A Structural Equation Model Study on the Cognitive Factors of Irony Processing

LI Ran , LI Shide*
(College of Basic Science, Tianjin Agricultural University, Tianjin 300384, China)
*Corresponding author

Abstract: Irony processing has always been a hot issue in experimental pragmatics. Existing studies have found out many cognitive factors contributing irony processing with unique paths and contribution rate of their own. Structural equation model can clearly demonstrate the exact path and contribution rate of each factor to irony processing, namely the need for cognition, empathy ability, sarcasm preference and working memory capacity. Three offline questionnaires on the need for cognition, empathy ability and sarcasm preference and two online tests of working memory capacity and irony processing have been conducted. Two hypotheses are verified through hierarchical linear modeling and structural equation modeling. Statistic results show that the four cognitive factors all exert positive effect on irony processing, with sarcasm preference exerting a direct effect while the need for cognition showing an indirect effect through the mediation of working memory capacity and empathy ability respectively, which is of great significance to the teaching of linguistics and rhetorics.

1. Literature Review and Research Hypothesis
In recent years, the cognitive mechanism of irony in oral/written communication has been a hot topic in linguistics, and it is still inconclusive. There are mainly six kinds of processing theories: Standard Pragmatic View, Echoic Mention Theory, Pretense Theory, Allusion Pretense Theory, Echoing-Contrasting Cognitive Operation Model and Framework of Constraint-Satisfaction[1]. Researchers find that each theory has its own emphasis on a cognitive factor of irony processing with empirical data. In the eye movement experiments of written irony, Olkoniemi, Ranta & Kaakinen have found that subjects will have more regressions when reading irony sentences than reading literal sentences[2], which means that it takes more cognitive efforts to process irony sentences. Therefore, irony processing is related to readers' need for cognition. Echoic Mention Theory based on Relevance Theory points out that the cognition of irony is not to coordinate the conflict between literal meaning and context, but to use literal sentences to activate related propositions which are already existing in the listener’s mind (literal sentences are only external stimuli, so there is no need to process their meanings)[3]. Therefore, the cognition of irony is related to listeners’ working memory capacity. Clark and Gerrig’s Pretense Theory and Allusion Pretense Theory further emphasize the speaker's attitude when using irony, holding that the speaker deliberately pretends to perform a speech act, and hopes that listener can understand its falsehood, so as to detect the speaker’s hidden attitude[4]. This step requires listener to have sensitive emotion detection ability, that is, empathy ability. Constraint-Satisfaction Framework focuses on listener’s habit of using irony. Those who like using irony in daily expression tend to have stronger ability to capture irony clues for irony processing[5]. On this basis, we put forward the following hypothesis:

H1: Need for cognition (NFC), working memory capacity (WMC), empathy ability (EA) and sarcasm preference (SP) all positively influence irony processing.
preference (SSS) all have positive effects on irony processing, that is, the greater the four factors are, the faster irony can be processed.

The Echoing-Contrasting Cognitive Operation put forward by Ruiz de Mendoza, Spanish linguist, holds that irony processing activates two contrasting situations that are invoked by the same utterance[6]. One situation is about the real event, the other echoes a previous thought or belief in the listener’s mind which requires the functioning of working memory capacity. Two different situations (the actual and the expected situations) are activated simultaneously and end in contrast which causes listener’s reaction on the speaker. Only when listener notices the contrast can he/she detect the real intention and hidden attitude of the speaker, and this step places a high demand on listener’s empathy ability. Therefore, Mendoza’s operation model involves two explicit cognitive processes, namely, working memory calling and empathy awakening. Australian psychologist J. Sweller believes that all kinds of cognitive activities in problem solving consume cognitive resources and produce a certain cognitive load[7]. Therefore, we think that both the calling of working memory and the awakening of empathy need the help of NFC, which are closely related to irony processing efficiency and results. Therefore, this study proposes a second hypothesis:

H2: Need for cognition (NFC) plays an indirect role in irony processing with working memory capacity (WMC) and empathy ability (EA) as mediating variables.

At present, existing researches mainly discuss the influence of one or some cognitive factors on irony processing, but no research has integrated the above four factors (NFC, WMC, EA and SSS) for comparative study to observe the contribution rate and contribution path of each factor to irony processing. Therefore, this study mainly discusses the following two questions: 1. whether the four cognitive factors have positive effects on irony processing; 2. whether NFC has indirect effect on irony processing mediated by WMC and EA. The measurement model mainly answers the first question, and the structural model mainly answers the second one.

2. Model Establishment

Structural equation model includes measurement models and structural models. Measurement model indicates the relationship between observed variables and latent variables, while structural model indicates the relationship between different latent variables. As far as parameter estimation method is concerned, the maximum likelihood estimation method is adopted in this paper, because its advantage is that there is no strict requirement on the distribution state of sample data or the size of sample size.

2.1 Establishment of measurement model

The measurement model mainly investigates the relationship between latent variables and their corresponding observed variables. The measurement model in this paper mainly detects whether the measurement index of each cognitive factor has a good correlation with the corresponding factor. In the measurement model, we mainly observe the following indicators: ① P value: when P value is greater than 0.05, there is no significant difference between the theoretical model and the experimental data, that is, the theoretical model is supported by the data; ② CMIN/DF (ratio of chi-square to degree of freedom: when CMIN/DF is less than or equal to 5, the theoretical model and data fit well. Because chi-square value is easily affected by the sample size (when the sample size is large, p value will be less than 0.05) statisticians take CMIN/DF into account, which means that p value does not occupy an absolute dominant position in the measurement of structural equation model; ③ GFI (goodness of fit index): when GFI is greater than or equal to 0.90, the theoretical model and data fit well; ④ RMSEA (mean square root of progressive residual: when RMSEA is less than or equal to 0.08, the theoretical model fits the data well [8].

This study has established and tested five measurement models, namely, need for cognition (NFC) model (P=0.04, CMIN/DF=3.19, GFI=0.99, RMSEA=0.07), working memory capacity (WMC) model (P=0.00, CMIN/DF=6.13, GFI=0.98, RMSEA=0.11), empathy ability (EA) model (P=0.10, CMIN/DF=2.32, GFI=0.99, RMSEA=0.06), sarcasm preference (SSS) model (P=0.89, CMIN/DF=0.17, GFI=1.00, RMSEA=0.00) and irony processing model (P=0.00, CMIN/DF=6.20, GFI=0.98,
RMSEA=0.12). Generally speaking, the fitting degree of the above five measurement models is relatively good, and no correction is needed. On this basis the structural model can be constructed.

2.2 Establishment of structural model

2.2.1 Regression analysis of cognitive factors and irony processing
Both NFC and SSS are found to have significant direct effects on irony processing (t = 3.897, P < 0.01; t = 5.699, P < 0.01), and the effect of SSS (β = 0.270) was greater than that of NFC (β = 0.185). However, when the independent variable EA is added, SSS is not affected, but the significance of NFC is reduced from 0.000 to 0.016, and its confidence interval is reduced from 0.01 to 0.05. Therefore, we can conclude that EA has a mitigating effect on the contribution value of NFC, that is, NFC may affect irony processing through EA. When the fourth independent variable WMC was added, the direct effect of NFC was not significant (t = 1.037, P = 0.300). This suggests that NFC plays an indirect role in irony processing through WMC. Regression analysis confirms hypothesis 1, that is, NFC, WMC, EA and SSS all have positive effects on irony processing, in which the effect of NFC is indirect while the effect of the other three cognitive factors are direct. The model expression is as follows: Irony processing=0.05NFC+0.36WMC +0.24EA +0.14SSS

Although multiple regression analysis can explain the direct effects of cognitive variables on irony processing, it cannot reflect the indirect effects and paths of independent variables on dependent variables. Therefore, we try to show the whole picture of the indirect effect of NFC on irony processing through WMC and EA, and the direct effect of WMC, EA and SSS on irony processing through the construction of structural equation model.

2.2.2 Construction of irony processing structure model
Researchers used Amos 17.0 to construct the cognitive factor model of irony processing, in which the independent variables are NFC and SSS, the dependent variables are irony processing, and the mediating variables are WMC and EA. The explanatory effect of independent variables on the dependent variables through mediating variables was specifically investigated. The model fitting data are as follows: CMIN/DF=2.29, p=0.00, GFI=0.91, AGFI=0.89, CFI=0.95, RMSEA=0.06. Because of the large sample size (N=400), P value is less than 0.05, and other indexes are basically within the reference range, which shows that the fitting degree between data and the model is good, in other word, the structural model is supported by the data.

From the structural model, we can see that NFC has a significant indirect effect on irony processing, which is realized through two paths. One is through WMC, the other is through EA. The indirect effect of NFC through WMC (0.28) is significantly greater than its direct effect (0.05). The indirect effect of NFC through EA (0.24) is also significantly greater than its direct effect (0.05). The direct effect of SSS (0.14) on irony processing is greater than the indirect effect (0.03). Therefore, we infer that NFC is to promote irony processing positively by expanding WMC and awakening EA. But SSS directly affects irony processing without the motivation of NFC. This shows that NFC plays an indirect role both through WMC to irony processing, and through EA to irony processing, which confirms hypothesis 2: NFC plays an indirect role in irony processing with WMC and EA as mediating variables.
3. Discussion

3.1 The direct effects of NFC, WMC, EA and SSS on irony processing
The regression coefficients of WMC are larger than the other three independent variables. WMC can activate and maintain related multi-layer semantic information while suppress irrelevant interference information[9]. High-capacity working memory can promote the understanding of irony, while low-capacity readers can’t get various interpretations in their brains, so they may have difficulties in completing the task of irony processing.

Markedness hypothesis holds that the speaker’s implicit emotional state, as an emotional marker, can help readers judge the ironic meaning involved in the discourse, but whether listener can manage to capture speaker’s hidden emotion and identify the embedded emotional information is closely related to the listener’s empathy ability[10].

Individuals with strong SSS will expect irony to appear in discourse subconsciously, so they will not be surprised but satisfied when literal meanings are contrary to context. The contradiction between ironic discourse and context will not hinder its cognition, but accelerate its successful access to ironic interpretation. Therefore, individuals who tend to use irony personally will process irony more smoothly and accurately.

NFC refers to the cognitive efforts paid in the process of irony understanding. Literal meaning serves as the starting point of irony processing, and the achievement of ironic interpretation needs reverse reasoning on literal meaning under the trigger of context. Therefore, NFC seriously affects irony processing. However, when EA and WMC are added, the direct effect of NFC is no longer significant, so in this case we need to further discuss the role and function of NFC in detail.

3.2 Indirect effect of NFC on irony processing
The indirect effect of NFC is to promote irony processing by invoking working memory and arousing empathy. Some studies have found that subjects with high WMC had more regression in the first reading of ironic target sentences, and this regression process is actually a process of anti-literal meaning selection[2]. Since literal meaning is often prominent and available, listeners have to upgrade his/her NFC to suppress the prominent literal meaning, and retrieve the secondary contextual ironic meaning. It can be seen that although WMC directly affects irony processing, it only provides mental space for keeping literal meaning and contextual ironic interpretation. Without the support and active participation of NFC, listeners can’t understand the contradiction between literal meaning and contextual information, and therefore can’t retrieve correct ironic meaning.

Speaker’s ironic expression increases listener’s cognitive load, so that listener has to try his/her best to identify the real attitude and emotion that the speaker cannot express directly. It can be seen that NFC indirectly affects irony processing by activating empathy, and it is NFC that awakens listener’s empathy ability to find the psychological basis of the meaning contradiction between mental context and immediate context so as to shed light on the original intention of the speaker. The indirect effect of NFC should not be underestimated.

The empirical analysis of cognitive factors involving irony processing is the first step of understanding irony in a scientific and systematic way, which can in turn provide evidence and support to the studying and teaching of linguistics and rhetorics.

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