Linguistic anomalies in the language of patients with schizophrenia

Young Tak Jo\textsuperscript{a,1}, So Yeon Park\textsuperscript{b,1}, Jaiyoung Park\textsuperscript{c}, Jungsun Lee\textsuperscript{e}, Yeon Ho Joo\textsuperscript{c,*,1}

\textsuperscript{a} Department of Psychiatry, Kangbong Sacred Heart Hospital, Hallym University College of Medicine, Seoul, Republic of Korea
\textsuperscript{b} Department of Psychiatry, Yongin Mental Hospital, Yongin-si, Gyeonggi-do, Republic of Korea
\textsuperscript{c} Department of Psychiatry, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Republic of Korea

\begin{abstract}
In terms of thought disorder, the language of patients with schizophrenia itself could be a valuable resource. Some valuable studies on the language of patients with schizophrenia have been performed. However, most such studies have been confined to English-speaking countries, or at least those where Indo-European languages are spoken. Therefore, we investigated linguistic anomalies in the language of Korean patients with schizophrenia. Short texts written by 69 patients with schizophrenia from a single mental hospital and matched normal control participants were analyzed. We evaluated these texts in terms of semantic and syntactic errors. Then, we compared the error rates adjusted for text length between patients and normal control participants. We also divided the patients with schizophrenia into two groups by their duration of illness and compared these two groups to investigate the relationship between the duration of illness and linguistic anomalies. The patients with schizophrenia committed a total of 1.86 (2.52) semantic errors and 1.37 (1.79) syntactic errors per 100 characters, which were significantly more frequent than errors committed by normal control participants. Furthermore, there was a notably high number of semantic errors relative to syntactic errors in the language of patients with schizophrenia. Our study results are consistent with previous studies from English-speaking countries, implying that the linguistic anomalies of patients with schizophrenia are not confined to a single language. Because language is essential in mental function, further research on linguistic anomalies in patients with schizophrenia is recommended.
\end{abstract}

\section{Introduction}

Schizophrenia is a chronic, debilitating disorder characterized by hallucinations, delusions, and disorganized behavior. It has been recognized that the heritability of schizophrenia is around 80\% (Hilker et al., 2018), which strongly indicates that schizophrenia is a heritable, biological disease. Nevertheless, no replicable biomarker has been discovered, despite decades of research (Tandon et al., 2008b; Tandon et al., 2008a). Various research methods, such as neuroimaging, genetic analysis, and electrophysiology, are now being widely used to identify biomarkers of schizophrenia.

In terms of disease markers, the language of patients themselves could be a valuable resource (de Boer et al., 2020). In the absence of biological disease markers, psychiatrists diagnose patients as having schizophrenia through clinical interviews, which involve the use of language. Therefore, language could serve as a window for investigating the brain and its pathology (Elvevag et al., 2017). Furthermore, “formal thought disorder” could also be represented as a language disorder, considering that human thought is based on language. It has been suggested that language may constitute the psyche of individuals and, therefore, must play a significant role in the pathophysiology of schizophrenia (Hinzen and Rossellö, 2015).

Various valuable studies on the language of patients with schizophrenia have been performed. It has long been suggested that patients with schizophrenia appear to have some language deficits (Andreasen, 1979; DeLisi, 2001). According to the previous article, which comprehensively reviews language impairment in schizophrenia (Covington et al., 2005), phonology and morphology are generally preserved in patients with schizophrenia. Regarding syntax, it has generally been argued that patients with schizophrenia show relatively preserved syntactic abilities (Ruchshow et al., 2003; Kuperberg, 2010; Stephane et al., 2014). However, some studies have shown the opposite results (Marini et al., 2008; Moro et al., 2015). Furthermore, numerous studies have consistently shown that patients with schizophrenia make several
Semantic errors (Goldberg et al., 1998; Rossell and David, 2006; Stirling et al., 2006; Stephane et al., 2014; Tan et al., 2015). Therefore, some have suggested that schizophrenia is a semiotic disorder with an impairment in the semantic connection between a concept and a word (Harrod, 1986), although controversy about this remains (Harrow et al., 1986). Notably, participants with schizophrenia also show pragmatic deficits, which were well described elsewhere (Colle et al., 2013; Bambini et al., 2016).

Nevertheless, research about language has stagnated since the introduction of new research techniques, including neuroimaging and genetic analysis. Moreover, most studies about the language of patients with schizophrenia have been confined to English-speaking countries, or at least those where Indo-European languages are spoken (Çokal et al., 2018; Çokal et al., 2022). Only a few studies have investigated the language of patients with schizophrenia who speak non-Indo-European languages. There is thus a need for studies on linguistic anomalies in patients who speak other languages because there are many typological differences among the languages (Moravesik, 2012). Through clarifying the language anomalies of patients with schizophrenia in different geographical regions, we can clarify whether these anomalies are universal and unique to schizophrenia.

Therefore, we investigated linguistic anomalies in the language of Korean patients with schizophrenia. We attempted to clarify whether previously known linguistic anomalies of English-speaking patients with schizophrenia were replicated within Korean speakers. Specifically, we tried to figure out whether patients with schizophrenia show semantic errors rather than syntactic errors, as previously reported. We also investigated whether the disease progression of schizophrenia correlates with linguistic anomalies to determine whether the linguistic anomalies constitute the core pathophysiology. In this study, we utilized short written texts, not spoken narratives, considering that normal people could easily make various linguistic errors. Most people make not only simple errors such as stuttering or tongue slips but also more grammatical errors, such as deletion, addition, or exchange errors. Because we tried to consider language as a representation of thought, we examined written texts which could be less confounded by these everyday errors.

2. Materials and methods

2.1. Study participants and materials

Study participants were recruited at Yongin Mental Hospital, Yong-in-si, Gyeonggi-do, Korea, between January 4, 2021, and February 8, 2021. All of them were psychiatric patients who had previously been diagnosed with schizophrenia. They spoke Korean as their native language. After explaining the research, informed consent was obtained from all study participants. Then, the participants were asked to write short texts according to a previously designed survey (Supplement 1). This survey asks about the participant’s daily life during the last week, recommending at least ten rows of answers, and the answers usually show similar patterns to diaries. We offered a small souvenir to the participants after they had completed the texts.

For normal control participants, we utilized the Unpublished article corpus (version 1.0) by National Institute of Korean Language (National Institute of Korean Language, 2021). It is a corpus of unpublished articles, including essays, letters, or diaries, developed for AI. training. Among a total of 5937 participants, we extracted age and sex-matched participants who wrote diaries. These articles were typed but not corrected by editors. This study was approved by Yongin Mental Hospital Institutional Review Board (IRB Number: YIMH-IRB-2020-24).

2.2. Data cleaning and linguistic analysis

The study materials written by the study participants were entered into word processing software. In the case of personal information, the words and phrases were de-identified to protect the privacy of the study participants. If there were unidentifiable written characters, they were independently marked as unreadable words or phrases. After that, we analyzed the typed text materials from the study participants in a blinded manner with regard to their clinical information.

For linguistic analysis, we evaluated the texts in terms of semantics and syntax. After developing scoring criteria according to standard Korean grammar (Koo, 2015; Koo, 2016), we separately counted the number of semantic and syntactic errors in the written texts of the study participants. Semantic errors usually involve the inappropriate usage of words, such as nouns or verbs, in terms of linguistic acceptability (Bard et al., 1996). It means that native speakers realize the term is unacceptable since it does not match the context of a sentence. Syntactic errors usually represent ungrammatical sentences. For instance, incorrect word order or sentence structure is a syntactic error. Table 1 details the evaluation criteria for semantics and syntactic errors. Simple spelling errors or incorrect tenses were not included to focus on language competence rather than language performance.

However, because Korean has josa and eomi, similar to particles and endings that do not exist in English, the same definitions of semantic and syntactic errors could not be applied to these sentence constituents (Koh, 2022). Therefore, a more generalized criterion discriminating semantic and syntactic errors was required to cover josa and eomi. We defined inappropriate josa and eomi altering the meaning of a given text as a semantic error, whereas inappropriate josa and eomi without altering the inherent meaning (but cannot be accepted as appropriate by native speakers) as a syntactic error. All of these analyses were performed twice by two different investigators, and only errors confirmed by both of them were counted as valid.

2.3. Statistical analysis

The numbers of semantic and syntactic errors were counted for each study participant. However, because the number of errors should increase as the total length of a text increases, the semantic and syntactic errors should be standardized by the text length. Therefore, we calculated the numbers of semantic and syntactic errors per 100 characters and utilized these as semantic and syntactic error rates. After that, we compared the semantic and syntactic error rates of patients with schizophrenia to the error rates of the normal control participants. We also compared the error rates for each sub-category of semantic and

| Table 1 | Definition of semantic and syntactic errors. |
|---|---|
| Semantic errors | Inappropriate semantic component (words/phrases) selection |
| James blinks his eyes. | *James blinks his mouth.* |
| Inappropriate syntactic component (particles/endings) selection, with a change of meaning |
| James went to the office. | *James went from the office.* |
| Entirely wrong semantic component; e.g. neologism, unidentifiable characters |
| Happy day. | *Happyday.* |
| Syntactic errors | Inappropriate syntactic component selection, without a change of meaning; e.g. particles/endings, modality, passive-active |
| I have done my work. | *I have done in my work.* |
| Inappropriate order of syntactic components |
| James became a doctor. | *A doctor became James.* |
| Inappropriate sentence structure; e.g. omission, duplication, wrong complex sentences |
| I gave him a call last night. | *I gave him a call a message last night.* |

*Unacceptable sentences; Because Korean grammar does not directly correspond to English grammar, some terms are presented as approximate terms.
syntactic errors between patients with schizophrenia and normal control participants. Then, we divided the patients with schizophrenia into two groups by their median duration of illness to investigate the relationship between duration of illness and linguistic anomalies. For comparing groups, an independent t-test was used for parametric variables such as age, while Wilcoxon signed-rank test was used for non-parametric variables such as text length. For adjusting covariates, we performed ANOVA with the Tukey test as a post-hoc analysis. Finally, we performed a correlation analysis between the duration of illness and linguistic anomalies. All statistical analyses were performed using R version 4.0.0 (Team, 2013).

3. Results

3.1. Study participants

69 patients with schizophrenia and 69 matched normal control participants were included in this study. The mean age of patients was 53.8 (9.0) years old, and 36 patients (52.2 %) were male. The average duration of illness was 24.7 (8.6) years. The mean age was 53.5 (10.3) years old for normal control participants, and 34 patients (49.3 %) were male. There was no statistically significant difference in age and sex between the two groups.

3.2. Linguistic anomalies in patients and normal controls

All patients with schizophrenia wrote short texts by hand, while texts of normal controls were extracted from a public database developed by the National Institute of Korean Language. The average text length was 171.4 (155.8) characters among patients with schizophrenia, which was significantly shorter than 976.3 (644.5) characters among normal control participants (p < 0.001). Although the patients were instructed to write >10 rows of text, many did not write enough.

The patients with schizophrenia showed 1.86 (2.52) semantic errors per 100 characters on average, while normal control participants showed only 0.06 (0.12) semantic errors per 100 characters (p < 0.001). In addition, patients with schizophrenia committed 1.37 (1.79) syntactic errors on average per 100 characters, which were more frequent than 0.13 (0.40) errors among normal control participants (p < 0.001).

Table 2 shows the demographics and linguistic anomalies of the study participants in detail. These results were the same even after adjusting the sex of each participant as a covariate.

For sub-categories of semantic and syntactic errors, patients with schizophrenia committed more errors in all six sub-categories compared to normal control participants. Specifically, patients used 0.65 (2.35) entirely wrong semantic components per 100 characters on average, including neologisms and completely unidentifiable characters, which were significantly more frequent than 0.01 (0.04) within normal control participants (p < 0.001). Table 3 shows linguistic anomalies by sub-categories in all study participants. These results were also the same after adjusting the sex of each participant as a covariate, although statistical significance levels became less significant, probably due to smaller sample sizes. Fig. 1 summarizes linguistic anomalies in patients and normal controls.

3.3. Duration of illness and correlation analyses

We divided patients with schizophrenia by the median duration of illness (23 years). Overall, 34 patients were included in the group with a longer duration of illness, while 35 patients were in the shorter duration group. Upon comparing these two groups, the average age of the patients was understandably much older among the group with a longer duration of illness [58.0 (8.7) vs. 49.6 (7.4), t = 4.349, df = 67, p < 0.001]. Regarding linguistic anomalies, the numbers of semantic errors per 100 characters did not differ significantly between the groups with longer and shorter durations of illness (p = 0.433). It also showed no statistically significant difference after adjusting sex as a covariate. Meanwhile, the group with a longer duration of illness had 1.89 (2.22) syntactic errors per 100 characters, which was >0.86 (1.02) in the group with a shorter duration of illness. Although this difference did not reach statistical significance (p = 0.050), it showed significant difference (p = 0.011) after adjusting sex as a covariate. Table 4 shows details of the comparisons of the groups.

Upon analyzing the correlations between the duration of illness and linguistic anomalies, both semantic and syntactic error rates became higher with a longer duration of illness. However, none of these correlations reached statistical significance. In the cases of neologisms and unidentifiable characters, there were also no significant correlations. Fig. 2 shows scatterplots depicting the relationships between duration of illness and the number of linguistic anomalies.

4. Discussion

This study investigated the linguistic anomalies of patients with schizophrenia.
results showed that patients with schizophrenia had much higher error rates in their written language, compared to matched normal control participants. It is noteworthy that normal control participants showed error rates of <0.08% (Kim, 2020).

In addition, we found a noticeable amount of both semantic and syntactic errors within patients with schizophrenia. Nevertheless, we also revealed a notable number of semantic errors rather than syntactic errors in the language of patients with schizophrenia. In contrast, we found that normal control participants showed more syntactic errors than semantic errors, which has been revealed before (Yu and Chung, 2012). Thus, a high number of semantic errors may be a characteristic of the language of patients with schizophrenia. In fact, this is consistent with previous studies on patients with schizophrenia speaking English or other Indo-European languages.

While Korean is an agglutinative language in terms of the linguistic morphology (Sohn, 2001), English is an isolating language (Comrie, 1986). In addition, from a comparative linguistics perspective, Korean and English share few commonalities (Gamkrelidze and Vjaceslav, 2010). Therefore, our study implied that the linguistic anomalies of patients with schizophrenia are not confined to a single language, but involve an impairment of universal grammar, as proposed by Chomsky (Chomsky, 2000).

Upon comparing the two groups of patients with schizophrenia categorized by the duration of illness, there were no statistically significant differences in either semantic or syntactic error rates between the groups with longer and shorter durations of illness. Since patients with schizophrenia have been known to show discursive deterioration with the progression of the disease (DeLisi, 2008; van Haren et al., 2008), these results were unexpected. We also found that the group with longer duration of illness showed more syntactic error, not semantic error, than the group with shorter duration of illness after adjusting sex as a covariate. Since semantic errors have generally been considered more representative of schizophrenia, these results were also unexpected. This might be due to the selection bias of our study participants because Yongin Mental Hospital is a mental hospital that usually cares for chronically ill patients. Therefore, most of our study participants might already show semantic impairment – sometimes considered as a formal thought disorder – while syntactic impairment became severe as the illness lasted longer. On the other hand, our study might reflect that the linguistic anomalies could be disease traits that are not influenced by disease progression or deterioration (Condray et al., 1995). We also found no statistically significant correlation between the duration of illness and semantic or syntactic errors in the language of patients with schizophrenia.

This study had some limitations. First, we could not rule out the effect of a deterioration in the general intelligence of patients with schizophrenia. However, it has been revealed that patients with schizophrenia show anomalies in their language comprehension ability and theory-of-mind independent of their general intelligence (Gavilan and Garcia-Alba, 2011). In addition, we could not essentially delineate cognitive function from linguistic ability because the neuropsychological test is at least partly based on language (Hinzen and Rosellio, 2015). Second, we did not consider education levels of the study participants. Because it has been widely recognized that linguistic ability is highly influenced by education level, it would have been better to adjust it as a covariate. However, due to the limitation of data, we could not adjust education years.

Third, in comparing the two groups of patients with schizophrenia, the cut-off duration of illness was set arbitrarily. It would have been better to differentiate patients by well-known disease stages. However, as previously mentioned, most of our study participants are generally categorized as chronic patients since their durations of illness are longer than 10 years. Moreover, we decided to divide our patients into groups categorized by the duration of illness, there were no statistically significant differences in either semantic or syntactic error rates between the groups with longer and shorter durations of illness. Since patients with schizophrenia have been known to show discursive deterioration with the progression of the disease (DeLisi, 2008; van Haren et al., 2008), these results were unexpected. We also found that the group with longer duration of illness showed more syntactic error, not semantic error, than the group with shorter duration of illness after adjusting sex as a covariate. Since semantic errors have generally been considered more representative of schizophrenia, these results were also unexpected. This might be due to the selection bias of our study participants because Yongin Mental Hospital is a mental hospital that usually cares for chronically ill patients. Therefore, most of our study participants might already show semantic impairment – sometimes considered as a formal thought disorder – while syntactic impairment became severe as the illness lasted longer. On the other hand, our study might reflect that the linguistic anomalies could be disease traits that are not influenced by disease progression or deterioration (Condray et al., 1995). We also found no statistically significant correlation between the duration of illness and semantic or syntactic errors in the language of patients with schizophrenia.

This study had some limitations. First, we could not rule out the effect of a deterioration in the general intelligence of patients with schizophrenia. However, it has been revealed that patients with schizophrenia show anomalies in their language comprehension ability and theory-of-mind independent of their general intelligence (Gavilan and Garcia-Alba, 2011). In addition, we could not essentially delineate cognitive function from linguistic ability because the neuropsychological test is at least partly based on language (Hinzen and Rossellio, 2015).

Second, we did not consider education levels of the study participants. Because it has been widely recognized that linguistic ability is highly influenced by education level, it would have been better to adjust it as a covariate. However, due to the limitation of data, we could not adjust education years.

Third, in comparing the two groups of patients with schizophrenia, the cut-off duration of illness was set arbitrarily. It would have been better to differentiate patients by well-known disease stages. However, as previously mentioned, most of our study participants are generally categorized as chronic patients since their durations of illness are longer than 10 years. Moreover, we decided to divide our patients into groups of identical sizes for maximized statistical power.

Lastly, we used public article corpus as normal control, not recruiting control participants. Because the general format differs from patients with schizophrenia in our study, comparisons between these two groups...
should be careful. However, as we mentioned before, we extracted diaries from the article corpus, and our patients also answered a survey asking about daily lives. Furthermore, these articles were typed but not edited by any other editors.

In conclusion, we found that patients with schizophrenia showed numerous semantic and syntactic errors in their written language, compared to normal population. To the best of our knowledge, this is the first linguistic analysis of Korean patients with schizophrenia. Considering that at least part of the human psyche is based on language, linguistic anomaly could be an essential part of the pathophysiology of schizophrenia. Furthermore, it has recently been recognized that linguistic abilities can affect the quality of life or daily functioning of patients with schizophrenia more directly than general cognitive function (Agostoni et al., 2021; Bambini et al., 2022). Therefore, we hope that further investigation of the language of patients with schizophrenia will be performed in the future.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scog.2022.100273.
CRediT authorship contribution statement

**Young Tak Jo:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft. **So Yeon Park:** Investigation, Resources, Funding acquisition, Writing – review & editing. **Jaiyoung Park:** Investigation, Data curation, Writing – review & editing. **Jungsun Lee:** Supervision, Writing – review & editing. **Yeon Ho Joo:** Conceptualization, Supervision, Writing – review & editing.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

Acknowledgments

The authors sincerely thank Dr. Kikyung Yi, Dr. Hye Jin Seo, and Dr. Yuree Kang for supporting the recruitment of the study participants. The authors also thank Ms. Ji Soo Lee for providing valuable comments on the manuscript.

Funding

This research was supported by the Yong-In Mental Hospital affiliated Yong-In Psychiatric Institute Research Fund and the National Research Foundation of Korea (NRF-2022R1F1A1067605).

References

Agostoni, G., Bambini, V., Bechi, M., Buonocore, M., Spangaro, M., Repaci, F., Cocchi, F., Bianchi, L., Guglielmino, C., Sapienza, J., Cavallaro, R., Bosia, M., 2021. Communicative-pragmatic abilities mediate the relationship between cognition and daily functioning in schizophrenia. Neuropsychology 35, 42-56.

Andreasen, N.C., 1979. Thought, language, and communication disorders. I. Clinical assessment, definition of terms, and evaluation of their reliability. Arch. Gen. Psychiatry 36, 1315-1321.

Bambini, V., Arcara, G., Bechi, M., Buonocore, M., Cavallaro, R., Bosia, M., 2016. The communicative impairment as a core feature of schizophrenia: frequency of pragmatic deficit, cognitive substrates, and relation with quality of life. Compr. Psychiatry 71, 106-120.

Bambini, V., Agostoni, G., Buonocore, M., Tonini, E., Bechi, M., Ferri, I., Sapienza, J., Martini, F., Cusco, F., Cocchi, F., Bischetti, L., Cavallaro, R., Bosia, M., 2022. It is time to address language disorders in schizophrenia: a RCT on the efficacy of a novel training targeting the pragmatics of communication (PragmaCom). J. Commun. Disord. 97, 106196.

Bard, E.G., Robertson, D., Sorace, A., 1996. Magnitude estimation of linguistic acceptability. Language 32-68.

de Bover, J.N., Brederson, S.G., Vopel, A.E., Sommer, I.E.C., 2020. Anomalies in language as a biomarker for schizophrenia. Curr. Opin. Psychiatry 33, 212-218.

Chomsky, N., 2000. New Horizons in the Study of Language And Mind. Cambridge University Press, Cambridge.

Çoçek, D., Sevilla, G., Jones, W.S., Zimmerer, V., Deamer, F., Douglas, M., Spencer, H., Turkington, D., Ferrier, N., Varley, R., Watson, S., Hinzen, W., 2018. The language profile of formal thought disorder. NPJ Schizophr. 4, 18.

Çoçek, D., Palominos-Flores, C., Valiente, R., Tjär-Abaco, G., Bora, E., Hinzen, W., 2022. Referential noun phrases distribute differently in Turkish speakers with schizophrenia. Schizophr. Res. In press.

Colle, L., Angeleri, R., Vallana, M., Sacco, K., Bara, B.G., Boscò, F.M., 2013. Understanding the communicative impairments in schizophrenia: a preliminary study. J. Commun. Disord. 46, 294-308.

Comrie, B., 1988. Linguistic typology. Annu. Rev. Anthropol. 17, 145-159.

Condry, R., van Kammen, D.P., Steinhauser, S.R., Kasparek, A., Yao, J.K., 1995. Language comprehension in schizophrenia: trait or state indicator? Biol. Psychiatry 38, 287-296.

Covington, M.A., He, C., Brown, C., Naci, L., McClain, J.T., Fjordbak, B.S., Semple, J., Brown, J., 2005. Schizophrenia and the structure of language: the linguist's view. Schizophr. Res. 77, 85-98.

Delisi, L.E., 2001. Speech disorder in schizophrenia: review of the literature and exploration of its relation to the uniquely human capacity for language. Schizophr. Bull. 27, 481-496.

Delisi, L.E., 2008. The concept of progressive brain change in schizophrenia: implications for understanding schizophrenia. Schizophr. Bull. 34, 312-321.

Elseyag, B., Foltz, P.W., Rosenstein, M., Ferrier, I.C.R., de Deyne, S., Mizraj, E., Cohen, A., 2017. Thoughts about disordered thinking: measuring and quantifying the laws of order and disorder. Schizophr. Bull. 43, 509-513.

Gamkrelidze, T.V., Vajaselav, V.I., 2010. Indo-European and the Indo-Europeans: a reconstruction and historical analysis of a proto-language and proto-culture. Translated by Nicholas J. In: Part I: The Text. Part II: Bibliography. Index. De Gruyter Mouton, Berlin.

Gavilan, J.M., Garcia Albea, J.E., 2011. Theory of mind and language comprehension in schizophrenia: poor mindreading affects figurative language comprehension beyond intelligence deficits, 24, 54-69.

Goldberg, T.E., Aloia, M.S., Gourovitch, M.L., Missar, D., Pickard, D., Weinerberger, D.R., 1998. Cognitive substrates of thought disorder, I: the semantic system. Am. J. Psychiatry 155, 1671-1679.

van Haren, N.E., Cahn, W., Hulshoff Pol, H.E., Kahn, R.S., 2008. Schizophrenia as a progressive brain disease. Eur. Psychiatry 23, 245-254.

Harrod, J.B., 1986. Schizophrenia as a semiotic disorder. Translated by Nicholas J Schizophr. Bull. 12, 12-13.

Harrow, M., Prather, P., Lanz-Kettering, L., 1986. Is schizophrenia a semiotic disorder? Replies to Harrod. Schizophr. Bull. 12, 15-19.

Hiller, R., Helenius, D., Fagerlund, B., Skythse, A., Christensen, K., Werge, T.M., Nordentoft, M., Glenthøj, B., 2018. Heritability of schizophrenia and schizotypal spectrum based on the Nationwide Danish Twin Register. Biol. Psychiatry 83, 492-498.

Hinzen, W., Roselló, J., 2015. The linguistics of schizophrenia: thought disturbance as language pathology across positive symptoms. Front. Psychol. 6, 971.

Kim, Y.-I., 2020. Analysis of error types of < Korean orthography > in university students’ writing. Korean J. Gen. Educ. 14, 189-209.

Koh, S., 2022. An analysis of Josa and Eomi in translating Korean TV dramas into English with artificial intelligence. J.English Teach.MoviesMedia 23, 14-28.

Koo, B.-K., 2016. Introduction to Korean Grammar II. Jipmoondang, Seoul.

Kuperberg, G.R., 2010. Language in schizophrenia Part 1: an introduction. Lang. Linguist Compass 4, 576-589.

Marini, A., Spoletti, I., Rubino, I.A., Giaffa, M., Bria, P., Martinotti, G., Banfi, G., Boccaccino, R., Strom, P., Sircusano, A., Caltagirone, C., Spalletta, G., 2008. The language of schizophrenia: an analysis of micro and macrolinguistic abilities and their neuropsychological correlates. Schizophr. Res. 105, 144-155.

Moravcsik, E.A., 2012. Introducing Language Typology. Cambridge University Press, Cambridge.

Moro, A., Bambini, V., Bosia, M., Anselmetti, S., Riccaboni, R., Cappa, S.F., Smeraldi, E., Cavallaro, R., 2015. Detecting syntactic and semantic anomalies in schizophrenia. Neuropsychologia 79, 147-157.

National Institute of Korean Language, 2021. Unpublished Article Corpus (Version 1.0). R Core Team, 2013: R: A Language And Environment for Statistical Computing. Rossell, S.L., David, A.S., 2006. Are semantic deficits in schizophrenia due to problems with access or storage? Schizophr. Res. 82, 121-132.

Ruchows, M., Tripell, N., Groen, G., Spitzer, M., Kiefer, M., 2003. Semantic and syntactic processes during sentence comprehension in patients with schizophrenia: evidence from event-related potentials. Schizophr. Res. 64, 147-156.

Séguin, H.-M., 2001. The Korean Language. Cambridge University Press, Cambridge.

Stepane, M., Kuskowski, M., Gundel, J., 2014. Abnormal dynamics of language in schizophrenia. Psychiatry Res. 216, 320-324.

Strömgren, J., Hellström, J., Bläcke, A., Deakin, W., 2006. Thought disorder in schizophrenia is associated with both executive dysfunction and circumscribed impairments in semantic function. Psychol. Med. 36, 475-484.

Tan, E.J., Neill, E., Rossell, S.L., 2015. Assessing the relationship between semantic processing and thought disorder symptoms in schizophrenia. J. Int. Neuropsychol. Soc. 21, 629-638.

Tandon, R., Keshavan, M.S., Nasrallah, H.A., 2008a. Schizophrenia, ‘just the facts’ what we know in 2008 part 1: overview. Schizophr. Res. 100, 4-19.

Yu, H.-R., Chung, H.-M., 2012. On the awkward sentences in college students’ texts. J. Korean Lang. Cult. 48, 201-228.