



Research Article

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A multimodal discourse analysis of English dentistry texts written by Saudi undergraduate students: A study of theme and information structure

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Abstract: The study of multimodality in discourse reveals the way writers articulate their intended meanings and intentions. Systemic functional analyses of oral biology discourse have been limited to few studies; yet, no published study has investigated multimodal textual features. This qualitative study explored and analyzed the multimodal textual features in undergraduate dentistry texts. The systemic functional multimodal discourse analysis (SF-MDA) is framed by Halliday's (Halliday, M. A. K. 2014. *Introduction to Functional Grammar*. Revised by Christian M. I. M. Matthiessen. 4th ed. London/New York: Taylor and Francis) linguistic tools for the analysis of Theme and Kress and van Leeuwen's (Kress, Gunther, and Theo van Leeuwen. 2006. *Reading Images: The Grammar of Visual Design*. London: Routledge) framework for the analysis of visual designs. Oral biology discourse intertwines two thematic progression patterns: constant and linear. Although a split-rheme pattern was minimally employed, disciplinary-specific functions of this pattern emerged. The SF-MDA of the composition of information in oral biology pictures extends Kress and van Leeuwen's functional interpretations of the meaning-making resources of visual artifacts. Finally, the pedagogical implications for science tutors and for undergraduate nonnative science students are presented.

Keywords: oral biology discourse, dentistry discourse, thematic progression, composition of information value, systemic functional linguistic, systemic functional multimodal discourse analysis

1 Introduction

The study of multimodality in discourse has increased over the past two decades because it reveals the way writers articulate their intended meanings and intentions. Multimodality determines “the combination of different semiotic resources, or modes, in texts and communicative events, such as still and moving image, speech, writing, layout, gesture, and/or proxemics” (Adami 2016, 451). Discourse investigations of multimodal biology discourse are limited to a few studies (Hannus and Hyönä 1999, Kress 2003, Guo 2004, Baldry and Thibault 2005, Jaipal, 2010); yet, no published study has explored and analyzed the way multimodal semiotic forms are organized and presented in this discipline. As a biology discourse invariably employs pictorial representations (photographs and drawings), it suited the aim of this study. The theme and information structure contribute significantly to the development of cohesive and coherent multimodal texts. Halliday's (1978, 2014) social semiotic approach to language, systemic functional linguistics (SFL), and Kress and van Leeuwen's (2006) framework for the analysis of the grammar of visual design fit with the aim of the present study because they set out the explanation of how students make meaning of language and the various multimodal semiotic resources.

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The present study conducted a systemic functional multimodal discourse analysis (SF-MDA) to explore the realization of the textual metafunction of the different semiotic resources in a key topic in the *Oral Biology* course, i.e., developmental abnormalities: defects of the face and oral cavity.

The study is pertinent, since it is the first to explore the way Saudi undergraduate dentistry students produce cohesive and coherent multimodal texts. It is also of interest as the number of Saudi English as a foreign language (EFL) students enrolled in a dentistry undergraduate program in Saudi Arabia has increased dramatically during the past 10 years. In 2016, for example, the number of Saudi students enrolled in the bachelor of science dentistry program increased by 22.34% from 9,883 to 12,091 (Saudi Ministry of Education 2016). As the Saudi government intends to localize the dental profession, which has thus far been mostly occupied by foreign expatriates, it is not surprising to see many Saudi students attracted to this major. The study may provide insights for science tutors and undergraduate EFL/English as a second language (ESL) science students.

2 Literature review

Investigations of the language of scientific discourse aim to reveal the creative effects of language through systemic linguistic analyses and descriptions of its peculiar features. Halliday (2004), for example, investigated scientific English throughout history and showed how it uses grammatical nominalizations and favors relational clauses (attributive for assigning properties and identifying for definitions), material or mental. Discourse studies of the textual multimodal features in tertiary contexts have included the disciplinary fields of business (Alyousef 2013, 2015a, 2016, 2017), science and computing (Drury et al. 2006, Jones 2006), mathematics (O'Halloran 1998, 1999b, 2005, 2008), journalism and media (Hawes 2015), history (North 2005), and nursing (Okawa 2008). The majority of research focused on primary or secondary school contexts (Hsu and Yang 2007, Jaipal 2010, Korani 2012). For example, Hsu and Yang (2007) explored the effect of science text and image integration on Grade 9 students' reading comprehension. A control-experimental design with pre- and posttests, and semistructured interviews was used. The students were randomly assigned into a focus group ($n = 69$) that read the traditional textbook and an experimental group ($n = 63$) that read an SFL-based textbook which had been created by the researchers. The two texts contained similar scientific concepts but had major differences related to structure of print, image modality, and salience and the interaction between the two forms. The quantitative findings revealed that the experimental group demonstrated better reading comprehension than did the control group. On the other hand, the interview results indicated that an SFL image has better efficacy. This indicated that reading comprehension is facilitated when images and print are integrated. Hsu and Yang (2007) concluded that SFL could serve as a resource for developing and designing scientific textbooks.

Discourse investigations of multimodal biology texts are confined to a few studies (Hannus and Hyönä 1999, Kress 2003, Guo 2004, Baldry and Thibault 2005, Jaipal 2010). For example, Jaipal (2010) developed a multimodal SFL-based framework for science classroom discourse in order to investigate its potential to provide insights into how a Grade 11 biology teacher selected, sequenced, and modified semiotic modalities to support students in constructing a scientific meaning for the concept "chemosynthesis." The framework was also based on Lemke's (2002) semiotics typology of meaning for discourse analysis. Data were collected through classroom observations, semistructured interviews with students, student artifacts, and ongoing, informal interviews with the teacher. The findings revealed the usefulness of this framework for understanding teachers' explanations and for supporting, scaffolding, extending, and reinforcing meaning making. Jaipal (2010), however, did not investigate the construal of "theme" and information value in biology discourse; instead, the researcher identified aspects related to genre, such as the structure and sequencing of a topic, lessons, concepts, modalities, and words. In visual diagrams, typographical (e.g., images, arrows) and compositional tools (e.g., texture, color) were identified. Hannus and Hyönä (1999) investigated the use of pictures in biology elementary-level textbooks using the eye-tracking methodology to trace the students' trajectory with precision. The findings showed that high-ability

children performed better at integrating the relevant passages of text and pictures, which was required to answer the more demanding comprehension questions about the textbook passages. Guo (2004) studied the use of textbook articles on the molecular biology of the cell by second year bachelor of science majors. He proposed social semiotic frameworks for analyzing two common types of visual display in biology texts that interact with each other to make meaning: schematic drawings and statistical graphs. Whereas the ideational (or representational) meaning of the former is expressed through the topological aspects of shape, color, size, spatial relation, and action, the latter is understood through the relative numerical relationships between two sets of variables, or through the distribution of an attribute of some entities among a sample or a population. Guo (2004), however, did not investigate the construal of thematic progression (TP) patterns in biology discourse. It is, therefore, pertinent to explore and analyze the multimodal textual features in undergraduate dentistry students' responses to the assignments.

To sum up, systemic functional investigations of biology discourse are limited to a few studies, and no published study has explored and analyzed the multimodal textual features. The present study conducted an SF-MDA of the textual features of a key topic in multimodal oral biology texts. What follows is a brief description of the data and method of analysis.

3 Theoretical framework: SF-MDA

The nomenclature SF-MDA has been used since oral biology texts started to include pictorial representations. The SF-MDA was framed by Halliday's (2014) SFL social semiotic approach to the analysis of theme/rheme and TP patterns and Kress and van Leeuwen's (2006) approach to the grammar of visual design in order to explore the salient textual features of oral biology texts and the ways in which undergraduate dentistry students construct cohesive and coherent multimodal texts.

Since Halliday's (2014) SFL approach considers the functions of language in social interaction, it is relevant to the context of the present study. SFL is concerned with the interpretation of texts in relation to the context in which these texts are produced and received. It conceptualizes context into three language registers: field of discourse, which is concerned with the experiential meanings being discussed; tenor of discourse, which focuses on the construction of social relations and roles; and mode of discourse, which is concerned with how semiotic forms are organized and presented. The latter register is represented in texts by our use of thematic and cohesive structures, which, with the aid of the former two registers, organize the informational structure of a text into a coherent whole. Due to spatial limitations, I have only investigated theme and information structure in oral biology texts, since these linguistic resources play an important role in the organization and cohesive flow and coherence of a text, as is shown next.

Halliday (2014, 64) defines theme as the "point of departure for the message; it is that which locates and orients the clause within its context." Theme defines the topic of the clause, while rheme constitutes the remaining elements of the message that develop the theme by providing additional information. For example, the phrase "an anomaly" in the sentence "an anomaly is usually something that is abnormal at birth" is a *topical* (or *experiential*) theme, while the rest is the rheme. A sentence can also include other two theme types which are optional: *textual* (e.g., furthermore, therefore) and *interpersonal* (e.g., probably, must). Theme conflates with the subject in declarative clauses (e.g., John got up early); the finite in interrogative clauses (Did [*theme*] John get up early?); the predicator in imperative clauses (Leave [*Theme*] the book here?); or WH in WH interrogatives (Where [*Theme*] did John go?). The finite carries the selections for number, tense, and polarity (yes or no). The predicator tells us what process was actually happening. In such cases, *theme* is unmarked because this is "the most typical/usual" (Eggins 2004, 318) choice, whereas it is marked when it conflates with a prepositional or an adverbial group/phrase to provide circumstantial details about an activity.

Whereas *given* refers to "what is already known or predictable," *new* information, as its name suggests, refers to "what is new or unpredictable" (Halliday, 2014, 89). Rheme, however, does not necessarily conflate with *new* since it is marked off by pitch or tonic prominence. The system of theme/

rheme is typically conflated with the information functions of given/new. It should be pointed out that *theme* does not necessarily conflate with what is being discussed (i.e., the subject or given information). A *subject* is excluded from being the theme of a clause in the case of a marked topical theme which has a mood function other than subject, such as the theme “For an older child or adult, [Theme: Topical]” in “For an older child or adult, [Theme: Topical] *tongue-tie can make it hard to sweep debris of food from the teeth* [Rheme]” (Sara’s text). The function of the marked theme in the example above is to guide the reader through the text by setting the scene for the clause carrying that message.

On the other hand, TP refers to how cohesion and coherence in a text are created by repeating meanings from the theme of one clause in the theme of subsequent clauses, or by placing elements from the rheme of one clause into the theme of the next. There are three TP patterns (Egins 2004): the *theme reiteration* (or “constant”) pattern which keeps the same topical theme in focus throughout a sequence of clauses; the *linear* (or “zig-zag”) pattern by which information situated in the rheme position moves to the theme position in the subsequent clause, and the *multiple-rheme* (or “fan”) pattern by which a theme introduces a number of various aspects in the rheme position, which are then employed as themes in the subsequent clauses.

The SF-MDA of pictorial representations was framed by Kress and van Leeuwen’s (2006) framework for the analysis of the grammar of visual design, which is primarily based on SFL. Kress and van Leeuwen (2006) assigned representational, interpersonal, and compositional meanings to the analysis of visual images. First, visual structures, like linguistic structures, include visual representational processes or activities within and are associated with participant roles and specific circumstances. For example, Kress and van Leeuwen (2006) argue that when the participants are connected by “vectors” of motion or eyelines, they are presented as “doing” something. Second, when analyzing the interpersonal metafunction of the visual modes, one has to take into consideration the relationship between the visual representational processes and the viewer, which can be revealed through specific visual techniques that build this relationship, such as facial expressions, gazes, gestures, the angle (is it horizontal or vertical), and distance of the shots, all contribute to the level of involvement by the viewer and the degree of social distance between the represented participants and the viewers. The third and final feature is the compositional metafunction, which helps to determine the extent to which the visual and verbal elements achieve a sense of coherence to the whole unit which requires the study of the page layout. Kress and van Leeuwen’s (2006) systems for the analysis of the textual organization in images seemed appropriate for the aims of my study because they reveal the configurations of the multimodal texts through the representational and interactive meanings of the image to each other through three “interrelated systems” – composition of information value (top/bottom, center/margin, left/right); visual salience (size, contrast, color, focus); and visual framing by dividing lines (or its absence). The absence of framing stresses group identity, whereas its presence signifies individuality and differentiation. While the composition of information value is similar to Halliday’s *given-new* organization in orthographic texts, salience and framing are counterparts of *theme/rheme*.

4 Data and method of analysis

The corpus used in this qualitative study was written by eight high-achieving Saudi students enrolled in the bachelor of science dentistry program. Thus, it consisted of eight major assignments (6,085 words) written in English on a key topic in the *Oral Biology* course, namely, developmental abnormalities (or defects) of the face and oral cavity. The eight texts were comparable since they shared the same topic. The *Oral Biology* course is one of the foundation courses in the dentistry undergraduate program. The students were enrolled in the bachelor of science dentistry program and were given the pseudonyms Sara, Ibrahim, Khalid, Shatha, Hajer, Yara, Zahra, and Noura. A purposive sampling was employed in which the students were deliberately sought based on gender mix and a high level of achievement. Since the number of participants cannot be claimed to be a representative sample, the study does not attempt to generalize or replicate but rather to understand a specific context as it stands.

The SF-MDA included three stages:

- An analysis of thematic choices (topical, textual, and interpersonal) and TP patterns in the orthographic texts.
- A visual analysis of theme and information value in the pictorial images.
- A description of the meaning-making processes in the pictorial representations and the interplay between both modes in reaching full meaning.

The unit of analysis in the present study is the T-unit. A T-unit is defined as “a clause complex which contains one main independent clause together with all the hypotactic clauses which are dependent on it” (Fries 1995, 318), i.e., an independent clause with one or more dependent clauses. The choice of the T-unit was prompted by the fact that it is an optimal unit for capturing TP patterns. The identification of theme depends on the position of the dependent clause in the complex T-unit. If it occurs initially, the entire clause is deemed to be the theme; conversely, if the independent clause occurs initially, the grammatical subject is the theme. The frequency of occurrence of each TP pattern was manually annotated. Instances of elliptical topical themes were included in the analysis as they signal the textual function given. Since the interpretations of disciplinary-specific pictorial representations are often as important as the language surrounding them, the SF-MDA also utilized the participants’ intuitive verbal interpretations (or intended reading path) (van Leeuwen 2005) of these artifacts. These interpretations (or understanding) of the pictures revealed the processes underlying the construction of conceptual and linguistic knowledge of theme and information value in the images.

The interpretations were audio-recorded, transcribed, and annotated after placing each interpretation next to its relevant image. In order to ensure reliability in the annotations of theme, the annotations’ codes were iteratively cross-checked in addition to being revised by a fellow linguist. In terms of validity, the percentage for the frequency of each TP type was calculated by dividing the total number of instances by the total number of occurrences of the overall patterns and then multiplying the result by 100. The use of quantitative data in the present qualitative study was aimed at making claims such as “most” and “higher” more precise.

Next I present and discuss the findings of the SF-MDA of oral biology texts.

5 Results and discussion

The findings of the SF-MDA of the textual features in oral biology texts are presented and discussed in this section, and an overview of the context of the study is included.

5.1 Context

The participants were asked to write an assignment about developmental abnormalities (or defects) of the face and oral cavity. They were required to refer to the textbook, *Oral Histology Development, Structure, and Function* (Nanci 2008). The purpose of the assignment is to understand well the principles of the development of the oral cavity and the face. Students are expected to be able to:

- have a clear understanding of the congenital and acquired anomalies of the oral cavity and
- know the precise structure and composition of oral tissue.

Each of the eight participants received an “A” for this assignment. Table 1 outlines the key statistics of the eight students’ texts.

The participants were not constrained by a word limit. With the exception of Yara, the participants’ texts were accompanied with images. It should be noted here that some pictorial representations were

Table 1: A pivot table of the participants' texts

No.	Participant	Text word count	Number of images	Number of tables
1	Sara	865	2	1
2	Ibrahim	966	4	0
3	Khalid	525	6	0
4	Shatha	742	5	0
5	Hajer	305	3	0
6	Yara	1,499	0	0
7	Zahra	656	2	0
8	Noura	527	4	0
	Total	6,085	26	1

similar to those in the other students' assignments since all eight students were required to write on the topic of defects of the face and oral cavity. As a result, only eight images were analyzed. It is likely that Yara did not include any visuals in her text because of her preference for a verbal learning style. The eight texts encompassed 26 images and one table. Sara was the only student who preferred to use a table to compare the symptoms of two types of macroglossia (or tongue hypertrophy), which includes cases of apparent tongue enlargement (Vogel et al. 1986).

5.2 SF-MDA findings and discussion

The sociocultural context of this assignment is construed by the three register variables of *field*, *tenor*, and *mode* (Halliday, 2014):

- *Field*: the text is on facial and oral cavity defects. Specialized scientific technical terms are related to oral biology and only known by specialists in the field. These terms are experientially represented in the written texts through the system of transitivity (relational identifying processes) and logically represented through lexical sense relations; the terms are represented in pictorial representations through the system of vectoriality (tilting, distance, and angle) (Kress and van Leeuwen 2006).
- *Tenor*: type of interaction – monologue, interactive – represented linguistically, in image-text format, through the declarative mood element. The students formally engaged with the major assignment which would only be read by a science academic tutor. The text includes interactive pictorial representations, drawings, and pictures, with some being adjacent to facilitate comparability.
- *Mode*: written to be assessed by the tutor. Multimodal discourse: texts and multisemiotic images. The former is linguistically represented through the systems of cohesion, TP, and *given/new*, whereas the latter is through the systems of composition, framing, and salience. Medium: print, accompanied by pictorial printed images: assignment submitted on A4 paper. Frame: informative expository text.

In order to successfully complete the oral biology assignment, students had to manage the expressions of *field*, *tenor*, and *mode* through experiential, interpersonal, and textual language metafunctions. Due to space limitations here, I only investigated the way theme and information value were represented by the eight Saudi EFL participants. The SF-MDA findings revealed that the most frequently occurring TP pattern was constant theme (81.25%), followed by the rare occurrence of linear pattern (16.25%) and the minimal use of split-rheme pattern (2.50%). As the students were not constrained by a word limit and were free to choose the developmental defects about which to write, the frequency of constant theme in the eight multimodal texts ranged between 73% and 97%. The occurrence of this pattern in the written texts was higher than that of the images (69.17% and 12.08%, respectively).

The finding related to the extensive use of constant theme is not surprising as this corresponds with most of the studies (e.g., Li and Fan 2008, Ebrahimi and Ebrahimi 2012, Alyousef 2015a, 2015b). Excerpts of this pattern are shown below (reiterated experiential themes are italicized).

Tongue-tie can intervene with one's ability to make certain sounds – such as “t,” “d,” “s,” “z,” “th,” and “l.” *It* can particularly be challenging to roll an “r.” (Sara's text)

Mucoceles are pseudocysts of minor salivary gland origin. *They* are formed when salivary gland secretions dissect into the soft tissues surrounding the gland. (Khalid's text)

These small tumors arise from the epithelium. *They* have no malignant potential. *Most* are excised. HEMANGIOMA AND LYMPHANGIOMA [subheading]. *More than half of these angiomas* occur in the head and neck. (Shatha's text)

Two pits develop on the frontal process. *They* divide the frontal process into three parts. (Hajer's text)

Congenital pits of the lower lip typically present as bilateral, paramedian depressions in the vermilion border. *They* represent small accessory salivary glands. (Yara's text)

The reconstructive process can be complicated. *It* often involves multistage procedures (Zahra's text)

Focal enlargement of the tongue usually is caused by congenital tumors, particularly lymphatic malformations and hemangiomas (pictures 6 and 7). *It* also may occur in patients with multiple endocrine neoplasia type 2B. (Noura's text)

Sara, Zahra, and Noura used the reference item *it* to refer back to a previously mentioned thematized participant, while Khalid, Shatha, Hajer, and Yara used the reference item *they*. This pattern preserves the theme focus, as new information is presented. The findings also revealed that the students did not use personal pronouns (*we*) in the theme position. This finding corresponds with Hyland's (2005) claim that while students are inclined to avoid interjections and personal pronouns, “expert writers” employ these features to build close relationships with readers. Interestingly, the eight students extensively used bullet points to list the characteristics of some of the developmental defects of the face and oral cavity, the symptoms, and their causes, as shown below (implicit finites in the rheme position are placed in square brackets and implicit themes are italicized and placed in square brackets).

The symptoms of macroglossia may be as follows:

- [*The first symptom of macroglossia*] [is] Dyspnea – labored breathing, cessation of breathing during sleep (apnea).
- [*The second symptom of macroglossia*] [is] Dysphagia – difficulty in swallowing certain food or liquids.
- [*The third symptom of macroglossia*] [is] Dysphonia – disrupted speech, possibly manifest as lisping.
- [*The fourth symptom of macroglossia*] [is] Sores infecting corners of the mouth.
- [*The fifth symptom of macroglossia*] [is] Marks on the side border of the tongue due to pressure from the teeth.
- [*The last symptom of macroglossia*] [is] A tongue that perpetually extends the mouth may develop ulceration. (Sara's text)

The implicit themes and the relational attributive or identifying processes (or verbs) in the above examples are grammatically truncated (or encoded) through the use of bullet points. Whereas a relational identifying process identifies an entity (e.g., [*The last symptom of macroglossia*] [is] *a tongue*), a relational attributive process describes the qualities of the entity (e.g., [*The third symptom of macroglossia*] [is] *Dysphonia-disrupted speech*). The rheme is joined with the theme in relational processes through the use of some form of the verb *be*, as in “[*The first symptom of macroglossia*] [is] Dyspnea-labored breathing, cessation of breathing during sleep (apnea)” (Sara's text). The use of bullet points makes the constant theme pattern and other elements implicit. This seems to be a characteristic feature of oral biology texts, as the main aim is to maintain a reader's focus on the rheme of a clause, which represents new information. The topical theme “symptoms of macroglossia” is implicitly repeated six times since the aim is to concentrate on the main symptoms of macroglossia. Recall of information becomes easier with the

use of bullet points which, in turn, “facilitate the transition from prescription to action” (Chiapello and Fairclough 2002, 198). The findings also revealed few instances where the students did not benefit from the powerful means of these tools; instead, they reiterated the topical themes in the subheadings, i.e.,

BREAST-FEEDING PROBLEMS. *Breast-feeding* requires babies to keep their tongue over the lower gum while sucking. (Sara’s text)

LIP ANOMALIES: Clefting. *Clefting anomalies of the upper lip* are more common and more varied than clefting anomalies of the lower lip. (Ibrahim’s text)

ORAL CAVITY ANOMALIES. *Malformations of the oral cavity* may result from errors in the embryonic fusion of the anterior tongue. (Khalid’s text)

LIPOMAS. *Intraoral lipomas* are rare. (Shatha’s text)

The topical themes in the subheadings were reiterated in the ensuing clauses to provide new information. Bullet points perform a number of linguistic functions. First, key features of an aspect are given prominence by being foregrounded and placed in a theme position while peripheral information is being dispensed (O’Halloran 1999b). Second, the main function of bullet points is to avoid redundancy by using the constant theme pattern. Finally, they encode textual information and relational processes in the most economical manner.

The SF-MDA results also showed that most of the students used the topical themes “abnormalities,” “anomalies,” “disorder,” and “malformations” interchangeably to refer to the same entity. Along similar lines, Shatha employed the topical themes “facial deformities” and “cleft lips and palates,” while Yara used the terms “lesion” and “patch.” The use of synonyms in a constant theme pattern makes the text more cohesive. The frequent use of abstract complex technical terms as topical themes indicates that these inanimate nominal groups play a major role in the development of theme and information value in oral biology texts, such as *ankyloglossia*, *dyspnea*, *dysphagia*, *dysphonia*, *dysplasia*, *epithelial dysplasia*, *endocrine frenulum*, *hemangioma*, *Idiopathic muscle hypertrophy*, *lingual thyroid*, *lymphangioma*, *macro-glossia*, *pseudo macroglossia*, and *frictional keratosis*. This finding is in line with a number of studies (Iedema 2000, Alyousef, 2013).

Linear (or zig-zag) theme pattern was the second frequent type in the students’ texts (Table 2). This finding corresponds with the results in Alyousef’s (2015a, 2015b) studies of business discourse. All the participants employed nondefining relative clauses with the pronouns “that,” “which,” “more,” and “this” to describe the “thing” being discussed. These elements “serve two functions: as a marker of some special status of the clause (i.e., textual) and as an element in the experiential structure” (2015a, 10). Excerpts of linear or zig-zag pattern in the students’ texts, wherein information placed in the rheme position is repackaged in a subsequent theme are shown below.

Poor oral hygiene. For an older child or adult, [Theme: Topical] tongue-tie can make it hard to sweep debris of food from the teeth [Rheme]. *This* [Theme: Topical] can lead to tooth decay and inflammation of the [gums] gingivitis [Rheme]. (Sara’s text)

Some drugs [Theme: Topical] may cause cleft lip and cleft palate [Rheme]. *Cleft lip and cleft palate* [Theme: Topical] may be caused by exposure to chemicals or viruses [Rheme]. (Ibrahim’s text)

Thus deformity of the cranium [Theme: Topical] may also be seen as a facial deformity [Rheme]; indeed [Theme: Interpersonal] *this* [Theme: Topical] may be more obvious than the skull deformity [Rheme]. Leukoplakia [Theme: Topical] is a term used to describe a white patch or plaque [Rheme] that [Theme: Textual] cannot be characterized clinically or pathologically as any other condition [Rheme]. *This definition* [Theme: Topical] does not imply any specific histological changes [Rheme]. Lichen planus [Theme: Topical] is the most common cause of persistent white patches in the mouth [Rheme]. *The patches* [Theme: Topical] are often striated, forming a lace-like pattern [Rheme]. (Shatha’s text)

The traditional intervention for infants with Robin sequence and airway obstruction [Theme: Topical] has been tracheotomy [Rheme]. *The tracheotomy* [Theme: Topical] remains in place until [Theme: Textual] the child and airway

Table 2: Thematic progression patterns in the students' texts

Thematic progression type	Semiotic resource	Sara		Ibrahim		Khalid		Shatha		Hajer		Yara		Zahra		Noura		Sub-total	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Reiteration (parallel)	Text	17	73.91	18	64.28	27	72.97	22	64.71	6	50.00	45	73.77	16	76.19	15	60.00	166	69.17
	Visual	2	8.69	4	14.28	9	24.32	5	14.71	3	25.00	0	20.00	2	9.52	4	16.00	29	12.08
Linear (zig-zag)	Text-Visual	19	82.60	22	78.56	36	97.29	27	79.42	9	81.81	45	73.77	18	85.71	19	76.00	195	81.25
	Text	4	17.40	3	10.72	1	2.71	6	17.64	2	18.19	15	24.59	3	14.29	5	20.00	39	16.25
Multiple-Theme	Visual	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	Text-Visual	4	17.40	3	10.72	1	2.71	6	17.64	2	18.19	15	24.59	3	14.29	5	20.00	39	16.25
Sub-total	Text	0	10.35	3	10.72	0	0.00	1	2.94	0	0.00	1	1.64	0	0.00	1	4.00	6	2.50
	Visual	0	10.35	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	Text-Visual	0	20.70	3	10.72	0	0.00	1	2.94	0	0.00	1	1.64	0	0.00	1	4.00	6	2.50
	Sub-total	23	100	28	100	37	100	34	100	11	100	61	100	21	100	25	100	240	100

[Theme: Topical] are bigger [Rheme] and [Theme: Textual] it [Theme: Topical] is no longer needed [Rheme]. The tongue [Theme: Topical] is progressively moved forward with the mandible, improving the airway [Rheme]. *This* [Theme: Topical] technique has been successful in experienced hands [Rheme]. (Yara's text)

Ankyloglossia [Theme: Topical] can also prevent the tongue from contacting the anterior palate [Rheme]. *This* [Theme: Topical] can then promote an infantile swallow [Rheme]. It [Theme: Topical] can also result in mandibular prognathism [Rheme]; *this* [Theme: Topical] happens when the tongue contacts the anterior portion of the mandible with exaggerated anterior thrusts [Rheme]. (Zahra's Text)

The thematic complement in Sara's text is marked: "for an older child or adult." A marked theme provides a contextual frame for the ensuing message (Davies 1997). The marked theme in Sara's text conflated with the prepositional phrase to provide circumstantial details. Marked themes are thematic because they are *foregrounded* as the theme. They could be an adverbial phrase, a prepositional phrase, or a complement which could potentially be functioning as subject but is not. Marked themes make texts more coherent through the use of theme predication, which includes thematic and informational choices (Eggs 2004). Theme predication refers to the case where a constituent is moved from the theme position and placed in the rheme position in order to be emphasized through intonation, while the real new information is intact. Thus "John" in the second example below is stressed and became new: John [Theme: Topical] broke the vase [Rheme]. *It* [Theme: Topical] was John [Rheme] who [Theme: Topical] broke the vase [Rheme].

The rare use of split-rheme pattern was found in the texts of four participants: Yara, Ibrahim, Noura, and Shatha. They employed this pattern by using bullet points in order to list two or three themes in the rheme position that were picked up and developed in the subsequent themes.

Macroglossia [Theme: Topical] can be **focal or generalized** [Rheme].

- Focal enlargement of the tongue usually [Theme: Topical] is caused by congenital tumors, particularly lymphatic malformations and hemangiomas [Rheme][...].
- Generalized macroglossia [Theme: Topical] is seen in Beckwith-Wiedemann syndrome and hypothyroidism [Rheme]. (Yara's text)

The orbicularis oris muscle [Theme: Topical] is the principal muscle of the lip [Rheme] and [Theme: Textual] *it* is divided into **two parts** [Rheme] [...] *The deep component*, in concert with other oropharyngeal muscles, [Theme: Topical] works in swallowing and serves as a sphincter [Rheme]. *The superficial component* [Theme: Topical] is a muscle of facial expression [Rheme] and [Theme: Textual] inserts into the anterior nasal spine, sill, alar base, and skin to make the philtral ridges [Rheme]. (Ibrahim's text)

White patches [Theme: Topical] have three main histological features: abnormal keratinization, hyper- or hypoplasia of the epithelium, and disordered maturation (dysplasia) [Rheme]. *Dysplasia* [Theme: Topical] is the only significant histological guide to the possibility of malignant change [Rheme]. (Shatha's text)

Macroglossia [Theme: Topical] can be **focal or generalized** [Rheme]. *Focal enlargement of the tongue* usually [Theme: Topical] is caused by congenital tumors, particularly lymphatic malformations and hemangiomas [Rheme][...]. *Generalized macroglossia* [Theme: Topical] is seen in Beckwith-Wiedemann syndrome [32] and hypothyroidism [Rheme]. (Noura's text)

Ibrahim employed this pattern to describe the two parts of the primary muscle of the lip, orbicularis oris: the deep and superficial components. Likewise, Yara and Noura used this pattern to introduce the two subdivisions of macroglossia. Although Shatha used this pattern to name three main histological features of white patches in the oral cavity, she only elaborated on dysplasia because of its ability to turn into a malignant lesion. These results showed some of the functions of this pattern in oral biology texts: describing the types or key features related to facial or oral cavity defects. The second topical theme "it" in Ibrahim's excerpt is ellipsed and was recovered from the first sentence. The split-rheme pattern is considered the most difficult for students as different pieces of information are packed or listed in the rheme position and then picked up and used as themes in the following clauses. This finding is in keeping with Alyousef's (2015a) study of finance texts (<2.50%). The absence

of this pattern in the other four participants' texts may suggest their limited proficiency level and probably their limited writing opportunities. However, the good results the students achieved indicate that they did not have difficulties that hindered their lexico-grammatical choices and the multimodal meaning-making processes.

The data lacked instances of objective interpersonal themes with anticipatory “it” in the subject position with (*be to +*) *infinitive*. Writers employ this theme to extend their viewpoints (“it is *expected* that...”) when presenting key features of an aspect. This finding seems expected as oral biology texts deal with facts rather than presumptions (Abd-El-Khalick et al. 2008). Martínez (2003) investigated theme in biology journals and found a lower proportion of interpersonal themes in the discussion section. This indicates the students' influence by the dominant ideologies of scientific oral biology texts. What follows is the SF-MDA of the pictorial representations.

5.2.1 SF-MDA of the pictorial representations

Pictorial representations (photographs, drawings, paintings, movies) support students' learning, as they help them to construct scientific learning when attempting to recall a message. Image–text relations are metafunctionally integrated across the experiential, textual, and logical meanings at the discourse stratum (Liu and O'Halloran 2009). As stated earlier, the SF-MDA of oral biology pictorial representations (or the visual semiotic mode) and the surrounding text aimed to reveal the underlying processes through which students constructed knowledge of theme and information value. The pictorial representations (fabrications) in oral biology discourse include realist photographs and abstract drawings.

Oral biology images function intersemiotically (across different semiotic resources) through the interaction of the images and the accompanying text, as readers shift their attention from one semiotic mode to another. The pictorial representations provide spatial information that clarifies the meaning in the accompanying text, as students shuttle between the visual and verbal modes. O'Halloran (1999a, 317) refers to “meaning arising from interaction and interdependence between these semiotic codes in joint construction” as a “semiotic metaphor.” The primary semiotic code that formed the “semiotic metaphor” is the text accompanying the picture, as it served as the point of departure and the anchor for the message. Concepts, such as *ankyloglossia* and *dyspnea*, are transformed into another format. The meaning-making processes of pictorial representations encompass multimodal explanations, as they explain the key features of an aspect. As these representations clarify the text, a logico-intersemiotic semantic relation of *elaboration* exists. The accompanying text provides a strong topical focus by presenting further explanations that are not present in the photographic image. Ideologically, the text plays the prime (or lead) role while the images a subservient role. Oral biology images contain visually realized implicit processes and participants that can be recovered from the prior verbal text (van Leeuwen 2006). The two semiotic resources, however, construct a similar meaning as they share the same topical theme. As van Leeuwen (2005, 79) states, “the two are not concatenated in linear fashion. They *fuse*, like elements in a chemical reaction.” This finding exemplifies the ideational complementarity relation of *distribution* mentioned by Unsworth (2006) and Daly and Unsworth (2011), as the two semiotic modes jointly construct similar content.

The SF-MDA findings revealed that oral biology pictorial representations included instances of constant theme (Table 2), as they aim to illustrate and, thereby, complement verbal texts.

For example, the implicit conceptual knowledge underlying the photographic picture of ankyloglossia (or tongue-tie) in Zahra's text (Figure 1) constitutes an important part of meaning-making. It can be made explicit through Zahra's verbal interpretation (or reading path) of the picture as follows:

Ankyloglossia or tongue-tie [Theme] is a congenital oral anomaly [Rheme] that [Theme: Textual] may decrease the movement of the tongue tip [Rheme] and [Theme: Textual] [it] is caused by a short, thick lingual frenulum [Rheme]. (Zahra's text)



Figure 1: A photographic picture of ankyloglossia (or tongue-tie) from Zahra's text.

This interpretation included two instances of constant theme. Thus, ankyloglossia is the theme and what follows is the rheme. *Saliency* and *framing* are the main principles of information value in images. *Saliency* can be realized through size, color contrasts, movement, or anything that distinguishes a word from others (i.e., through different weight, font, or set). Ideas are expressed by means of adjacency and color. They are expressed in the oral biology texts by the degree of difference between the adjacent pictures. Color is a mode of representation, which is organized in oral biology images through splashes with high color saturation, especially Figures 1 and 2, which are brighter and more illuminated. The high color saturation in Figure 1 reveals the accumulation of saliva on both sides, which represents the patient's suffering from ankyloglossia. In fact, a tongue-tie can lead to the accumulation of saliva or even drooling of saliva. Different shades of the orange color are being used in the two images to emphasize the lip. As Kress and van Leeuwen (2006, 145) noted, color is conceived of as "a combinatory *system* with five elementary, 'abstract' colors ('red' in general, rather than a specific red, and so on) from which all other colors could be mixed." For example, the ankyloglossia visual image used different colors (for lips, teeth, mouth, etc.) to represent the real-world (or bodily) elements and distinguish the different parts of the human oral cavity, while creating topical unity and coherence. The mouth in the ankyloglossia image (Figure 1) is given greater *saliency*, as it stands out from its immediate textual environment, i.e., the human face, since the aim of this semiotic mode is to illustrate the attachment of the lingual frenulum to the lower part of the tongue. The lingual frenulum represents the nucleus of information to which all the other elements are in some sense subservient. The tongue represents the ideal (given) and the lingual frenulum represents the real (or new) information. The angle of the shot is at an extreme close-up distance which draws the reader's focus and involvement. Thus, the topical given theme ankyloglossia anomaly is *foregrounded* in

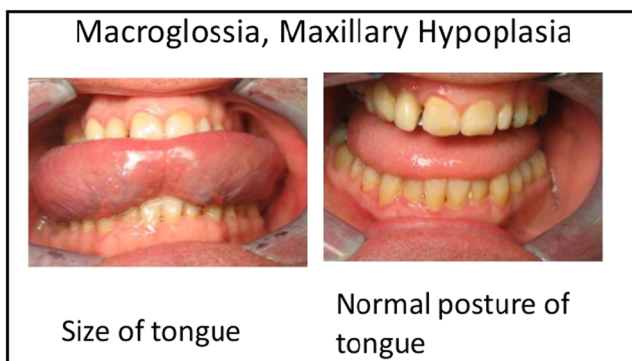


Figure 2: A photographic picture of macroglossia/maxillary hypoplasia from Sara's text.

the zoomed image, while new information is elicited from the students' interpretations of images, or from the text accompanying the picture. In other words, the topical theme in the text accompanying the oral biology picture is *saliently* illustrated in Figure 1. This indicates that the structure of the two semiotic modes is in complete intersemiotic parallelism. Intersemiotic parallelism refers to "a cohesive relation which interconnects both language and images when the two semiotic components share a similar form" (Liu and O'Halloran 2009, 10). The two tongues in the macroglossia/maxillary hypoplasia adjacent photographs (Figure 2) stand out as distinct (or salient) entities because they are not equal in size. They are the mediators since they represent the most salient entities in the two images. The angle here is at a close-up distance. Likewise, the mouth and the nose (Figure 3) are the most salient entities (or topical themes) in Ibrahim's two adjacent illustrative drawings of lip anomalies. Over 25% of the images in the students' texts included adjacent pictures or drawings.

A reader attempts to compare the two adjacent pictures by initiating the gaze at the left picture. The topical themes in the two adjacent images function intrasemiotically since they facilitate comparability. By intrasemiotically, I mean moving your eyes from one component to another within the same semiotic mode. This contrasts with the intersemiotic shifts explained earlier. As the image encompasses two adjacent pictures, the reading path (or a viewer's interpersonal function of gaze) is linear, i.e., from left to right and from top to bottom. The SF-MDA of informational content in Figure 1 revealed, however, that new visual information is at the center of the zoomed picture, rather than to the right. Kress and van Leeuwen's (2006) left-hand and right-hand English-language spatial dimensions, therefore, do not correspond with the compositions of given-new/ideal-real in zoomed images of congenital and acquired anomalies of the oral cavity. This corresponds to Alyousef's (2015a, 2015b) and Jones' (2006) findings that new visual information does not always occur to the right side. O'Halloran (1999b, 27) states that while "verbal discourse functions to describe commonsense reality, visual display connects our physiological perceptions to this reality and in combination with metaphorical shifts, creates new entities which are intuitively accessible." Fei (2004) refers to the element that marks the beginning of the reading path of the dominant visual semiotic element as the "center of visual impact" or, using van Leeuwen's (1993) earlier term, a brief "scanning" of a page to peruse visually salient elements. Whereas Fei (2004) equates image with language in terms of visual perception, van Leeuwen (1993) prioritizes image over language, and Kress (2003) proposes that scanning determines the dominant semiotic resource. In his analysis of the eye image in biology texts in secondary schools, Kress (2003) argues that salience is captured by the bolding of captions. Higher level relations are marked by proximity, while the lower levels use connecting lines. The visuals aided students in building up their taxonomy of oral biology terms.

Framing refers to the demarcation of the elements of a text (verbal or visual). It can be realized through a wide range of semiotic modes (or resources) and, within each mode, by a number of different means.

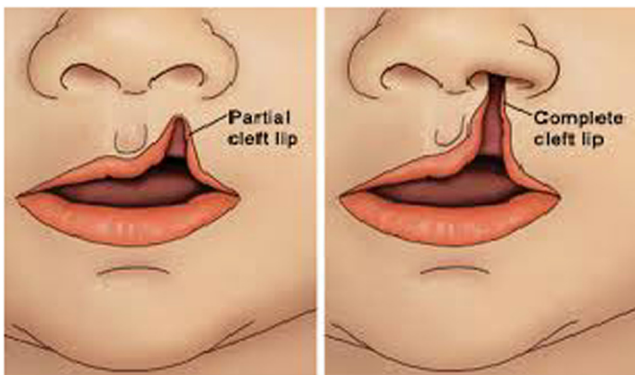


Figure 3: An illustrative drawing of cleft lip types from Ibrahim's text.

For example, the participants in Figure 3 are demarcated by means of an actual frame line that divides the two images, which refer to two distinct classifications of the same concept. The process is expressed here in each drawing by means of the labeled lines (or leaders) and the borderlines circumventing the mouth and the nose.

6 Conclusion and implications

The students have understood well the principles of the development of the oral cavity and the face, as evidenced by their verbal interpretations of oral biology pictorial representations and the high scores they received for this assignment. The students have understood the congenital and acquired anomalies of the oral cavity and also identified the structure and composition of the oral and dental tissues. This study contributes to our understanding of the way in which theme, the composition of information value, and the logico-semantic relations are constructed in the oral biology multimodal texts. These texts intertwined two TP patterns: constant and linear theme patterns. The findings also revealed disciplinary-specific functions of the split-rheme pattern, which was minimally used.

The SFL provides the theoretical basis for future development of a powerful framework for systematically describing the lexico-grammatical aspects of all types of visual artifacts. As Unsworth (2006, 57) stated, “the strength of SFL in contributing to frameworks for the development of intersemiotic theory emanates from its conceptualization of language as one of many different interrelated semiotic systems,” such as mathematics, music, painting, and so forth. This framework needs to be capable of expansion/modification as new forms of communication emerge (Unsworth 2006). The SF-MDA of the composition of information in oral biology images extends Kress and van Leeuwen’s (2006) functional description of meaning-making resources of visual artifacts in terms of compositional zones. New visual information in oral biology texts is at the center of a zoomed picture. The students’ explanations (or interpretations) contributed to our understanding of the meaning-making processes and the way they processed and integrated print and visual images in scientific English. The participants’ interpretations and the SF-MDA revealed the processes underlying the construction of conceptual and linguistic knowledge of theme and information value. However, we should keep in mind that the abstract aspect of visual representations can yield different interpretations; therefore, only a subset of the full range of the writers’ communicative potential has been presented. This observation contradicts the view that the structuring of the reading path is a linear, staged, goal-oriented process. Readers of multimodal texts construct meaning from these texts by “design[ing] the way the text is read, its reading path, what is attended to and, in the process, construct a unique experience during their transaction with a text” (Serafini 2012, 157). In addition, the SF-MDA revealed the construction of the intra- and intersemiotic meanings in the multimodal oral biology texts. Meanings were construed by the students through the intersemiotic shifts (or the resemiotization processes) from textual form to visual and vice versa. The reiteration of a theme in the text surrounding the images provides a strong topical focus by presenting further explanations (elaboration).

The following key linguistic features are drawn from the results of the SF-MDA of oral biology texts:

- The development of theme and information value in oral biology texts is based on extensive use of inanimate, abstract, complex, and topical themes not known by the general community but by specialists in the field.
- The extensive use of textual themes.
- The use of nondefining relative clauses with pronouns to describe a “thing.”
- Key features of an aspect are foregrounded through the use of bullet points in order to facilitate recall and to avoid repetition of the same information through the use of a constant theme pattern.
- Image–text relations in oral biology discourse aim to illustrate and, thereby, complement verbal texts. The two modes jointly construct similar content.

- A logico-intersemiotic semantic relation of elaboration exists between the images and the text surrounding the images since the former provide spatial information.

The present study is limited to eight oral biology texts and, therefore, the findings are not based on a representative sample of the discipline's academia. A number of pedagogical implications of the study are suggested for science tutors as well as undergraduate EFL/ESL science students, especially those whose first language has a different information structuring pattern from English, such as Arabic and Chinese. Students can employ the split-rheme pattern in longer essays where different pieces of information are listed in the rheme position and then picked up and introduced in the theme position in subsequent clauses. This pattern can also be employed through the use of the powerful means of bullet points where the key features of an aspect (e.g., characteristics of some of the developmental defects of the face and oral cavity, the symptoms, and their causes) are listed. Thus, the key features are foregrounded and placed in the theme position and peripheral information is dispensed with instead of being reiterated. Bullet points facilitate recall of information. TP patterning plays a major role in facilitating the comprehension of a text and in producing a well-structured text. Science tutors can introduce students into types of TP patterns and in particular, the split-rheme pattern, which is regarded as the most difficult for students. They need to focus on the process of writing and not only the product by presenting a number of class activities on the use of theme. Tutors should introduce different strategies for creating a cohesive text through the implementation of activities which could include exercises that require students to identify and analyze TP patterns. Subsequently, they can be asked to write an essay to practice organizing theme in their writing. This will aid students to easily control the flow of their texts and to organize their texts more effectively.

Abbreviations

EFL	English as a foreign language
ESL	English as a second language
SFL	Systemic functional linguistic
SF-MDA	Systemic functional multimodal discourse analysis
TP	Thematic progression

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