DITRANSITIVE PROCESS TYPES AS A FEATURE OF MEDICAL ARTICLES

SABIHA CHOURA
Professeur Agrégé, University of Arts and Humanities of Sfax, Tunisia

ABSTRACT

The present research examined ditransitive verbs in medical research articles from a systemic functional perspective. In particular, it focused on the analysis of these verbs according to the different process types in the experiential metafunction. These process types are namely material processes, mental processes, relational processes, verbal processes, behavioral processes, and existential processes. The objective of this research was to display the distribution of different ditransitive process types in the medical corpus. It also attempted to account for the differences as well as the similarities found in these distributions according to sections. To achieve these objectives, ten medical articles taken from the British Medical journal were analysed quantitatively and qualitatively. The present research showed variations in the distribution of the different ditransitive process types in the medical corpus; while material and relational processes are the most frequent in the medical corpus, verbal and mental processes are rarely present. As for behavioural and existential processes, they are totally absent. This is accounted for in terms of the exigencies of scientific writing and in particular the medical discipline, the norms of research article writing and the patterns of ditransitive complementation. The present study also revealed variations in the frequency of occurrence of ditransitive process types according to sections. This is accounted for in terms of the specificities of each section in the research article. Therefore, academic writers should select particular ditransitive process types over others so as to conform to the norms of genre and discipline.

KEYWORDS: Ditransitive Complementation, Experiential Metafunction, Process Types, Research Article Genre, Medical Discipline, Scientific Writing

INTRODUCTION

The present research aims at studying the distribution of ditransitive process types in scientific writing in a particular discipline which is medical science from a systemic functional perspective. It also attempts to examine these processes in a particular genre which is the research article genre as well as its distribution in its different sections. It is based on a quantitative analysis conducted thanks to the UAM corpus tool as well as a qualitative analysis. The analysis shows that material and relational processes are the most frequent ones. It also reveals that mental and verbal processes are rarely present in the corpus understudy while behavioural and existential processes are completely absent. This can be explained by the nature of the scientific writing and in particular the medical discipline, the specificities of the research article and the the grammar of ditransitivity.

Since the present research studies the distribution of ditransitive process types in medical research articles, it is necessary to review ditransitive verbs, the experiential metafunction, scientific writing and the research article genre.

Ditransitive Verbs

Mukherjee (2005, p.80) defines a ditransitive verb as “a trivalent verb that requires a subject, a direct object and an indirect object for a complete syntactic complementation.” In the case of ditransitive complementation, the speaker
employs three participants; that is to say, the verb is complemented by two further constituents. Matthiessen et al. (2010, p.20) provide the following example:

The mother had given the boy a balloon.

The sentence, in this example, is composed of a process which is *had given* and three participants which are *the mother, the boy and a balloon.*

Among the studies on ditransitive complementation is that of the article named *The syntax-pragmatics interface and Finnish ditransitive verbs* written by Kaiser. In this article, he puts emphasis on the syntactic dimension of this pattern. In other words, he (2002, p.1) is concerned with the order of the occurrence of the direct and the indirect object; he claims that “the base-generated order of Finnish ditransitive structures is DO-IO, and that the IO-DO order is generated by scrambling the IO over the DO to a VP-external position. According to [his] analysis, this movement is driven by pragmatic factors.” (ibid.) Francez and Beavers also study ditransitive complementation. On the one hand, Francez (2006) is concerned with the study of possessors, goals and the classification of ditransitive predicates. Beavers (2011), on the other hand, examines a specific category of ditransitive verbs which is that of ditransitive verbs of caused possession.

Another research is provided by Mukherjee (2005) who comes up with “a framework in which the traditionally established gap between competence-related models of language cognition and performance-related descriptions of language use can be bridged.” (p. 2) This study investigates the knowledge of the speakers as far as ditransitive verbs are concerned. Actually, he (2005, p. 262) analyzes six ditransitive verbs in his corpus. These verbs are *give, tell, show, ask, send and offer,* he investigates the frequency of occurrence of complementation patterns of these verbs. In other words, he looks for the patterns which are frequently associated with ditransitive verbs. From the findings of the study, he maintains that the choice of one pattern over another cannot be traced to a single factor; indeed, different factors contribute to this selection. He (2001, p. 263) also considers peripheral ditransitive verbs. He finds out that “new ditransitive verbs were shown to evolve on grounds of specific licensing strategies (e.g. metaphorical extension) that make it possible to extend the meaning of the verb to the typical ditransitive situation schema.” There is also the research conducted by Jung and Miyagawa (2004, p. 1) who examine ditransitive verbs in Korean. They aim at showing that Korean language has a system of case marking enabling to directly identify causative ditransitive verbs. In this context, they claim that “data from Korean provides direct evidence that there is CAUSE in verbs such as give. The type of evidence has to do with case-marking alternation, which is found only with causative verbs and with verbs such as give.” Another research concerning ditransitive complementation is exposed by Schilk (2011, p. 171) who examines «structural nativazation in Indian English lexicogrammar with a specific focus on collocation and verb-complementation of ditransitive verbs.” He concludes that nativazation is affected by the interplay between lexis and grammar. He supports his argument by the analysis of collocational profiles and the patterns of ditransitive verb complementation.

Previous research also consists of the work of Timyama and K. Bergen (2010, p. 137) who conduct a comparative study concerning caused-motion constructions and ditransitive constructions in English and Thai. Both ditransitive constructions and caused-motion constructions have two constituents following the verb. However, in caused –motion constructions, the first NP complementing the verb is a direct object whereas the second is an oblique object which is characterized by a marker having the meaning of direction. They find out that these constructions are affected by the meanings associated with these constructions. For example, “in English, the caused-motion construction tends to occur with verb subclasses whose meaning is consistent with forced motion along a path, while the ditransitive construction is likely to occur with verb subclasses of possessive transfer.” In Thai, both constructions are likely to have verbs conveying transfer of possession or an extension of this meaning because these two constructions stand for possession transfer. The
study also shows that pragmatic motives justify the selection of either the first pattern or the second pattern. These motives vary depending on the language. They also maintain that “by postponing heavier elements, English speakers have more time to formulate difficult constituents and this also makes it easier for the listener to recognize all constituents in a sentence.” However, in Thai, speakers opt for the caused-motion construction if one of the complements of the verb is heavy.

**Systemic Functional Linguistics**

Since the interconnection between syntax and systemic functional linguistics as far as this structure is concerned is scarcely studied in the literature, the present research will be based on a systemic functional analysis. From a systemic functional perspective, Lock (1997, p.76) defines ditransitive clauses as follows: « Clauses which have a recipient or Beneficiary as an Indirect Object are referred to as ditransitive »

Among the previous works on systemic functional linguistics is that of Sujatna (2012) who examines Bahasa Indonesia clauses from two perspectives: clause as message and clause as representation. Other researches on the experiential metafunction include the work of Harvey (2001) who investigates relational identifying clauses in English technical manuals; he (2001, p.1) argues that the selection of the relational process depends on the equivalence between the Token and the Value. As he puts it, “verb choice in (technical) identifying clauses is strongly associated with the degree of equivalence constructed between the two central nominal groups in the clause (the Token and Value).” (ibid.) This relationship of equivalence is affected by various factors such as the structure of the nominal group, the ergativity of the clause and the interpersonal, logical and textual features. Another research in the same trend is provided by Arús and Lavid (2001) who focus on the grammar of relational processes in two languages which are English and Spanish along two genres which are machine-aided translation and multilingual generation. The study of relational processes results in a more accurate translation from English to Spanish and vice versa. This research also has practical implications for translation and parsing. However, the present research is new and original in that it examines a syntactic structure which is ditransitive complementation from a functional perspective. In the analysis of ditransitive verbs, the experiential metafunction will be adopted. At this level, “transitivity is a system of the clause, affecting not only the verb serving as Process but also participants and circumstances.” (Halliday & Matthiessen, 2004, p. 181) The present research will be limited to the process. Indeed, “the transitivity system construes the world of experience into a manageable set of PROCESS TYPES” (Halliday & Matthiessen, 2004, p.170). In the experiential level of analysis, Halliday and Matthiessen (2004, p.171) distinguish between main types of process including material, relational and mental processes and borderline ones referring to existential, behavioural and verbal processes.

**Material Processes**

The material process represents processes of doing and happening. Actually, “a ‘material’ clause construes a quantum of change in the flow of events as taking place through some input of energy” (Halliday and Matthiessen, 2004, p.179). In the material clause, in addition to the process, one participant, namely the actor, is the one who brings about change. It is identical with the subject. Nevertheless, in the case of a passive transformation, the subject and the actor are no longer similar. In a material clause, the actor brings about change which has an impact on another participant. In such a case, “the ‘material’ clause represents a doing” (Halliday and Matthiessen, 2004, p.180). The participant undergoing the effect of the actor is either a goal or a patient. The first one refers to the participant for whom the action “was directed at, or extended to” (ibid.) while the second points to the participant who “suffers or undergoes the process” (ibid, p.181).
Material clauses can also include other participants like recipient, client, attribute and scope. (Halliday and Matthiessen, 2004, p.190)

Mental Processes

According to Halliday and Matthiessen (2004, p.197), mental clauses are “processes of sensing”. He defines the mental clause as the one which “construes a quantum of change in the flow of events taking place in our consciousness.” This can stem from an individual’s own consciousness or from something else encroaching on it. In the mental clause, the subject can be realized by a nominal group standing for a conscious entity. However, the complement is a nominal group which refers to entities of various types. The Senser is “human-like; the significant feature of the Senser is that of being ‘endowed with consciousness’”(ibid., p. 201). In contrast, the Phenomenon can be a thing, an act or a fact.

Relational Processes

Relational clauses are meant for characterization and identification. Be and have are typical examples of relational processes. Unlike “verbs in ‘material’ and ‘mental’ clauses [which] are salient at the accented syllable” (Halliday and Matthiessen, 2004, p.214), those in relational clauses “are typically non-salient.” (ibid.) The participants in relational clauses are not like those in mental clauses as they can be things, acts and facts. In a relational clause, there should be necessarily two participants and a process which links both of them.

Verbal Processes

As Halliday and Matthiessen (2004, p. 252) claim, verbal clauses “are clauses of saying.” These clauses play an important role in narratives as they establish “dialogic passages” or “develop accounts of dialogue on the model of ‘x said, and then y said’ together with quotes of what was said.” Verbs such as say, report, explain, argue, talk and tell illustrate this idea. However, in news reporting, verbal processes identify the sources of information. He concludes that the use of verbal clauses differs from one discourse to another. In academic discourse, for instance, they enable the writers to “quote and report from various scholars while at the same time indicating the writer’s stance with verbs like point out, suggest, claim, assert” (Halliday and Matthiessen, 2004, p. 253).

Verbal clauses are composed of a Sayer and a Process. There can also be another participant standing for the addressee. The latter can be either a Receiver, a Verbiage or a Target. In this context, Halliday and Matthiessen (2004, p. 255) define the Verbiage as “the function that corresponds to what is said, representing it as a class of thing rather than as a report or quote.” It can refer to “the content of what is said” or “the name of the saying”. As far as the former is concerned, the process refers to goods and services. As for the latter, it refers to speech functional categories. These include a question, statement and order, etc (Halliday and Matthiessen, 2004, p. 256).

As for the Receiver, it stands for the human being receiving what is said. Actually, Halliday and Matthiessen (2004, p. 255) maintain that “the Receiver is the one to whom the saying is directed. He also adds that “the Receiver is realized by a nominal group typically denoting a conscious being.” Consider the following example where to your parents is a Receiver.

Did You Repeat That To Your Parents?

As far as the target is concerned, Halliday and Matthiessen (2004, p. 256) state that “the Target occurs only as a sub-type of ‘verbal’ clause; this function construes the entity that is targeted by the process of saying.”
Behavioural Processes

Halliday and Matthiessen (2004, p. 248) situate behavioral clauses between mental and material ones. “These are processes of (typically human) physiological and psychological behavior, like breathing, coughing, smiling, dreaming and staring.” (ibid.) Behavioral clauses usually consist of a Behaver that denotes a conscious being and a Process. These clauses can also include a Behavior in addition to the first participant. According to Halliday and Matthiessen (2004, p. 252), behavioral clauses are often used in fictional narrative in order to present indirect speech. In such a way, they become a useful tool for “attaching a behavioral feature to the verbal process of ‘saying’.” (ibid.) They (2004, p. 251) also argue that “certain types of circumstances are associated with behavioral processes.” These are circumstances of Matter and Place. The latter stand for orientation in the behavioral clauses and they are usually introduced by prepositions such as to, at and on.

Existential Processes

Existential clauses refer to the happening or existence of something. Halliday and Matthiessen (2004, p. 257) assume that these clauses are not frequent. They have various functions. One of the functions of existential clauses is to present participants in narratives. Presenting phenomena, places and other areas of interest is another function of existential clauses. These clauses have “no representational function in the transitivity structure of the clause; but [they serve] to indicate the feature of existence, and it is needed interpersonally as a Subject.”(ibid.)It just draws the receiver’s attention to the forthcoming new information. Existential clauses are composed of an Existent.

Scientific Writing

Scientific writing differs from other types of writing. In fact, Rogers (2007, p. 1) compares scientific writing with literary writing; he argues that “scientific writing differs substantially from literary writing. While literary writing is an art based on principles of personal style, fiction, and originality, good scientific writing is a craft that builds on clear communication of scientifically researched facts.”

The analysis of ditransitive verbs in scientific writing in particular is justified by the gap existing in the literature for genre specific analysis as far as this structure is concerned. Mukherjee (2005, p. 262) also maintains that the patterns of ditransitive complementation have to be studied in a specific genre. In this respect, he (2001, p. 267) argues that:

At the level of language description, it will be useful to complement the language-as-a-whole description offered in the present study with a more fine-grained analysis of genre-specific trends in using ditransitive verbs. In this context, further thought should be given to the problem as to how to map genre specific descriptions onto models of general language use; the question of how to relate the language as a system to genres as subsystems is still open to debate.

Previous researches on the characteristics of scientific writing include the work of Alley and Lebrun. Indeed, while Alley (1996) focuses on features like precision, clarity, familiarity, fluidity and forthrightness, Lebrun (2007, p. v) claims that “unique writing techniques rarely presented in books on technical writing will bring the writer closer to the six qualities that are the hallmark of great scientific writing : fluid, organized, clear, concise, convincing and interesting (FOCI).”

Medical writing as part of scientific writing is also characterized by clarity. In this respect, Rogers (2007, p.1) claims that “the beauty of medical and scientific writing is its ability to express the most complicated concepts in clear words and to point out the beauty of science without distracting decoration.”Medical writing should also be objective. Actually, Goodman and Edwards (2006, p. 17) argue that medical writing should be objective. In fact, they maintain that
“medical scientists presenting their results should not risk being accused of having the motives of moneylenders or the
guile of politicians.”

**Research Article**

Not only will the present research focus on scientific writing genre, but also on the research article genre. Indeed,
the present research focuses on the four main sections of a research article which are Introduction, Methods, Results and
Discussion. Researches on these sections are not as frequent as researches on other sections such as abstracts. In this
connection, Hyland (2004, p.70) studies disciplinary differences as far as abstracts are concerned. Indeed, he concludes that
the structure of abstracts displays variation in different disciplines. As he puts it, “the analysis points to considerable
disciplinary variations in move structuring in the corpus, which once again suggests that credibility, significance and
persuasion are community-specific matters.”

Day and Gastel (2011, p. 9) maintain that there are many formats for a research article such as IRDAM, IMRADC, IMRMRMRD, but the most frequent one is the IMRAD format. They (2010, p. 9) argue:

The logic of IMRAD can be defined in question form: What question (problem) was studied? The answer is the
introduction. How was the problem studied? The answer is the methods. What were the findings? The answer is the results.
What do these findings mean? The answer is the discussion.

**The Introduction Section**

While analyzing the features of the introduction, Day & Gastel (2006, p. 58) outline the five elements which
should be included in the Introduction. The Introduction, first of all, should provide the readers with the problem dealt
with: its nature and its scope. The second element in the Introduction is the reference to other works which have
investigated the same area of research. The third is to present the method of investigation; the reader needs to be informed
about the authors’ approach in tackling the problem. The fourth element in the Introduction is the presentation of the main
results of the research while the fifth one is the statement of its corresponding conclusions. Indeed, the introduction should
present the important findings together with the conclusions drawn from the research.

**The Methods Section**

Day & Gastel (2006, p. 60) define the main objective motivating the writing of the methods section; indeed, they
argue that “the main purpose of the Materials and Methods section is to describe (and if necessary defend) the experimental
design and then provide enough detail so that a competent worker can repeat the experiments.” In other words, the
Methods section provides an efficient tool which makes the research replicable; other researchers must be able to
reproduce the results of the current research. Moreover, this section is important in that it makes the research’s results
generalizable and valid. To put it differently, the Methods section provides information “that will let readers judge the
appropriateness of the experimental methods (and thus the probable validity of the findings) and that will permit
assessment of the extent to which the results can be generalized.”(ibid.) Therefore, the Methods section “establishes
credibility for the Results by showing how they were obtained.” (Cargill, M. and O’Connor, P., 2009, p.10)

As for the materials, Day & Gastel (2006, p. 61) state that the researcher should “include the exact technical
specifications and quantities and source or method of preparation. Sometimes, it is even necessary to list pertinent chemical
and physical properties of the reagents used.”In addition, they advise the writers to write generic or chemical names instead
of the advertising ones and to use a nonproprietary name.
As far as the subjects undergoing the research, Day & Gastel (2006, p. 61) claim that subjects in the research should be identified. In other words, if the subjects are not human, the sources as well as the characteristics should be specified. Nevertheless, if the subjects are human, the writers should provide the criteria adopted in choosing the subjects as well as the consent of the subjects. Whether the subjects are human or animals, the researcher should include the approval of the concerned committee.

The Results Section

Day and Gastel (2006, p. 66) argue that, in the Results section, the writer has usually to provide a comprehensive description of the experiments without repeating any information s/he has mentioned in the Materials and Methods section. S/He also presents the data. The writer, in the Results section, has to select the data rather than to present the whole bulk of information to the reader. This idea is supported by Aaronson (1977, p.23) who claims that “the compulsion to include everything, leaving nothing out, does not prove that one has unlimited information; it proves that one lacks discrimination.”

Furthermore, the writer has to state the limitations of the experiments; that is to say, the writer has to state the facts that s/he has not managed to obtain in this research. The writer should also use meaningful statistics so as to describe the results of the experiments. This idea is confirmed by Swales who asserts that this section usually includes quantitative results and statistical operations. Nevertheless, he maintains that it can also involve “some observational asides”. (Swales, 1990, p.171)

The Discussion Section

Day & Gastel (2006, p. 70) mention that the Discussion consists of six components. First of all, the writer should discuss the findings stipulated in the Results. As they claim, in addressing researchers: “try to present the principles, relationships, and generalizations shown by the results.” Indeed, one of the major purposes of the Discussion is to establish a relationship between the obtained results. Showing the significance of the findings is important in this section as they (2006, p. 71) mention that “the Discussion should end with a short summary or conclusion regarding the significance of the work.” In doing so, the researcher should not overgeneralize the conclusions to a scientific truth beyond the data analyzed. In addition, Day (1996, p.47) claims that the writers in the Discussion section should not exaggerate the results. As he puts it, “in showing the relationships among observed facts, [writers] do not need to reach cosmic conclusions.”(ibid.) Second, the writer should mention exceptions “or any lack of correlation and define unsettled points.” Third, s/he should establish a relationship between the present study and previous ones. Fourth, it consists of a discussion of “the theoretical implications of [the] work, as well as any possible practical implications.” Fifth, it exposes the conclusions. Sixth, it ends with a summary of the “evidence for each conclusion.”

METHODS

Corpus

The corpus understudy is composed of ten articles extracted from the British Medical Journal. These articles published in 2011 contain 41,677 words.

Instrument

The present research is based on the application of the UAM Corpus Tool which “is a set of tools for the linguistic annotation of text” (O’Donnell, 2011, p.4).
Procedure

The analysis is based on three steps.

Step 1

The corpus is extracted from online journals. It is a collection of 10 medical research articles. These articles are taken from the British Medical Journal (BMJ). They are published on the following website: http://www.bmj.com/

They conform to the IMRAD format as they are composed of four main sections which are namely Introduction, Methods, Results and Discussion in addition to other optional sections like acknowledgement and funding.

Step 2

In this step, a new project is created using the UAM corpus tool. Afterwards, two layers are made. In this context, O’Donnell (2011, p.7) defines a layer as follows: “A “Layer” is a type of analysis of the text files.” The first layer is entitled section; it aims at studying the distribution of ditransitive process types in the four main sections. The second layer is labeled process types.

This layer is meant to classify ditransitive verbs according to the six classes mentioned above. Every layer is composed of a scheme. A scheme contains different systems. Each system is made up of features. Consider, for example, the system entitled process_types.

It consists of six features which are: material, mental, verbal, relational, behavioural and existential. As for the system called sections, there are four features which are: introduction, methods, results and discussion. After creating the layers and the schemes, texts are incorporated into the new project. Then, each text is annotated separately. Indeed, the four sections in each text as well as the different ditransitive verbs are annotated.

The different frequencies are presented thanks to the corpus statistics pane. In this respect, O’Donnell (2011, p.32) argues that “the Corpus Statistics pane allows various statistics to be derived from your tagged corpus.”

Feature usage can be a useful tool to do so. In fact, it enables to detect the frequency of occurrence of a particular feature in a specific layer. Actually, O’Donnell (2011, p.32) argues that feature usage allows the researcher to “specify a feature in a layer (most typically, the root feature of the layer), and the program describes the usage of features in the corpus at that layer (counts, mean, and standard deviation).”

Step 3

This step is important as it displays the interpretation of the results. Indeed, the findings are not significant without their associated explanation. For example, the differences in the distributions of process types along the different sections in the medical discipline are explained.

In this respect, Triki and Sellami-Baklouti (2002, p. 37-38) claim that “the objective of the linguist is not to translate a given text into a sets of numbers but rather to classify those numbers in a meaningful way and to interpret them after having proved their significance, providing thus empirical evidence for his/her conclusions about a given text.”

RESULTS

Table 1 displays the distribution of the six ditransitive process types in the medical corpus.
Table 1: Distribution of Ditransitive Process Types in the Medical Corpus

<table>
<thead>
<tr>
<th>Medical Discipline</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>202</td>
<td>41.65%</td>
</tr>
<tr>
<td>Mental</td>
<td>18</td>
<td>3.71%</td>
</tr>
<tr>
<td>Relational</td>
<td>238</td>
<td>49.07%</td>
</tr>
<tr>
<td>Verbal</td>
<td>27</td>
<td>5.57%</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Existential</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>485</strong></td>
<td></td>
</tr>
</tbody>
</table>

The study showed that the six process types are not equally distributed in the medical corpus. In fact, behavioural processes and existential ones are completely absent. This can be explained by the specificities of ditransitive verbs. Indeed, ditransitive verbs are complemented by two constituents. However, behavioural and existential processes cannot take three participants. While relational processes are the most frequent as they represent 49.07%, material processes are rated second since the frequency of their occurrence is 41.65%. The frequency of occurrence of ditransitive relational processes can be explained by the functions displayed by such processes. Actually, these processes are important in defining or describing a particular variable in the research. They serve as a tool to establish a relationship based on either similarities or differences between two entities in the medical discipline. As for material processes, their frequency can be explained by the fact that they denote the type of relationship between entities and they describe the activities undertaken by the researchers while preparing the material and conducting the analysis. Mental and verbal processes are not as frequent as relational and material processes as they represent 3.71% and 5.57% respectively. The limited frequency of mental processes can be explained by the nature of the discipline. As far as verbal processes are concerned, they reveal the talk between the different participants in the research.

Distribution of Ditransitive Process Types in the Introduction Section

Table 2 shows the distribution of ditransitive process types in the Introduction section.

**Table 2: Distribution of Ditransitive Process Types in the Introduction Section**

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>12</td>
<td>30.77%</td>
</tr>
<tr>
<td>Mental</td>
<td>1</td>
<td>2.56%</td>
</tr>
<tr>
<td>Relational</td>
<td>26</td>
<td>66.67%</td>
</tr>
<tr>
<td>Verbal</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Existential</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39</strong></td>
<td></td>
</tr>
</tbody>
</table>

In the Introduction section, relational processes are the most frequent ones. As for material processes, they are rated second as they are 30.77%. However, mental processes are very rare as there is only one occurrence of these processes.

In this section, relational processes play an important role in establishing connections between entities/ideas. In fact, these processes can be used to introduce the problem. For example, the writer can opt for a relational process in order to relate the problem with its reasons. Consider the following sentence:
Adiposity and low aerobic fitness in children are associated with a clustering of cardiovascular risk factors. (Text 1)

Not only do relational processes serve as a tool for the presentation of the problem, but they are also an efficient way to describe the method of investigation. Actually, they can be used to identify the subjects involved in the experiment. This idea is clearly illustrated in the following example:

Confused patients were included in the process of scale development of other tools. (Text 4)

As far as material processes are concerned, they are meant to review the literature. That is to say, they aim at describing the works performed by other researchers. In the following example, the writer reviews one of the measures introduced by previous studies.

Several countries procure one of the vaccines for publicly funded vaccination programmes. (Text 2)

The only instance of mental processes in the Introduction section highlights the importance of the present research; it expresses one of the problematic issues in this field of research which should be investigated in the present study. Consider the following example:

As surgical procedures should be evaluated against non-surgical methods, we compared the efficacy of disc prosthesis and a multidisciplinary rehabilitation programme. (Text 8)

**Distribution of Ditransitive Process Types in the Methods Section**

The following table illustrates the distribution of the different process types in the Methods section.

<table>
<thead>
<tr>
<th>Methods</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>103</td>
<td>46.40%</td>
</tr>
<tr>
<td>Mental</td>
<td>8</td>
<td>3.60%</td>
</tr>
<tr>
<td>Relational</td>
<td>91</td>
<td>40.99%</td>
</tr>
<tr>
<td>Verbal</td>
<td>20</td>
<td>9.01%</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Existential</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>222</strong></td>
<td></td>
</tr>
</tbody>
</table>

In the Methods section, material processes exceed relational ones as they represent 46.40% and 40.99% respectively. Verbal processes are rated third in terms of the distribution of process types. As for mental processes, they are classified fourth. Like the Introduction section, the Methods section does not include any frequency of occurrence of behavioural and existential processes.

In the Methods section, material processes outnumber the other processes because this section is based on a description of the steps undertaken by the researchers to conduct the experiment. Since material processes express actions, they are the most frequently used in this section. For example, material processes can reveal how the researchers select the subject in the experiment. Take, for example, the following sentence:

They were recruited from local hospitals or primary care to their nearest university hospital as usual without any supplemental recruitment attempt. (Text 8)
Compared to the Introduction section, mental processes are more frequent in this section; indeed, researchers, in this section, try to justify the aims and intentions behind undertaking particular measures. The following example illustrates this idea.

These adaptations were aimed to promote children’s physical activity during recess (playtime or break) as well as unstructured physical activity during school time. (Text 1)

Relational processes are used to introduce and describe the procedures and components in the experiment. Consider, for example, the following sentence:

The intervention lasted one school year (end of August 2008 to mid-June 2009) and was based on the following four lifestyle behaviours: physical activity, nutrition, media use, and sleep. (Text 1)

As far as verbal processes are concerned, they report the talk between the researchers and the doctors. They also convey the talk between the researchers and the patients. The following sentence exemplifies this idea.

We asked all competent patients who agreed to participate in the study to provide a specimen of blood for analysis of haematological and biochemical parameters. (Text 4)

### Distribution of Ditransitive Process Types in the Results Section

Table 4 demonstrates the distribution of ditransitive process types in the Results section.

<table>
<thead>
<tr>
<th>Process Type</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>39</td>
<td>39.39%</td>
</tr>
<tr>
<td>Mental</td>
<td>2</td>
<td>2.02%</td>
</tr>
<tr>
<td>Relational</td>
<td>56</td>
<td>56.57%</td>
</tr>
<tr>
<td>Verbal</td>
<td>2</td>
<td>2.02%</td>
</tr>
<tr>
<td>Existential</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

In the Results section, relational processes are 56.57%. Although not as frequent as relational processes, material processes represent 39.39%. Mental and verbal processes are very rare and they are equally presented as they are 2.02%.

In the Results section, the researchers opt for relational, material and mental processes in order to link the Results section to the Methods section. Actually, they remind the reader of the main activities undergone while conducting the experiments. Consider, for example, the following sentences:

The results were similar when angiotensin receptor blockers were compared with either placebo or with active treatment for all of the above outcomes (P>0.05 for interaction for all comparisons) (fig 6-8). (Text 9)

A low sodium diet (66 (57 to 76) mL/min; P=0.002) or angiotensin receptor blockade plus a low sodium diet (61 (53 to 70) mL/min; P<0.001) was added to ACE inhibition. (Text 5)

It includes women aged 50-64, who are invited to screening every three years. (Text 6)

Moreover, relational processes are used to stipulate the findings of the present research to the readers. Indeed, the writers can provide answers to the research questions mentioned in the introduction. For example, they can ascertain or
reject the link between two variables in the research. Actually, one of the objectives of a scientific paper is to transmit the message to the readers. This idea is exemplified through the following sentence:

Angiotensin receptor blockers were not associated with any increase in the risk of myocardial infarction when compared with controls (relative risk 0.99, 95% confidence interval 0.92 to 1.07; P=0.85) (fig 2⇓). (Text 9)

**Distribution of Ditransitive Process Types in the Discussion Section**

Table 5 shows the distribution of ditransitive process types in the Discussion section.

<table>
<thead>
<tr>
<th>Discussion</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>48</td>
<td>38.40%</td>
</tr>
<tr>
<td>Mental</td>
<td>7</td>
<td>5.60%</td>
</tr>
<tr>
<td>Relational</td>
<td>65</td>
<td>52.00%</td>
</tr>
<tr>
<td>Verbal</td>
<td>5</td>
<td>4.00%</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Existential</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>113</strong></td>
<td></td>
</tr>
</tbody>
</table>

In the Discussion section, material and relational processes are frequent. Indeed, while relational processes are 52.00%, material ones are 38.40%. The frequency of occurrence of mental processes is 5.60%. Verbal processes come fourth in terms of the distribution of process types.

Since the Discussion is the last section in the research article, providing hints to the methodology is beneficial. In fact, the writer can employ verbal processes to convey the conditions under which the experiment takes place. Consider the following sentence:

For the periods on the regular sodium diet, the patients were advised to maintain their habits regarding sodium intake. (Text 5)

Verbal processes are also used to make references to other works; in other words, they express the findings stipulated by previous pieces of research in order to give credibility to the present research. Take, for instance, the following sentence:

Most previous palliative prognostic studies have not needed to rely on patients’ consent before recruitment or have reported only the results from “evaluable” patients.12 1318 32 (Text 4)

Not only do verbal processes make references to previous work, but also do mental processes. Indeed, writers use mental processes in order to mention the attempts and efforts of previous researches in the same field of research. A case in point is the following sentence.

Yet few published studies have tried to estimate the price difference for the two vaccines to be equally cost effective. (Text 2)

Moreover, relational processes can introduce the interpretations of the findings. Indeed, they serve as a link showing the relationship between the finding and its interpretation. Consider, for example, the following sentence:

Accordingly, the lower proteinuria and blood pressure cannot specifically be attributed to the lower sodium intake, as inadvertent changes in other food components might be involved. (Text 5)
As for material processes, they convey the findings of the present research. When exposing the results of the present research, the writers opt for material processes in order to explain the kind of relationship between two major constituents in the present research.

Angiotensin receptor blockers **exert** their action on angiotensin I receptors, which not only block the deleterious effect of angiotensin II but also results in overstimulation of angiotensin II receptors, probably resulting in antihypertrophic and antifibrotic effects. (Text 9)

**DISCUSSIONS**

Unlike previous researches, the present study examined ditransitive process types in medical research articles. It showed that the these processes are not equally distributed in the corpus; in fact, while material and relational ditransitive process types are the most frequent in the corpus, mental and verbal processes are the least presented. As for existential and behavioural processes, they are totally absent from the corpus. This can be explained by the communicative purposes of the research article, the characteristics of scientific writing and the patterns of ditransitive verbs. The absence of existential and behavioural processes is due to the fact that they do not require three participants as ditransitive verbs do. The limited frequency of mental processes can be explained by the nature of the discipline and genre. Indeed, scientific writing and in particular medical science are based on facts. They are characterized by precision and clarity. Verbal processes are infrequent; only one verbal process is used to report previous works. In fact, in the hard sciences, the writers are not obliged to employ reporting verbs in order to support previous researches. As Hyland (2004, p. 37) puts it: “The different epistemological structure and social organization of the hard sciences, on the other hand, often allow writers to assume more common ground with readers, requiring less need to demonstrate the relevance and reliability of prior studies using reporting verbs.” That is why, the other verbal processes are used to inform the readers about the talk between the different participants in the research.

Although the writers do not need to establish a solid ground for their ideas, employing a single verb to report other studies is unexpected; normally, verbal processes should be more frequent in order to report the findings of the present research as well as the previous ones. The frequency of relational and material processes can be accounted for by the exigencies of the research article genre. Since every piece of research should be reproducible, the research article should describe the conditions under which the experiment takes place including the variables, the procedures and the activities of the researchers. The research article should also be original in that it conveys a new piece of knowledge to the scientific community; that is why, in the medical corpus, relational processes are mainly used for identification and description while material processes are meant for denoting activities and stipulating the results. The present research also displayed variation in the distribution of ditransitive processes according to sections. This can be accounted for in terms of the characteristics of each section in the research article. For example, in the Methods section, material processes are the most frequent ones because this section is devoted to the description of the activities undertaken by the researchers while conducting the experiment. However, in the Introduction section, relational processes are more frequent than material ones. Indeed, this section is meant for the description of the methodology and the problem as well as the reference to previous works. Mental processes are more frequent in the Discussion section than the Results section because the former indicates the limitations of the previous and the present work and includes a call for future research. This research could be more interesting if it was based on a larger corpus and if it compared the distribution of process types across different disciplines and different genres.
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REFERENCES


