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On Scientific Identification of Semantic Waves: Based on Corpus-assisted Discourse Analysis

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Abstract

This research takes the initiative to achieve objective identification of semantic waves in disciplinary discourse from the perspective of fractal elements through corpus-assisted discourse analysis. This research will contrastively analyze different expression of the shared semantics between scientific discourse and popular science discourse mainly in terms of Systemic Functional Grammar (SFG), and then rank the fractal elements to form an objective scale based on their strengths of SD/SG. The scale built through the integration of corpus discourse analysis and review of previous relevant theoretical literature realizes the objective construal of the dynamic change of SD/SG as discourse unfolds, extending the employment of semantic wave in exploring the scientific knowledge building in discourse and developing semantic wave by further integrating this knowledge building theory with Systemic Functional Linguistics (SFL).

Keywords

semantic wave, disciplinary discourse, corpus, fractal elements

1. Introduction

As one of the dialogical focal point between Systemic Functional Grammar (SFG) and social pedagogy (Maton, 2011, 2013; Martin, 2017; Martin & Matruglio, 2020; Luo, 2019, 2020a), the delineation of semantic waves is to visualize the changes of Semantic Density (SD) and Semantic Gravity (SG) as the disciplinary discourse unfolds, therefore presenting the key features of cumulative knowledge building (Maton, 2013, 2014a). In this case, the notion of semantic wave tends to be utilized to analyze knowledge building mechanism in disciplinary discourse, and such utilization requires objective depiction of semantic waves. However, the existing identification frameworks for semantic wave in

discourse were built mainly through introspection, and the objectivity is therefore easily questioned. To achieve objective identification of semantic wave in discourse, this research attempts to build an updated scale for SD/SG through corpus-assisted discourse analysis. Specifically speaking, based on the theoretical assumption that scientificity is proportional to SD and inversely proportional to SG, this research examines variations in linguistic expressions of the same meaning across discourse types with different scientificity, and integrates the analytical results with prior rationales for SD and SG determination in discourse as comprehensively as possible, building a more objective and scientific SD/SG scale for different fractal elements. The achievement will not only extend the employment of semantic wave in exploring the scientific knowledge building in disciplinary discourse but promote the development of "semantic wave" by further integrating this notion with SFG.

2. Semantic Wave in Legitimation Code Theory

Karl Maton (2000), an educationalist, has proposed the initial concept of Legitimation Code Theory (LCT), within which the notion of semantic wave is one of the five constituent principles (Maton, 2011). Semantic wave consists of two parameters, SD and SG (Maton, 2011, 2013). SD refers to the degree of semantic condensation within symbols or other social practices, while SG denotes the extent to which the semantics relates to its context (Maton, 2011). The strength of SG positively correlates with the degree to which meaning is context-dependent, and the same holds true for SD with the degree of semantic condensation within symbols (Maton, 2011). The dynamic strength variations in the two parameters are key to illustrate cumulative knowledge building in disciplinary discourse (Maton, 2013, 2014b; Zhu, 2014).

2.1 The Development of Semantic Wave

The development of semantic wave primarily stems from the dialogue between SFG and LCT. Martin (2013) proposed the "power trio" that comprises power words, power grammars and power composition to conceptualize SD within the semantic wave. Martin (2014) introduced "mass" and "presence" which respectively correspond to SD and SG. Both terms are closely associated with SFG's three meta-functions, and all the associations were proved positive (Martin & Matruglio, 2020; Zhu, 2015).

To recapitulate, the notion of semantic wave has provided linguistic resources for construing uncommon-sense knowledge building. It is the intersection between linguistics and educational sociology that allows us to gain insights into the mechanisms and characteristics of knowledge building in discourse.

2.2 Scales for SD/SG of Different Fractal Elements

Several attempts have been made to construct scales for SD/SG. Bernstein (2000) builds a cline along which the strength of SG diminishes from description to abstraction. Li and Hu (2016) analyzed a diplomatic speech by Fu Ying based on this cline and evaluative theory, proposing the concept of

"evaluative gravity" and presenting its correlation with SG. Additionally, Luo et al. (2017), built an alternative scale for the strength of SG in reference to Cloran's (1994, 2010) cline of rhetorical units. The scale was adopted for the analysis of disciplinary spoken discourse based on the assumption of reverse trends in SD and SG variations from one grammatical unit to another (Luo, 2020).

As for the framework for identifying the strength of SD, Maton & Doran (2017a,b) built SD clines by exploring how different subtypes of "wording", "word-grouping", "clausing" and "sequencing" manifest varying degrees of "Epistemic-Semantic Density" (ESD). For instance, in the "wording" part, Maton and Doran (2017a) used wording tools to differentiate technical words from everyday words, categorizing the subtypes of the two types of words and ranking their ESD. In the "word-grouping" part, Maton and Doran (2017a) divided the phrases as modifiers in nominal phrases from a functional perspective into "embedded", "categorized" and "located", ranking the ESD of the three subtypes. Yu (2018) annotated two excerpts respectively from an astrophysics popular science book and an astrophysics textbook in terms of the scale concerning the ESD of 'wording' proposed by Maton and Doran, comparing how knowledge is constructed in the two discourse types. Luo and Yang (2020) built an SD scale in terms of the degrees of involvement of different subtypes of participants and circumstances (Halliday & Matthiessen, 1999) and employed it in conjunction with the SG scale previously proposed to analyze disciplinary spoken discourse selected from classroom instruction.

Numerous as the previous studies on SD/SG are, most previously-established scales are limited to introspection and fail to take a panoramic view of the entire range of fractal elements at different ranks, an agreed-upon scale for SD/SG that encompasses a wide range of fractal elements therefore lacking. This research intends to rank the fractal elements in terms of the strength of SD/SG through corpus-assisted discourse analysis, building a tailored scale for SD/SG to evaluate the difficulty of disciplinary discourse.

3. Research Design

This study will compare the episodes that are highly similar in semantics but different in linguistic expressions by means of corpus-assisted discourse analysis. Traditionally, researchers have contrasted the linguistic expressions of everyday and scientific English to identify the differences in semantic condensation and abstraction between different fractal elements (Halliday, 1998a, 1998b; Peng, 2019; Lei, 2020; Luo & Yang, 2020). This is because the substantial differences in scientificity between the two types of discourse lead to high probability of differences in linguistic expressions when the same knowledge is built (Halliday & Martin, 1993; Halliday, 1998a). Consequently, this research will compare the linguistic expressions of news reports and scientific Research Articles (RAs) published in academic journals, as the two genres differ markedly in scientificity. Given that higher scientificity generally corresponds to greater difficulty for readers (Halliday, 1993), the same knowledge built in academic articles will be more difficult to comprehend than that in news reports. More specifically,

semantic condensation and abstraction would most likely happen when then content in news is transferred into academic articles.

In summary, this study will quantitatively compare episodes that share the same semantics and respectively from the two kinds of discourse pair by pair, so as to recognize possible types of variation in fractal elements and rank these elements in terms of their strengths of SD/SG. This research intends to solve the following two questions:

Q1: What are the differences in the employment of fractal elements between scientific RAs and news reports?

Q2: How can the involved fractal elements be ranked by their strengths of SD/SG?

3.1 Data Collection

This research collected episodes from scientific RAs published in academic journals and their corresponding news reports. The episodes respectively from the two sources and highly similar in semantics is firstly manually identified, followed by reexaminations by means of Google's Simhash script. Specifically, this research in the first place collected published research articles pertaining to natural science and their corresponding news reports. Each two episodes respectively from the two sources have at least three nominal phrases, numbers and verbs with the same meaning, according to Collins Dictionary. After manual verification of the congruence in logical relationships between these nominal phrases or numbers within the paired episodes, they were imported into the Simhash program for pairwise content similarity reassessment. Zhang et al. (2016), recommended setting the similarity threshold at 0.5, 0.6 or 0.7. As Simhash may produce similarity-reducing deviations when testing short texts, we appropriately lowered the threshold for high similarity in this research, setting it at 0.6 instead of 0.7. Only pairs with a similarity degree of 0.6 or higher would be ultimately collected in the corpus, each pair containing two episodes respectively from the two sources. Consequently, this research built a corpus consisting of 156 episodes from 88 natural science journal articles and the other 156 episodes from 88 corresponding news reports, with each episode consisting of a minimum of one sentence and a maximum of three sentences.

3.2 Data Collection

A pair-wise analysis was conducted to identify the dissimilar linguistic expressions conveying identical semantics between two episodes within each pair in terms of experiential function of SFG. Specifically, the 156 pairs were transcribed into TXT files and then imported into the UAM Corpus Tool 3.3x, wherein the experiential meanings of the identified linguistic expressions were coded.

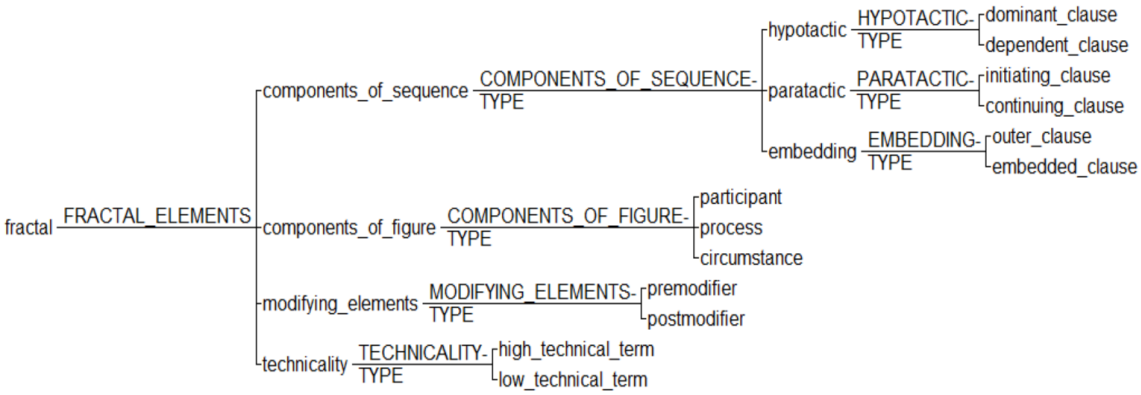

Figure 1. Coding Framework of Fractal Elements

Drawing from Halliday's (2004) description of sequence, figure and element combined with Luo's (2019) centripetal/centrifugal fractal building theory, the two scholars built an initial coding framework and independently coded the first 50 pairs of episodes. Followed by coding, the two scholars convened to discuss and solve the differences of the coding results, expanding and modifying the coding framework. With the new coding framework built, the two scholars coded additional 50 pairs of episodes, discussed again to resolve coding discrepancies, and made final adjustments to the coding framework. The final annotation system is shown in Figure 1.

According to the specific situation of the corpus and related prior theories, the new coding framework meticulously takes "sequence", "figure" and "element" into account. The coded elements are mainly pre- and post-modifiers used to modify "Thing" in noun phrases, the effects of technicality on knowledge building also considered. Utilizing this coding framework, the two scholars independently coded 156 pairs of episodes and discussed the differences in coding results. The inter-coder reliability was then evaluated, rising from original 0.82 to 0.91 after the discussion.

4. Research Results and Discussion

With the primary aim of building an updated scale for SD/SG tailored for analyzing knowledge building in disciplinary discourse, this research has compared the episodes extracted from scientific RAs and news reports, identifying the transformation processes between different fractal elements expressing the same semantics. The analysis outcomes are detailed and discussed in this section.

4.1 The Transformation Types

While there are 21 pairs without any obvious transformation, a total of 255 transformation processes were identified in the remaining 135 pairs. The transformations between fractal elements employed to pack the same semantics can be categorized into three types: transformations between fractal elements at different ranks, transformations between fractal elements at the same rank but different in types, and

transformations between technical terms and non-technical terms. The types and occurring frequencies of the transformation processes between fractal elements are presented in Figure 2.

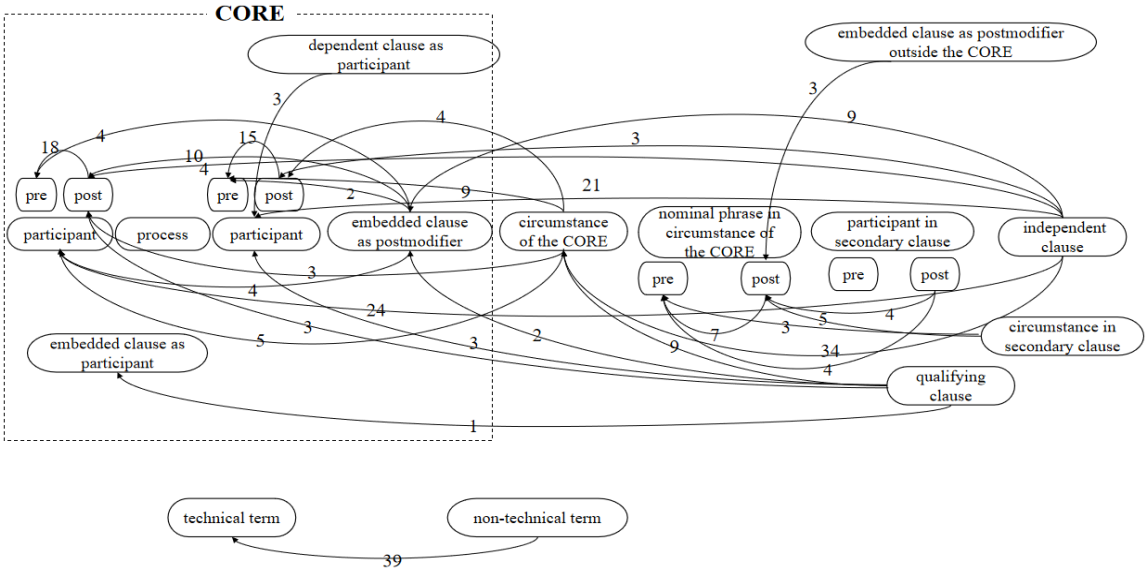

Figure 2. The Transformation Processes from News to Scientific RAs

Figure 2 graphically illustrates the transformations between fractal elements from News to scientific RAs. In Figure 2, the starting points of the arrows denote the fractal element types in news, while the arrow tips denote the fractal elements in RAs. Each arrow thus signifies a specific transformation process between fractal elements from news to RAs, with the same semantics packed in both fractal elements of the same arrow. While all starting points are located at the right ends of the arrows, all tips are at the left ends. The number attached to each arrow denotes the occurring frequency of each type of transformation process within the corpus.

Process and the participants most tightly involved in the process constitute the CORE in a clause complex (Halliday & Matthiessen, 1999; Luo et al, 2017; Luo, 2019). This notion is similar to Valin's syntactic structure theory (2005), which considers the 'Subject + Predicate + Object' in the primary clause as the CORE. The "pre" and "post" in Figure 2 respectively represent "premodifier" and "postmodifier", both at the rank of modifying elements.

The "transformation between fractal elements at different ranks" has been widely observed in linguistic research. Halliday (2002) once classified grammatical units into multiple ranks, including clause, phrase, word and morpheme. The rankshift from higher to lower ranks is indicative of semantic condensation (Halliday & Mattiessen, 2004; Martin, 2013; Luo et. al., 2017). Similarly, Luo (2019) argued that the fractal elements below the clause are more complex in knowledge building than those above the clause. Therefore, the notion of rankshift suffices to explain the variation in SD across grammatical units at different ranks. With respect to SG, Bernstein's (2000) categorization of discourse

in terms rhetorical units identified abstraction and generalization as the two types of rhetorical units with minimal SG. Martin (2017) also claimed that the SG of discourse can be weakened by expressing concrete and specific cases in an abstract manner, rendering the semantics less context-related. Drawing from these viewpoints, it can be concluded that abstraction is the primary method for reducing SG. In this case, the less contextual knowledge introduced in a clause or a clause complex, the lower the SG would be. Since the temporal contextual information and the concrete action process are generally omitted or concealed when semantics is transferred from units at higher ranks to those at lower ranks, such transformation process indicates not only increase in SD but a decrease in SG.

As depicted in Figure 2, the semantics originally packed in independent clauses, qualifying clauses or embedded clauses as postmodifiers can transform into such fractal elements of lower ranks as participants, modifiers in nominal phrases and circumstances. See the following instance extracted from the corpus:

Episode 1 (News from NOAA website):

The research team found a 25‐day increase in the annual number of days of regionally widespread (or synchronous) fire danger and connected fire resource strain over the past four decades. The number of such days would double by the mid-21st century, according to the experts.

Episode 2 (Abatzoglou et al., 2020):

We show a 25-day increase in the annual number of days of regionally widespread connected fire and danger-fire resource strain over the past 4 decades, and a doubling of such days by the mid-21st century.

While episode 1 from a piece of news conveys the meaning through two independent clauses, the same meaning is built via a single clause in episode 2. The in-depth analysis reveals that the knowledge packed in the second independent clause in episode 1 is transformed into the underlined nominal phrase as participant in episode 2. This exemplifies a typical rankshift process, in which the semantics is condensed, resulting in an increase in SD. Meanwhile, the temporal contextual information and concrete action processes respectively manifested by the future tense and the concrete verb “double” in episode 1 are both concealed in episode 2 due to the nominalization. Consequently, the semantic abstraction intensifies due to the concealment of contextual information, and SG thereby diminishes alongside this process. In summary, SD increases while SG decreases when semantics is transferred from clause to participant.

Regarding the transformation process from circumstance to postmodifier in nominal phrases, it is noteworthy that the postmodifiers of “Thing” are typically parts of nominal phrases. In consequence, despite their own structural rank being equivalent to that of nominal phrases, their actual ranks are lower than phrases (Halliday & Mattiessen, 2004). Given that a circumstance is typically realized by an adverbial group or prepositional phrase, which is in the same rank as the participant that is typically realized by nominal phrase (Halliday & Mattiessen, 1999), the actual rank of a postmodifier is lower

than a circumstance. Consequently, the transformation from a circumstance into a postmodifier of a participant should be considered a rankshift, resulting in a semantic condensation process. Moreover, the significance of circumstances, in most cases, lies in the provision of contextual information to the entire process, while modifiers are solely responsible for the Thing to which they are attached. For instance:

Episode 3 (News from NOAA website):

A persistent source is identified primarily in the tropics, likely originating from natural vegetative emissions. A smaller time-varying source was found to scale with the anthropogenic source during phase-out, suggesting the possibility of human emissions being slightly underestimated. These are the two types of sources we have.

Episode 4 (Saltzman et al., 2022):

Based on the timing, magnitude, and spatial distribution of the imbalance we partition it into (a) a persistent or time invariant source primarily in the tropics, and (b) a smaller time-varying component that scales with the anthropogenic source during phase-out.

The “primarily in the tropics” in Episode 3 functions as a circumstance modifying the whole process, while that in Episode 4 merely modifies the participant “source”, and the contextual information it provides is merely applicable to this participant rather than the whole process. In this case, the SG in episode 3 is higher than that in episode 4. In a word, SD increases while SG decreases along with the transformations from circumstances to postmodifiers.

The occurring frequency of such transformation from postmodifiers to premodifiers is notably high, totaling 40 instances as shown in Figure 2. Such a high frequency of occurrence suggests a non-negligible transformation process with potential influence on SD/SG. This analysis result has confirmed that the postmodifiers are typically realized by prepositional phrases or participial phrases, while premodifiers’ own structures are generally of a rank lower than phrases, consequently, a rankshift occurs in such a type of transformation process. as demonstrated in the following instance:

Episode 5 (News from NOAA website):

As anthropogenic emissions continue to decline and natural emissions from soil, fire, and lightning increase in proportion, it will.....

Episode 6 (Wang et al., 2021):

Due to the impact of soil and lightning emissions on the total trend and the contribution of..... a linear trend would.....

The difference between the underlined segments in episode 5 and episode 6 lies in the position of modifiers. The underlined postmodifier in episode 5 shifts to the underlined premodifier in episode 6. Even though both of them are parts of the nominal phrases they modify, their own structures hold unequal ranks. The premodifier is in the word rank, resulting from the condensation of phrases or clauses (Halliday & Mattiessen, 2004). That is, the postmodifier “from soil, fire, and lightning” in

episode 5, while being a prepositional phrase, is condensed into “soil and lighting” in episode 6, which per se stands lower in rank than a phrase. Consequently, there is a semantic condensation between episodes 5 and 6. Aside from the difference in modifiers’ positions, another noteworthy discrepancy between the two episodes is that the postmodifier in episode 5 contains a preposition “from”, which elucidates the soil, fire, and lightning are the original locus of “natural emissions”, while the premodifier in episode 6 lacks such a preposition as can clearly convey this specific contextual information related to “natural emission”. Accordingly, the SG of the clause in episode 5 is higher than that in Episode 6. To recapitulate, the transformation from postmodifiers to premodifiers results in an increase in SD and a decrease in SG.

In addition to variations in fractal elements at different ranks, there are multiple transformations among different types of fractal elements at the same rank, which can be explained in terms of degrees of involvement in place of rankshift. Since the process plus participants attached to the process in the primary clause proves the CORE in the clause complex (Halliday & Matthiessen, 1999; Luo et al, 2017; Luo, 2019), the closer a fractal element is to the CORE, the higher its degree of involvement becomes, and the more condensed the semantics packed within the fractal element will be (Halliday & Matthiessen, 1999; Luo & Yang, 2020). As for SG, Luo (2019) has distinguished internal circumstances from external circumstances. The difference between the two types of circumstances lies in their degree of connecting to the CORE structure. If the contextual information built in a fractal element external to the CORE is rebuilt within a unit of equal rank in the CORE, this contextual information, originally provided for the entire process, would simply become responsible for a single unit in the CORE structure, leading to a decrease in SG. In summary, when semantics is transferred to a position closer to the CORE, its degree of involvement increases (Halliday & Matthiessen, 1999), resulting in a decrease in SG and an increase in SD (Luo, 2019).

As illustrated in Figure 2, transformations occur between various types of clauses such as independent clauses, qualifying clauses, embedded clauses as postmodifiers and the like. Halliday and Matthiessen (2004) introduced the concept of the clause complex, which refers to a structure where two or more clauses are logically or temporally connected with each other. Unlike independent clauses that are linked by conjunctions, equal in status and relatively independent to each other, a qualifying clause is more closely related to the primary clause in terms of logical or temporal relationship. The degree of involvement of a qualifying clause is higher than that of an independent clause; therefore, when the same knowledge is built in both clause types, qualifying clauses exhibit higher SD and lower SG than independent clauses.

If the semantics is transferred from independent clauses or qualifying clauses to embedded clauses as postmodifiers in the CORE, the knowledge will become further condensed and abstract. This is because an embedded clause is more centripetal than a qualifying or independent clause, resulting in a further reduction in SG and an increase in SD. For instance:

Episode 7 (News from NOAA website):

The research team mounted a high-precision GHG instrument on the roof of a public light rail train car to semi-continuously capture emissions as the train traversed across the Salt Lake Valley region. An alternative, cheaper method for monitoring the distributions of urban carbon dioxide was thereby developed.

Episode 8 (Mallia et al., 2020):

Michell mounted a high-precision GHG instrument on the roof of a light rail public transit train car that traverses across a range of urban typologies throughout the Salt Lake Valley (SLV) in Utah. An alternative, lower-cost method for monitoring the distributions of urban GHGs was thereby developed.

The underlined qualifying clause in episode 7 is transformed into the underlined embedded clause as postmodifier in episode 8. The semantics is centripetally transferred into the CORE, resulting in an increase in SD and a decrease in SG along with the increase in the degree of involvement. Likewise, Figure 2 also displays the transformation from circumstances external to the CORE to participants in the CORE, even though this transformation occurs less frequently (with only 5 instances). When semantics built in a circumstance is transferred to a participant in the CORE, the degree of involvement increases, leading to an increase in SD and a decrease in SG.

The transformation processes among different fractal elements of the same rank but external to the CORE could also be analyzed in terms of the degree of involvement. For instance:

Episode 9 (News from NOAA website):

While temperature changes across the U.S. of 1-2 degrees over the past 40 years are well known and established, changes in natural evaporative demand are not as well quantified.....

Episode 10 (Albano et al., 2022):

In spite of the 2-degree warming across the U.S. over the past 40 years, natural evaporative demand is not well quantified.....

The underlined qualifying clause in episode 9 undergoes a transformation into the underlined circumstance in episode 10. In addition to the transformation from the postmodifier “of 1-2 degrees” that modifies the participant in the secondary clause in episode 9 to the premodifier “2-degree” modifying the nominal phrase in the circumstance in episode 10, the postmodifier “across the U.S.” which modifies the participant in the secondary clause in episode 9, becomes a postmodifier of the nominal phrase in the circumstance of the CORE in episode 10. Since the postmodifier in circumstance of the CORE is more closely related to the CORE structure than that in the secondary clause, its degree of involvement is higher than the latter’s, thus being higher in SD and lower in SG.

As far as the transformation from everyday terms to technical terms is concerned, the SD of technical terms proves higher than that of everyday terms (Martin, 2013; Maton & Doran, 2017a), due to more condensed connotation in technical terms, which requires a greater number of words to illustrate their meanings to outsiders. Furthermore, technical terms are typically more abstract than everyday terms for

most audience. Audience can easily visualize the context associated with everyday terms, however technical terms would be difficult for the outsiders to position themselves in a specific context, thus hindering their comprehension. In consequence, as the SD increases through the utilization of technical terms, the SG decreases accordingly.

4.2 The Updated Scale for SD/SG

Based on the above-mentioned analysis and explanations of transformations between fractal elements, this research takes a comprehensive picture of the fractal elements involved in discourse, identifying the possible manifestations of semantic condensation and abstraction. The scale for SD/SG of fractal elements has been illustrated in Figure 3.

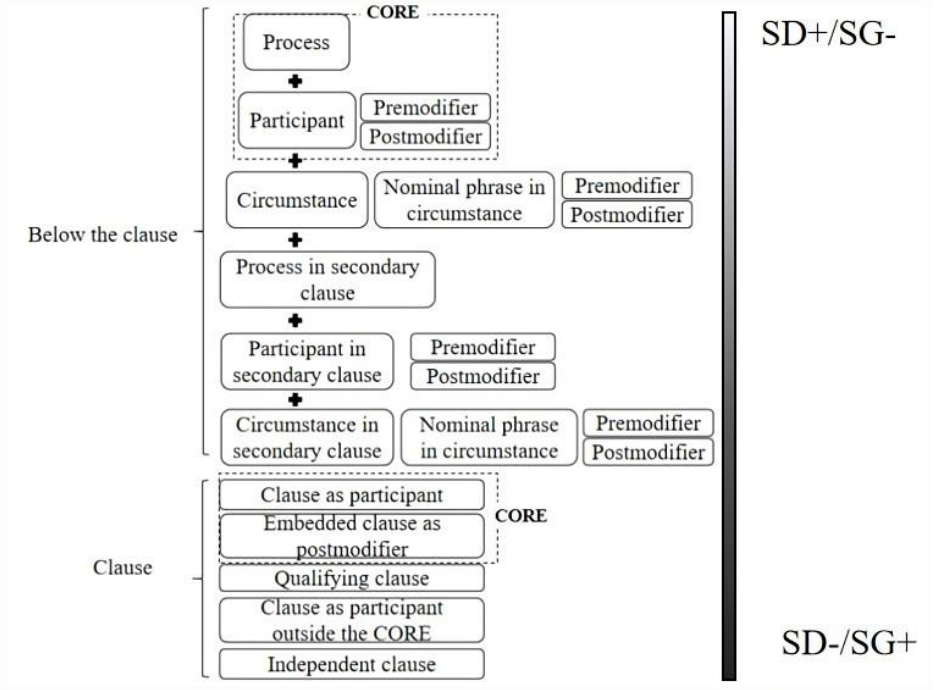

Figure 3. The Scale for SD/SG of Fractal Elements

As illustrated in Figure 3, the higher a fractal element's position is, the higher its SD and the lower its SG will be. The notion of rankshift (Halliday & Mattiessen, 2004) serves as the primary criterion for ranking the SD/SG of the fractal elements at different ranks, while ranking the SD/SG of different types of fractal elements at the same rank is based on the "degree of involvement" (Halliday & Matthiessen, 1999). Specifically, when the same semantics is transferred between fractal elements at different ranks, it becomes more condensed and abstract in fractal elements at lower rank. In addition, the comparison of SD/SG between fractal elements at the same rank can be achieved in terms of their degrees of involvement to the CORE. The closer a fractal element is to the CORE in terms of logical semantic relationship, the higher its SD and the lower its SG. For this reason, the fractal elements below the

clause in the CORE have higher SD and lower SG than circumstances, while circumstances have higher SD and lower SG than the fractal elements in secondary clauses. In summary, the new scale enables the comparison of SD/SG between fractal elements across different ranks and different types of fractal elements at the same rank.

While previous studies attempted to build the scale for SD/SG through introspection, this research identified the possible transformation processes between fractal elements based on corpus-assisted discourse analysis, ranked them in terms of SD/SG, and thereby built a more scientific and objective scale. As a result of the corpus-assisted discourse analysis, the updated scale's reliability and validity will be higher than the previous ones built through introspection. In consequence, this updated scale for SD/SG is likely to scaffold the exploration of knowledge building mechanisms in science discourse or popular science discourse.

5. Conclusion

Drawing on the theoretical support of SFG, this research uses a comparative lens to rank fractal elements in terms of their strengths of SD/SG. The objective scale for SD/SG of different fractal elements was built by quantitatively comparing the different linguistic expressions of the shared semantics between episodes from scientific RAs and news reports.

This research proves valuable practical and theoretical significance. First, the achievement of objective scale for SD/SG provides relatively objective and scientific identification framework for knowledge building, improving the reliability and feasibility of future research that delineates the semantic wave of disciplinary discourse. Second, using corpus-assisted discourse analysis, this research more comprehensively compares the SD/SG among different fractal elements, further integrated SFG with the notion of semantic wave. Such integration strengthens the explanation of discourse analysis (Maton et al., 2016), and improves the applicability of the semantic wave in empirical research.

Despite the innovations the present research contains, there are two limitations that future research can address. Firstly, in spite of the newly built scale for SD/SG in the present research, the precise scale values of SD/SG have not been assigned to the involved fractal elements, and a profile of the semantic wave for each episode cannot therefore be accurately depicted in this research. This is a problem that has long plagued scholars who are probing into semantic wave, and more empirical studies await to be done to determine the precise scale values of SD/SG for different fractal elements (Wu & Chen, 2022). It is noteworthy that research methods and theories are two interdependent sides of one coin, with developments in one field supporting improvements in the other. That is, the developments of research methods would support the improvements and applications of the corresponding theories, and theory developments would also request the corresponding advances in research methods. Therefore, only through the ongoing refinement of the scale for SD/SG and achieving precise descriptions of the semantic wave profile can the theory of semantic wave be widely applied in empirical studies on the

knowledge building. Moreover, while this research primarily further integrated the experiential meaning in SFG with semantic wave, it is non-negligible that SFG is multifunctional and all three of its meta-functions may be all relevant to the notion of semantic wave. As a result, the notion of semantic wave would be further developed, providing that we may integrate all three meta-functions with semantic wave theory in the future.

References

Abatzoglou, J. T., Juang, C. S., Williams, A. P., Kolden. C. R. & Westerling. A. L. (2020). Increasing synchronous fire danger in forests of the western. *Geophysical Research Letters*, *48*(2), e2020GL091377.

Albano, C. M., Abatzoglou, J. T., McEvoy, D. J., Huntimgton, J. L., Morton, C. G. et al. (2022). A multidataset assessment of climatic drivers and uncertainties of recent trends in evaporative demand across the continental United States. *Geophysical Research Letters*, *23*(4), 505-519.

Bernstein, B. (2000). *Pedagogy, Symbolic Control and Identity: Theory, Research, Critique*. Oxford: Rowman & Littlefield Publishers.

Cloran, C. (1994). *Rhetorical unit and decontextualisation: An enquiry into some relations of context, Meaning and Grammar*. Nottingham: School of English Studies, Nottingham University.

Cloran, C. (2010). Rhetorical unit analysis and Bakhtin's chronotype. *Functions of Language*, *17*(1), 29-70.

Halliday, M. A. K. (1993). General orientation to Writing Science: Literacy and Discursive Power. In M. A. K. Halliday & J. R. Martin (Eds.), *Writing Science: Literacy and Discursive Power* (pp. 2-24). London & Washington D. C.: The Falmer Press.

Halliday, M. A. K. (1998a). Things and relations: Regrammaticising experience as technical knowledge. In J. R. Martin & R. Veel (Eds.), *Reading Science: Critical and Functional Perspectives on Discourses of Science* (pp. 185-235). London & New York: Routledge.

Halliday, M. A. K. (1998b). Language and knowledge: The "unpacking" of text. In Allison, D., Zhiming, L. B. & S. A. Abraham (Eds.), *Text in Education and Society* (pp. 157-178). Singapore: Singapore University Press & World Scientific.

Halliday, M. A. K. (2002). On grammar. In J. Webster (Ed.), *The Collected Works of M.A.K. Halliday* (Vol. 2). London: Continuum.

Halliday, M. A. K. (2004). The Language of Science. In J. Webster (Ed.), *The Collected Works of M.A.K. Halliday* (Vol. 5). London: Continuum.

Halliday, M. A. K., & Martin, J. R. (1993). *Writing Science: Literacy and Discursive Power*. Pittsburgh, PA: University of Pittsburgh Press.

Halliday, M. A. K. & Mathiessen, C. M. I. M. (1999). *Construing Experience through Meaning: A language-based approach to cognition*. London: Bloomsbury Publishing Plc.

Halliday, M. A. K. & Mathiessen, C. M. I. M. (2004). *An Introduction to Functional Grammar*. London: Oxford University Press.

Mallia, D. V., Mitchell, L. E., Kunik, L., Fasoli, B., Bares, R. et al. (2020). Constraining Urban CO_2 Emissions Using Mobile Observations from a Light Rail Public Transit Platform. *Environmental Science & Technology*, *54*(24), 15013-15021.

Martin, J. R. (2013). Embedded literacy: Knowledge as meaning. *Linguistics and Education*, *24*(1), 23-37.

Martin, J. R. (2014). *Revisiting field "semantic density" in ancient history & biology discourse*. Paper presented at 41th International Systemic Functional Congress, Mendoza, Argentina.

Martin, J. R. (2017). Revisiting field: Specialized knowledge in secondary school science and humanities discourse. *Onomázein*, *3*(1), 111-148.

Martin, J. R., & Matruglio, E. (2020). Revisiting mode: Context in dependency in Ancient History classroom discourse. In J. R. Martin, K. Maton, & Y. J. Doran (Eds.), *Accessing Academic Discourse: Systemic Functional Linguistics and Legitimation Code Theory* (pp. 89-113). London: Routledge.

Maton, K. (2000). Recovering pedagogic discourse: A Bernsteinian approach to the sociology of educational knowledge. *Linguistics and Education*, *11*(1), 79-98.

Maton, K. (2011). Theories and things: The semantics of disciplinarity. In F. Christie & K. Maton (Eds.), *Disciplinarity: Functional Linguistic and Sociological Perspectives* (pp. 62-84). London: Continuum.

Maton, K. (2013). Making semantic waves: A key to cumulative knowledge-building. *Linguistics and Education*, *24*(1), 8-22.

Maton, K. (2014a). Knowledge and Knowers: Towards a realist sociology of education. *Journal of Education Policy*, *29*(3), 531-535.

Maton, K. (2014b). Building powerful knowledge: The significance of semantic waves. In E. Rata, & B. Barrett (Eds.), *The Future of Knowledge and the Curriculum* (pp. 181-197). London: Palgrave Macmillan.

Maton, K., Hood, S., & Shay, S. (2016). *Knowledge Building: Educational Studies in Legitimation Code Theory*. London: Routledge.

Maton, K., & Doran, Y. (2017a). Semantic density: A translation device for revealing complexity of knowledge practices in discourse, part 1—wording. *Onomázein*, *3*(1), 46-76.

Maton, K., & Doran, Y. (2017b). Condensation: A translation device for revealing complexity of knowledge practices in discourse, part 2—clausing and sequencing. *Onomázein*, *3*(1), 77-110.

Saltzman, E. S., Nicewonger, M. R., Montzka, S. A., & Lewis, S. A. Y. (2022). A Post-Phaseout Retrospective Reassessment of the Global Methyl Bromide Budget. *JGR Atmospheres*, *127*(3), e2021JD035567.

Valin, R. D. V. (2005). *Exploring the Syntax–Semantics Interface*. Cambridge: Cambridge University Press.

Wang, Y., Ge, C., Garcia, L. C., Jenerette, G. D., Oikawa, P. Y., et al. (2021). Improved modelling of soil NO x emissions in a high temperature agricultural region: role of background emissions on NO 2 trend over the US. *Environmental Research Letters*, *16*(8), 084061.

Zhang, X., Yao, Y. T., Ji, Y. S. & Fang, B. X. (2016). Effective and fast near duplicate detection via signature-based compression metrics. *Mathematical Problems in Engineering*. https://doi.org/10.1155/2016/3919043

Lei, X. (2020). The stylistic relationship between popular science discourse and science discourse: A case study of Hawking's two texts on black holes. *Foreign Language Education*, *41*(6), 54-59.

Li, Z. Z., & Hu, M. X. (2016). Evaluating gravity based on semantic gravity theory and evaluation theory: A case study of Fu Ying's "Is China a Superpower?" *Foreign Language Research*, *33*(4), 1-6.

Luo, Z. B. (2019). An SFG approach to the fractal lexicogrammar of semantic wave. *Foreign Language Learning Theory and Practice*, (3), 68-75.

Luo, Z. B., & Jiang, Y. H. (2015). The semantic wave construction model of grammar metaphor. *Modern Language Studies*, (3), 24-29.

Luo, Z. B., & Yang, B. J. (2020). On a legitimate construal of semantic waves: A case study of scientific texts. *Foreign Language Teaching and Research*, *52*(4), 607-619.

Peng, X. W. (2019). A study of English in subjects: problems and countermeasures of high level English education. *Foreign Language Education*, *40*(2), 1-7.

Wu, J. G., & Chen, Q. (2022). Legitimation Code Theory: interpretations and prospects. *Modern Foreign Languages*, *45*(4), 575-584.

Yu, H. (2018). A semantic density perspective on cumulative knowledge building in pedagogical discourse. *Foreign Languages in China*, *15*(3), 21-30.

Zhu, Y. S. (2014). The inheritance and innovation of Legitimation Code Theory on Bernstein's Theory of Knowledge Structure. Foreign Languages in China, *12*(4), 16-25.

Zhu, Y. S. (2015). From semantic gravity and semantic density to mass and presence. Foreign Languages in China, *12*(4), 16-25.