

#Irony or #Sarcasm— A Quantitative and Qualitative Study Based on Twitter

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Abstract

Current study is with the aim to identify similarities and distinctions between irony and sarcasm by adopting quantitative sentiment analysis as well as qualitative content analysis. The result of quantitative sentiment analysis shows that sarcastic tweets are used with more positive tweets than ironic tweets. The result of content analysis corresponds to the result of quantitative sentiment analysis in identifying the aggressiveness of sarcasm. On the other hand, from content analysis it shows that irony owns two senses. The first sense of irony is equal to aggressive sarcasm with speaker awareness. Thus, tweets of first sense of irony may attack a specific target, and the speaker may tag his/her tweet irony because the tweet itself is ironic. These tweets though tagged as irony are in fact sarcastic tweets. Different from this, the tweets of second sense of irony is tagged to classify an event to be ironic. However, from the distribution in sentiment analysis and examples in content analysis, irony seems to be more broadly used in its second sense.

1 Introduction

Philosophers and rhetoricians have been interested in irony and sarcasm for over 2500 years (Katz, 2000). In recent years, irony and sarcasm have been popular issues discussed qualitatively and quantitatively. Being a special way of language creativity, irony and sarcasm provide the opportunity to explore the interaction between cognition and language. Many frameworks have been proposed to illustrate the mechanisms underlying, such as Echoic Mention (Sperber and Wilson, 1981, 1986), Echoic

Reminder (Kreuz and Glucksberg, 1989), Allusional Pretense (Kumon-Nakamura et al., 1995), Pretense (Clark and Gerrig, 1984), Standard Pragmatic Model (Grice, 1975; Searle, 1978), Traditional Oppositional Model reviewed by Clift (1999), and Framing and Footing (Clift, 1999). Empirical psycholinguistic studies are also conducted to understand what should be recognized as irony or sarcasm from hearer angle. Computational linguistics have devoted in related studies in order to develop refined machine program in detecting human's real intention that is coated by used words.

Though many insightful works have been done, current study is still with the intention to further explore this issue. The quantitative sentiment analysis and qualitative content analysis are adopted in probing the similarities and distinctions between irony and sarcasm. Current study provides another angle to understand irony and sarcasm by adopting both qualitative and quantitative methodology in exploring this issue from speakers' performance in a different genre, internet language.

2 Literature Review

Irony is a term used to describe unscrupulous trickery in its Greek term *eironeia*. Sarcasm, on the other hand, means to speak bitterly, and to tear flesh like dogs in its Greek word origin *sarazein*. (Katz, 2000). The two seem to be slightly different in their meanings from word origin; however, with the progress of language using, how these two terms reflect different cognition and language creativity as well as how language is achieved to this creativity is worth of further discussion. In this section, section 2.1 and section 2.2 would separately introduce previous qualitatively and quantitatively studies. Section

2.3 would illustrate the research question in current study.

2.1 Previous Qualitative Studies on Irony or Sarcasm

There are many frameworks in accounting the mechanism of ironic effects. The review from Clift (1999) on the Traditional Oppositional Model (TOM) has critically pointed out the advantage of TOM locates at its illustration in the divergence between a speaker's words, and what he/she might mean by his/her words. However, this two-stage mechanism is criticized for ignoring the fact that two aspects of meaning must be perceived simultaneously to make an utterance as irony. Correspondingly, the Echoic / Interpretation model (Sperber and Wilson, 1981, 1986) is also criticized because the model claims that listeners process only what the ironic meaning, not the literal meaning the speaker said. Another echoic account is the Echoic Reminder (Kreuz and Glucksberg, 1989; Colston, 1997). In this account rather than directly mentioning another person's comments, a speaker can mention generally accepted beliefs about a situation, like a social norm, to remind the addressee of those beliefs when they have not showed up in the ongoing situation. On the other hand, Kumon-Nakamura et al. (1995) has proposed that irony is achieved by directly mentioning part of the expected situation that actually has occurred, when the remaining part of the expected situation has been violated. Colston (2000) has evaluated previous accounts and partially agreed that the two conditions for verbal irony comprehension are the violation on expectation, and the pragmatically insincere, the counterfactual, insincere or contrary relationship between what is uttered and what is ironically intended. This pragmatically insincere also echoes to the divergence of speaker intention and utterance form proposed by TOM. Though Colston has proposed counter examples in pointing the limitations of these two mechanisms' accountability, the examples proposed are still worth more discussion because they do not take the real conversation context, and the speaker's real intentions into consideration.

The results from reviewed previous qualitative content analysis are based on the analytic induction from observations. Though the proposed frameworks, Echoic Mention (Sperber and Wilson, 1981, 1986), Echoic Reminder (Kreuz and Glucksberg, 1989), Allusional

Pretense (Kumon-Nakamura et al., 1995), Pretense (Clark and Gerrig, 1984), Standard Pragmatic Model (Grice, 1975; Searle, 1978), Traditional Oppositional Model reviewed by Clift (1999), and Framing and Footing (Clift, 1999), all reflect the mechanisms that achieve ironic effects, they are limited in several ways. First, what they mainly concentrate on is irony. There is less illustration on the subtle distinct between irony and sarcasm. Second, each of the account is limited in the type(s) of irony that they can account. Third, the focus is mainly on how the interaction in communication reaches the effect of irony, but how the hearers perceive or process irony and sarcasm, or how the speakers deliver ironic or sarcastic messages need to further explore. Fourth, though Colston (2000) has not directly identified this fact, but from the comparison chart Colston has made, it shows that each framework can just illustrate certain type of irony, so instead of focusing on discussion frameworks, it would be more inspiring to explore the mechanisms operated in these two types of linguistic devices first.

Though rarely studies have been done in understanding the distinctive features between irony and sarcasm, the insightful observation from the footnotes of Clift (1999) indicates that speaker intention plays an important role; however, from the discussion in her footnotes, the two concepts seems to be overlapped because though sarcasm is defined as the hostile false words the speaker is aware of when uttering out, irony could be the false words the speaker may be aware of, or may be not aware of. Clift has claimed that sarcasm is one type of irony that is aggressive. The overlapped area, speaker awareness, implied from Clift's footnote seems to explain why previous studies reviewed by Clift (1999) tend to take the hostility of sarcasm as the attribute of irony. To briefly sum up, from Clift's point it seems that irony has two senses: in one sense it is an umbrella term that covers sarcasm. In another sense it is the linguistics creative device featured with unawareness and no aggressiveness in speaker intention. Whether the speaker is aware of or not and whether the utterance involves aggressive emotion or not should be further examined from speaker angle.

2.2 Previous Quantitative Studies on Irony or Sarcasm

Quantitative Studies in its controllable designs provide another point of view to understand the issue of irony and sarcasm. The rich quantitative

experimental investigations provide chances to control complicated linguistic variables in order to precisely perceive more straightforward relationship between the factors underlying the operation of irony and sarcasm. The quantitative studies can be discussed from two directions, psycholinguistic studies and computational linguistics.

In psycholinguistic studies, the designed materials or neurological equipment are used to measure the hypothesis formed on irony or on sarcasm (Gibbs, 1986; Bryant and Tree, 2002; McDonald, 2002; Bowes and Katz 2011). For example, what Clift (1999) has proposed as simultaneous processing on both literal and non-literal meanings in ironic statement has gained support from experimental studies (Schwoebel, Dews, Winner and Srinivas 2000). Besides, hostility as the feature to distinguish sarcasm from irony is testified in study conducted from Lee and Katz (1998). However, the pretense theory of verbal irony has not been supported much in some experimental designs (Gibbs and O'Brien, 1991).

In computational linguistics (Burfoot and Baldwin, 2009; González-Ibáñez et al., 2011; Reyes et al., 2013), huge data processing on Internet language provides the opportunity to retrieve the features in irony and sarcasm directly as well as to practically apply the results in machine learning. The motivation to study irony and sarcasm is often originated from the interest in opinion mining in product reviews in order to understand the evaluation from users. Though multimodal approach has been adopted, the popular methodology that has been widely used is sentiment analysis to detect the positive and negative emotion words used to understand what the messages conveyed is positive or negative. The investigation on irony and sarcasm has been richly discussed because as Bowes and Katz (2011) stated, "When an individual is sarcastic or ironic, he or she is expressing a sentiment (often superficially positive) but intending the opposite." This divergence in ironic and sarcastic utterance would cause difficulty in machine opinion detection.

However, the psycholinguistic studies focus more on retrieving hearers' comprehension to ironic and sarcastic statement because the participants are the recipients of the presented designed materials. Second, the materials manipulated do not include all types of irony and sarcasm. For example, the materials Lee and Katz (1998) designed are descriptions on events

with direct echoic remark to previous statement, though the form of irony and sarcasm is clear; however, the application of the results may only be limited to this form of irony and sarcasm. Kreuz (2000) has pointed out that psycholinguistic researchers focus more on "top-down" strategy in studying irony by manipulating key phrases in materials, instead of studying verbal irony "in the wild." Thus, complementary studies are needed to form the whole picture and to include other variety of the phenomenon. On the other hand, in computational linguistics irony and sarcasm are lack of quantitative distinction, but are viewed as the same in data processing (Elena 2012), which may with the danger that the true intention of the speakers on their opinions may be wrongly captured because psychological studies (Lee and Katz 1998) and qualitative study (Clift 1999) have discovered that sarcasm is the real aggressive one, but irony is not necessarily meant to attack.

2.3 Research Question

Given the fact that reviewed qualitative studies focus more on the interaction in communication, the reviewed psycholinguistic studies pay more attention on hearers' understanding to designed materials, and the reviewed computational linguistic studies do not distinguish irony and sarcasm, current studies would like to probe this issue from speaker angle in wild data from both qualitative and quantitative directions. The purpose of current study and the reason to take Twitter as the research target are illustrated in following discussion.

The Purpose is To Explore Features of Irony and Sarcasm: Current study is going to explore the features of irony and sarcasm from four questions, which are based on the claims and results from Clift (1999) and Lee and Katz (1998). The approaches adopted to answer these questions are content analysis and sentiment analysis on retrieved data. The four questions to be solved in current study are: (1) Is sarcasm more aggressive than irony? (2) Is there a specific target attacked in sarcasm, but not in irony? (3) Is the tweeter aware of his/her sarcastic or ironic tweets? (4) Are there any overlapped features between sarcasm and irony? The first question is going to be evaluated by sentiment analysis, and the later three questions are going to be evaluated by content analysis.

The first question is that Clift as well as Lee and Katz have pointed out that sarcasm owns aggressiveness, but irony does not. Based on the

basic idea pointed by Bowes and Katz (2011), "When an individual is sarcastic or ironic, he or she is expressing a sentiment (often superficially positive) but intending the opposite," the formal sentiment characteristic of sarcasm and irony is going to be explored in current study. To put the hypothesis in more detailed, given the fact that sarcasm is being identified as more aggressive than irony, the sentiment score in it should be more positive.

The second question is based on Lee and Katz (1998). Their study is conducted by asking participants to judge the degree of goodness of the examples to be ironic or sarcastic. The results have shown that sarcasm is with a specific target to attack, but irony is not. Given the fact that the result comes from audience's judgment, it is with interest to understand this issue from the speaker's angle, the tweeter.

The third question is based on Clift (1999) who claims that in irony the speaker may or may not be aware of false words he/she uttered, but the speaker is always aware of his/her own sarcastic utterance. The awareness of speaker can be identified by analyzing the contents of the tweets tagged with irony or sarcasm. If a speaker is aware of his/her false words, then the tag should be used in order to identify his/her own utterance stated in the tagged tweets is ironic or sarcastic because to tag a thing is to be aware of its quality; however, if the tweeter is unaware of his/her false words, then what is being tagged should not be his/her own utterance, but at this moment the tweeter is at the audience's angle to evaluate a thing as being ironic or sarcastic. This is what Clift (1999) has pointed as "To be ironic, a speaker need not be aware that his words are false" it is sufficient that his interlocutors or his audience be aware of this, "thus the content of the tagged tweets should be the description on an event because the tag is just the revelation of the judgment from the tweeter. Namely, the speaker's intention revealed in the tag is his/her attitude to the event he/she perceives when he/she is the audience.

The fourth question is that Clift (1999) thinks sarcasm is one type of irony. The speaker may be or may be not aware of ironic utterance, but the/she must be aware of his/her sarcastic utterance. Thus, there should be overlapped feature between sarcasm and irony based on the speaker awareness. However, "aggressiveness" has been pointed out from Clift as well as Lee and Katz to be the feature distinguishes sarcasm from irony. Hence, it should be reasonable to

hypothesize that irony should have two senses. In one sense, the speaker is aware of what he/she says is opposite to what is intended to mean. The second sense is to be distinct from sarcasm in being not aggressive and without awareness.

The Reason to Take Twitter as the study target: Current study is going to explore the characteristics of sarcasm and irony from speaker angle by adopting quantitatively computational sentiment analysis and qualitatively content analysis. The data used in current study is collected from social network Twitter because it provides the function of #hashtag, which allows the users to classify their tweets at their will by using the sign # plus the label name they like. Hence, with collecting the tweets labeled as #sarcasm or #irony we can anchor the speaker's intention. The tagging is a kind of crowdsourcing (Elena, 2012). The crowdsourcing is similar to the psycholinguistic studies that ask participants to judge how good the example is to be ironic/sarcastic as in the study conducted by Lee and Katz (1998), but it is different from previous studies in that the judges are not the hearers, but the speakers themselves. Language speakers may not be able to precisely define what irony and what sarcasm is; however, the labels should be reliable to reflect the nature of irony and sarcasm from speaker angle because the labels used are the most natural language performance from language users. Besides, the collected data are not transcription from oral data that needs auditory paralinguistic cues, but the original written messages employing visual cues, so the strategies adopted in expressing the speaker's true intention as well as in achieving ironic or sarcastic effects can be more clearly perceived and understood in current study.

3 Quantitatively Sentiment Analysis

This section would be divided into two parts: the adopted methodology as well as the discussion on the retrieved result.

3.1 Method

The sentiment analysis in current study adopts Breen's approach (Miner et al. 2011) with the opinion lexicon that contains 2,006 positive words and 4,783 negative words proposed from Hu and Liu (2004). Examples of positive words are "revitalize" or "whoooo" etc. Examples of negative words are "zombie", "blab", or "fuck" etc. The amount of positive words deducts the amount of negative words in a single tweet would be the sentiment score of the

tweet. Based on the sentiment score current study classifies the tweets into positive (sentiment score > 0), negative (sentiment score < 0), or neutral tweet (sentiment score = 0). When counting the score, the labels #irony and #sarcasm would be removed to avoid influencing the scoring results. 500 #irony tweets and 500 #sarcasm tweets have been randomly sampled for current study.

From previous theoretical discussion, it implies that sarcastic statements are more aggressive than ironic ones. Though Clift (1999) takes sarcasm as one type of irony, empirical psycholinguistic study from Lee and Katz (1998) shows that hearers perceive aggressiveness as the feature that distinguishes sarcasm from irony. Thus, it is with interest to understand how speakers use emotion words in these two types of language creativity. The mechanism operated in sarcasm and irony involves pragmatic insincerity, the divergence between what the speakers intend to mean and how the expression the speaker presents, so the tweet that with more aggressive intention should be sugar coated with more positive emotion words. It is with interest that in speaker performance whether the type of the tweet (sarcastic or ironic tweet) would affect the sentiment score of the tweet. The mean in group irony is -0.176, and the mean in group sarcasm is 0.514.

The alternative hypothesis specifies that the type of the tweet (ironic tweet or sarcastic tweet) affects the sentiment score of the tweet. The sample mean difference of -0.338 is due to random sampling from populations where $\mu_1 \neq \mu_2$. The null hypothesis states that the type of the tweet (ironic tweet or sarcastic tweet) is not related to the sentiment score of the tweet. The sample mean difference of -0.338 is due to random sampling from populations where $\mu_1 = \mu_2$. The conclusion would be made by using $\alpha = 0.05$ tail.

3.2 Results and Discussion

The two samples are independently retrieved, so the independent t-test should be adopted. The result of t test indicates that the null hypothesis is rejected [$t = -10.68, p < 0.01$]. However, even though the sampling size is large, the departure from the normality is too significant as shown in Fig.1. The densities of irony and sarcasm both are not symmetrical distribution. Thus, the nonparametric test, the Wilcoxon test is used when there is serious violation on normality assumption. The result of Wilcoxon test indicates that the null hypothesis is rejected [$W = 78916, p$

< 0.01], so we can conclude that the type of the tweet (ironic tweet or sarcastic tweet) affects the sentiment score of the tweet.

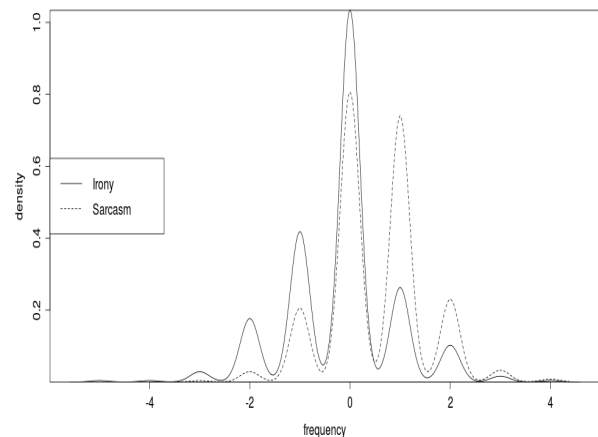


Fig. 1. Estimated Probability Density of Ironic and Sarcastic tweets

On the other hand, from Fig.1 it shows that the distribution patterns of the two linguistic devices are different. In Fig.2 it further illustrates that sarcastic tweets use more positive tweets, but ironic tweets use more neutral tweets. There is a distinct in these two types of tweets.

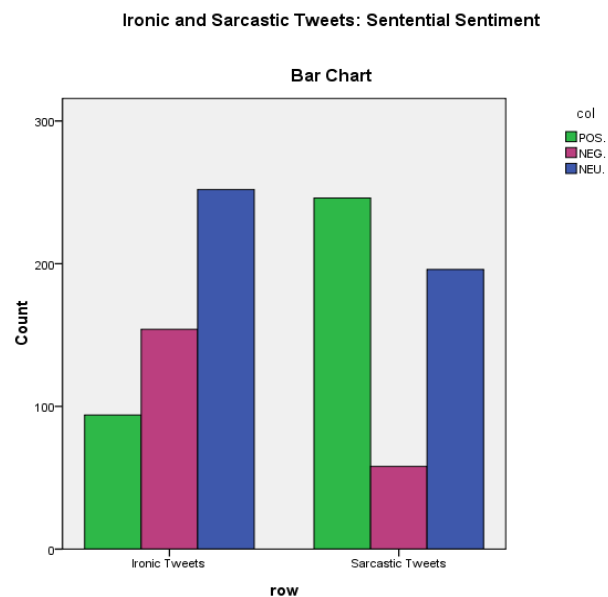


Fig. 2. Frequency of Positive, Negative, and Neutral Tweets in Ironic and Sarcastic Tweets

Hence, the result from current study manifests two important points. First, irony and sarcasm are different in their emotion express from speaker's angle. The speakers tend to use more positive tweets to convey sarcasm, but more neutral tweets to convey irony. Second, based on the underlying mechanism of sarcasm and irony,

there is a divergence between what the speaker said and what he/she intended to mean, thus the positive words used in tweets seems to represent the aggressive intention. It has shown that sarcasm is more aggressive than irony from speakers' natural language performance. This result corresponds to the study on hearers' comprehension conducted by Lee and Katz (1998).

4 Qualitatively Content Analysis

The discussion in current study would be divided into three sections to separately answer following questions: (1) Is there a specific target attacked in sarcasm, but not in irony? (2) Is the tweeter aware of his/her sarcastic or ironic tweets? (3) Are there any overlapped features between sarcasm and irony?

4.1 Is there a specific target attacked in sarcasm, but not in irony?

From the listed examples (1-f) to (1-j), it shows that the target of utterance are not limited to others, but also the speaker himself/herself in sarcastic tweets. On the other hand, in ironic tweets though the attack on specific target is rarely few, it does exist. For example, the "Our prof" in (1-a) is a specific target to be talked about in the tweet tagged as irony. This fact seems to be different from the result of Lee and Katz (1998). With or without a specific target could not be powerful enough to distinguish irony from sarcasm. To be more specifically, sarcastic tweets do have a specific target, but ironic tweets may also have a specific target to attack.

(1-a) RT @matthewyabs: Our prof in CRITHIN has the initials MAD.... #irony

(1-b) The only man who can save Max Cliffords public relations is.....Max Clifford #irony

(1-c) "@JustTheJay: A slut calling other's 'flirt '. #irony"

(1-d) @SillyLiberals @SouthernCharm @pari123awaaz u do realise US made these extremist, through its foreign policy and amp; created your "enemies" #Irony

(1-e) Worrying about weight gain while happily eating 5 slices of pizza and a doughnut. #irony food is my love.

(1-f) This play is amazingly good. #sarcasm

(1-g) i really have fantasstic friends.. #sarcasm

(1-h) Boyfriend of the year award. #sarcasm

(1-i) you always find a way to ruin my night! #thankyou #sarcasm

(1-j) I ordered 6 new pairs of shoes...this saving money thing is going pretty good for me #Sarcasm

(1-k)Oh! there's water coming out of the smoke alarm. :) cool! #sarcasm #irony

4.2 Is the tweeter aware of his/her sarcastic or ironic tweets?

From tweets (1-f) to (1-j), it can be observed that the tagged utterances are the words from the speakers rather than the description on an event. As example (1-f), though the tweet says "the play is amazingly good," the tag "#sarcasm" indicates what the speaker really intend to mean is the opposite. The sarcastic effect is built based on what is said by the tweeter, and the speaker is aware of what he/she has said. On the other hand, the contents of ironic tweets are more about a general event, such as (1-a) to (1-e). For example, in (1-d) the ironic effect locates in the nature of the contrast between "foreign policy" and "create enemies." Hence, it shows that ironic effect is less built by the tweeters' own words in tweets, but the event the tweeters point out.

However, there is case that the tweeter is aware of his/her words to be ironic. Example (1-e) omits the subject, so the whole utterance is more like a narration of an event. However, the "food is my love." with the put of the period inside seems to be aimed to complete the whole utterance. The "my" does indicate the subjectivity of the utterance. Thus, the tweet is not to objectively describe an event. The speaker is aware of what his/her has tweeted is ironic. This shows that ironic tweets can contain the tweets that are with speaker's awareness. Namely, the speaker could be aware of his/her own words as an irony. This result evidences the hypothesis of Clift (1999) that irony can be aware or not be aware by the speaker.

4.3 Are there any overlapped features Between sarcasm and irony?

In example (1-k), the speaker tags a tweet simultaneously as irony and sarcasm. This coexistence of these two linguistic devices as the tag marker to a single tweet shows that sarcasm

and irony could be overlapped. Though "Oh! there's water coming out of the smoke alarm." seems to be a general description to this event, the emoticon ";) " and the comment "cool!" are subjective. The whole content, the descriptive words and the subjective comments should be viewed as a whole utterance that is to express subjectively that the speaker does not really think the coming out of water from the smoke alarm is cool. This subjective expression contributes to being tagged as both sarcasm and irony. It should not be viewed separately that the descriptive words are the reason to be tagged as irony, and the subjective comment is the reason to be tagged as sarcasm. This is because if there is a correspondence between the order of content and the order of tag, and the order of the tags reflects the progress of the speaker's cognition, then what corresponds to sarcasm should be the subjective comments, ";) cool!" and what corresponds to the irony should be the descriptive words, "Oh! there's water coming out of the smoke alarm." However, there is not such a case. In this case, the speaker seems to be hard to decide whether it is an irony or sarcasm, so he/she tagged them both, which indicates that these two terms are not distinguished in their functions in this example.

Evaluating this case with the cases illustrated in 4.2, it shows that the content of sarcastic tweets are built on what the speaker said, but ironic tweets can be general description, or the speaker's own words. Hence, it is more appropriate to propose that irony has two senses. The first sense is that it is equal to the sarcasm in being aggressive and with self-awareness. This is different from the hypothesis made by Clift (1999) that sarcasm is a type of irony. There is a single tweet tagged simultaneously with irony and sarcasm in, it does not show that irony is the hypernym of sarcasm, but implies the interchangeability between the two. The second sense is the exclusive one that specifies the utterance about ironic events, so it is nonaggressive and without speaker awareness.

5 General Conclusion

The quantitative sentiment analysis and qualitative content are used complementarily in current study to probe distinctions and similarities between irony and sarcasm.

The quantitative sentiment score has illustrated that sarcastic tweets are more positive, but ironic

tweets are more neutral. This echoes to the claim that sarcasm is more aggressive because being more aggressive in emotion should be sugar coated with more positive emotion words. This result also corresponds to the finding in content analysis of sarcastic tweets and ironic tweets. Most of the content of the tweets tagged #sarcasm are subjective utterance from the speaker, but to tweets tagged with #irony, the content is more about the description of an event. Thus, the tag #irony is more used by the users to classify an event as irony. At this moment the tweeter is at the audience's angle to evaluate a thing as being ironic. Besides, this less subjective content corresponds to its result of sentiment analysis in being more neutral. Hence, the quantitative sentiment analysis and qualitative content analysis both identify that being aggressive can be effectively distinguish sarcasm from irony.

However, there are also examples that the speaker is aware of his/her tweets as ironic, or the speaker marks his/her own subjective words as #sarcasm #irony simultaneously. This illustrates that irony owns two senses. The first sense of irony is equal to the more aggressive and "awareness" sarcasm. However, this is different from the hypothesis made by Clift (1999) that sarcasm is a type of irony. There is a single tweet tagged simultaneously with irony and sarcasm in, it does not show that irony is the hypernym of sarcasm, but implies the undistinguishable between the two. This also accounts why some ironic tweets may include a specific attacking target, which is different from the result of Lee and Katz (1998). However, it is noticeable that the result of content analysis and quantitative statistics both indicate that irony may be more widely to be used in neutrally classifying an event rather than being interchangeable with sarcasm.

Current study has identified the distinctions and similarities between irony and sarcasm. The features that differentiate irony and sarcasm: the degree of aggressiveness and the content of the utterance. The degree of aggressiveness is evidenced by the using of more positive emotion words in sarcastic tweets. The content of the utterance is about description on ironic event or sarcastic self-utterance. However, there still leaves room for future study on irony and sarcasm. For example, Internet language is hard to operate auditory paralinguistic cues, but to utilize visual cues as in capitalization, emoticons, punctuation, and hashtags to show the real

intention of the speaker in order to achieve the effect of sarcasm and irony. Thus, to make comparison between the paralinguistic cues used in oral and internet language is a direction to further understand this issue. Meanwhile, the details about how these two linguistic devices operate their effects should be further investigated with more various examples. The results of the studies can be further applied on opinion mining and instructions on language learning in information structuring.

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