_p^2 = .09. Bonferroni comparisons revealed reading-status differences in the soft, M_D = 0.48, p = .03, and loud condition, M_D = 1.07, p < .001, but not in the control condition, M_D = 0.35, p = .09. While ego-depletion ratings did not correlate with truthfulness ratings, rs < .05, ps > .70, they showed a correlation with confidence scores during read-aloud evaluations, r (78) = .25, p = .02, but not during silent evaluations, r (78) = .20, p = .07.

Discussion

The study examined whether voice volume affects speakers' truth judgments of trivia statements and found no significant impact. Interestingly, confidence levels reflected in their truth judgments varied with the interaction between reading status and volume conditions. Participants who had to manipulate their voice volume were more confident in their evaluations while reading aloud compared to silent evaluation, a pattern not observed in the control group.

Most previous studies examining the relationship between voice volume and truth judgments of listeners have not distinguished whether the association arises from perceived enhanced speaker credibility or perceived improvement in information quality. This study addressed this gap by asking speakers to make truth judgments in a context without a communication target. This design aimed to exclude natural expressions typically present during communication and deliberately avoided socially induced persuasion attempts. Although previous research has found that speakers tend to speak louder to convey confidence, even without a communication target (Goupil & Aucouturier, 2021; Jiang & Pell, 2017; Kimble & Seidel, 1991), the findings of this study suggest that speakers' truth judgments of the information they convey are not solely influenced by volume. Instead, the positive association between voice intensity and perceived credibility appears to be driven by enhanced perceived speaker credibility rather than the information quality itself. This interpretation aligns with participants' naïve theory that louder volume reflects greater confidence rather than causing

confidence. Consistent with previous research (Goupil et al., 2021), voice intensity acts as a sign rather than a signal. Variations in intensity alone do not communicate information quality. Individuals do not have perceptual sensitivity to voice intensity. The effects of voice intensity are shaped by contextualized inferences. Building on the current findings, future research could unpack the components of perceived speaker credibility associated with voice intensity into perceived speaker competence and perceived speaker confidence (Goupil & Aucouturier, 2021).

Our study contributes to the growing body of research on embodied cognition by presenting a null finding on the association between voice loudness and perceived information credibility. While participants generally associated louder voices with greater confidence, suggesting a non-arbitrary association between bodily states and concepts, our results challenge simplistic assumptions about vocal volume influencing information perception. This finding is particularly notable given the potential experimental demand effects in a within-subject design and the clear meaning associated with voice intensity, which might have been expected to yield positive results. Voice intensity manipulations have been shown to affect both subjective emotion ratings and objective cardiovascular responses (Siegman et al., 1990). Additionally, other vocal characteristics, such as pitch, have been found to influence speakers in ways consistent with their associated meanings (Stel et al., 2012). Taken together, these findings highlight the need for further research in this area.

Truth judgments did not differ significantly by reading status; however, participants were more likely to remain neutral when reading aloud and more likely to judge statements as true when evaluating silently. This discrepancy may be attributed to differences in processing fluency. Silent evaluation may facilitate uninterrupted processing, potentially enhancing fluency and leading to higher truthfulness ratings (Oppenheimer, 2008). However, since fluency ratings were not measured in the current study, this explanation remains speculative.

The findings on confidence levels are intriguing. Confidence in truth judgments was not influenced by reading itself but was instead affected by volume control during reading, which enhanced confidence compared to silent reading. This relationship was further supported by a positive correlation between ego-depletion ratings and confidence scores during reading. Notably, the type of control in this study was not cognitively demanding, as evidenced by the overall low ego-depletion ratings. For this low-demanding task, the increased engagement by volume control may have led to higher confidence levels, illustrating the effort heuristic in truth judgments (Kruger et al., 2004). Meanwhile, the lack of an association between volume condition and confidence aligns with participants' naïve theory, where most believe that higher volume reflects greater confidence rather than causes it. The differing results between truth judgments and confidence in truth judgments are compatible with the distinction between cognition (i.e., accuracy) and metacognition (i.e., confidence; Goupil & Aucouturier, 2021).

This initial exploratory study has several limitations. First, while we examined potential sex differences and found none in the variables of interest, the sample size and distribution were not ideal for this analysis, as sex comparison was not a primary focus. Future studies specifically designed to examine sex differences are needed. Second, the study compared ratings across all statements, but segmental analyses of individual statements might yield different results (Ji et al., 2022). Third, we did not collect detailed information regarding participants' language background or history of neuropsychological disorders, with college student status as the only inclusion criterion. Future research would benefit from more comprehensive demographic screening, including assessments of language background and neuropsychological history, to better account for these variables and improve the generalizability of the findings. Fourth, the confidence indicators used were not stand-alone ratings but were extracted from participants' truth judgments. Future studies are encouraged to incorporate a separate measure of confidence rating to determine whether the current findings can be replicated. Last but not least, we attempted to obtain objective measurements of loudness. However, our recordings for the practice and experimental conditions were captured separately. According to Weenink (personal communication, December 22, 2024), the author of Praat, comparing intensities between different recordings has limited validity as recording circumstances such as microphone distance may vary. All original recordings are available on the project registration site for researchers interested in additional data extraction.

This study, the first to examine the relationship between speakers' volume and their own truth judgments, found no significant effects. As the saying goes, "Don't raise your voice. Improve your argument." It is hoped that these results will provide a foundation for future research in this area.

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