SCIENTIFIC DISCUSSION FORUMS AND SCIENTIFIC TEXTS FROM THE PERSPECTIVE OF LEXICAL COHESION

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Abstract

Apart from the core of academic discourse, both written and spoken, which must conform to the formal style rules, there are genres in the language of science where informality and personality features are perfectly adequate. Scientific discussion forums on the web enable the community of experts as well as science enthusiasts to seek answers to their questions and develop their ideas in an interactive and cooperative manner with few style restrictions, while maintaining the necessary clarity, matter-of-factness and truthfulness. The paper looks into the typology and distribution of lexical cohesive means in this genre (in the fields of physics and biology), particularly in comparison with formal academic texts.

Key words

cohesive chains, discussion forums, formality, informality, lexical cohesion, personality features, relexicalisations, science, scientific texts

1. Genre characteristics of scientific discussion forums

Written texts in general are characterised by lack of immediate interaction with recipients of messages, more careful planning and construction of texts in comparison with most genres of spoken discourse, and a distinctive use of a wide repertory of lexical, grammatical and structural means to secure desirable comprehensibility. There are certainly differences within the whole range of diverse genres of the written discourse, depending on variables such as the level of formality, specific purpose, intented readership, etc., and similarly significant differences exist within the spoken discourse. However, the variables of planning vs. randomness, preservability vs. transience, precision and concreteness vs. generalisation, abstraction and vagueness, surveyability vs. context-dependence (Urbanová and Oakland 2002: 32-33) are the markers of generally conceived differences between the two media.

Scientific texts, usually written, but also those produced within the spoken medium, are expected to be explicit, concise and impersonal, as these are the qualities dictated

by functional considerations. Scientific discussion forums as a genre which may be established within the language of science have, nevertheless, their specifics, which are often ambiguous. They are conveyed in the written mode, but they contain features of spokenness; they are focused on objective facts, but they also contain personal and subjective features; they use explicit expressions necessitated by the topic, but also implicit expressions, allusions, humour, digressions from the topic, etc.

This paper looks into the discourse of scientific discussion forums from the angle of lexical cohesion, focusing on the types of lexical cohesive ties identifiable in the texts of the chosen genre. Lexical cohesion is defined as a selection of lexical items which are in some way related to other lexical items in a text. Lexical cohesion contributes importantly to creating the texture (Halliday and Hasan 1976), a distinctive inherent quality of a text, and increases the overall coherence of the text. As an important lexical phenomenon in scientific discussion forums will be seen the choice of field-specific lexis (Krhutová 2009) as well as occurrence of generally scientific terms.

The Internet and communication mediated by this electronic information network have gradually introduced their own text formats and, consequently, new genres. Crystal (2001) identifies five basic "Internet using situations", viz. e-mail, synchronous chatgroups, world-wide web, virtual worlds, and asynchronous bulletin boards, newsgroups and mailing lists, all of which fluctuate between registers and broad genres. The latter type seems to include also scientific discussion forums (hereafter abbrev. SDFs). Generally, online discussions, referred to as Internet multi-party conversations, can be realised either in the form of synchronous groups (or synchronous discussion or chat), taking place in near real time (e.g. Internet Relay Chat, IRC), or in the form of asynchronous groups (or asynchronous discussion or chat) (cf. Herring 2008: 3), which happen in postponed time.

The latter type of online communication is represented by discussion groups. They could be characterized as a transition between so-called "adapted" and "emergent" web genres according to Herring´s classification (2011: 7) since they employ some phenomena only enabled by the web environment. The typical properties of discussion groups are non-linear interaction, importance of personal and idiosyncratic features (Crystal 2001) and lack of most fundamental properties of conversation, such as turn-taking, adjacency pairs, floor-taking (Herring 1999). Crystal (2001: 30) also adds as

the typical feature of Netspeak, as he called the Internet language, the delay in interactional responses and the absence of simultaneous feedback.

As far as the variety to which the genre of scientific discussion forums belongs, it is English for Academic Purposes or, labelled differently, English of Science, with some features of the conversational style. The combination of features typical of both written and spoken media makes it a hybrid medium, primarily written and monologic, but integrating features of spokenness and conversation. Crystal concludes that Netspeak or Internet language shares properties of both the spoken and written language and constitutes thus a new "species" of communication (2001:48). Computer Mediated Communication (CMC) is a widely used term for communication over the Internet (cf. Herring 1999, 2008, etc.). As it has been already mentioned, apart from the lexis of exact science (terms and concise words) and the core general vocabulary, SDFs also use slang, puns, vulgarisms, emoticons, etc. The integration of normally incompatible lexical and grammatical features renders SDFs a hybrid genre also for these reasons.

2. Lexical cohesive ties

Cohesion is a semantic concept, defined as "relations of meaning that exist within the text, and that define it as a text." (Halliday and Hasan 1976: 5) Cohesion works within as well as outside sentence boundaries, following usually the natural order of distribution of information from the given to the new. As a typical property of any text, Halliday and Hasan claimed that, "every sentence except the first exhibits some form of cohesion with a preceding sentence, usually with the one immediately preceding. In other words, every sentence contains at least one anaphoric tie connecting it with what has gone before." (1976: 293).

The main types of cohesive tie or devices include reference, substitution, ellipsis, conjunction and lexical cohesion (Ibid.) and the basic types of cohesion are grammatical, lexical and structural (Hasan 1985: 82). Cohesive ties are then also subdivided into cohesive links and cohesive chains. Typical tie relations include co-reference (represented by the grammatical cohesive type, reference), co-classification (substitution and ellipsis), and co-classification or co-extension (represented by lexical cohesive devices – repetition, synonymy, antonymy, meronymy (Ibid.: 82) Cohesive chains ar then divided into identity chains (the relation between its members is co-

reference) and similarity chains (relation of co-classification and co-extension). (Ibid.: 84).

Lexical cohesion, which is the focus of the current research into SDFs, takes the form of either reiteration (which encompasses either repetition or use of a synonym in the context of reference) or collocation (co-occurrence in the lexical environment) (Halliday and Hasan 1976: 318-319). Reiteration, besides exact repetition and synonymy, also involves the use of other alternations of the source lexeme, such as its hyponyms, hypernyms and opposites.

The divide between types of cohesion and its ties may be seen from a different perspective, considering the linguistic level of the phoric relation. It may be either semantic (realized by reference) or lexicogrammatical (including lexical cohesion, substitution and ellipsis). (Halliday and Hasan 1976)

In terms of lexical cohesion, Hasan includes the standard sense relations, viz. synonymy, antonymy and hyponymy, and claims that, "Whenever two lexical expressions stand in any of these relations, a cohesive tie is established." (1985: 80) She also adds to these sense relations meronymy and a "kind of lexical patterning that contributes to texture" although it is not a sense relation, namely repetition (Ibid.: 82). Repetition also creates a sort of relation since a "largely similar experiental meaning is encoded in each repeated occurrence of the lexical unit." (Ibid.)

Similarly, Urbanová (2008: 84-85) recognizes two lexical cohesive devices, namely reiteration, i.e. a repetition of key words or derivatives made from them, and sense relations, particularly synonymy and antonymy. Zmrzlá (2009: 39-40) suggests a subtler division of lexical cohesive ties into reiteration, which comprises repetition, equivalence, generalization, specification, co-specification, and contrast, and collocation, including an ordered set and implication. This classification, which combines approaches proposed by Halliday and Hasan (1976), Tanskanen (1995) and Dontcheva-Navratilova (2005) was practically adopted in my paper examining lexical cohesion in popular and theoretical scientific texts (Vogel 2010), which is used in this paper as a basis for comparison with results gained by analysis of lexical ties in scientific discussion forums.

3. Questions and hypotheses of the research

The assumptions about scientific discussion forums (SDFs) before the study was undertaken had been as follows:

1) SDFs rely heavily on lexical cohesive means, particularly reiteration, generalisation and specification (practically as any other scientific text), despite the relatively lower conciseness and formality when compared with the core of written formal style.
2) The ratio between lexical and grammatical cohesive means reveals a more prominent role of grammatical cohesion, particularly reference and ellipsis.
3) The proportions of individual lexical cohesive means applied in online discussion forums differ to a certain degree from both popular and theoretical scientific texts (cf. Vogel 2010).

The more detailed questions I sought to answer are as follows:

Q1: What is the "density" of lexical cohesive chains in the discourse of scientific discussion forums, particularly when compared with scientific texts (which were studied contrastively as popular and theoretical ones in Vogel 2010)?

Q2: What is the ratio between devices of lexical and grammatical cohesion in SDFs and its comparison with that of scientific texts (in the fields of physics and biology)?

Q3: What is the ratio between individual types of lexical cohesion in scientific discussions and texts?

Q4: What are the differences in register and how are they reflected in the means of lexical cohesion?

4. Examination of cohesive ties in scientific discussion forums (SDFs)

4.1. Corpus of SDFs and the applied methodology

The corpus of scientific discussion forums consists of two subcorpora, one for physics and for biology. The period covered by the online discussions (i.e. until the contributors reduce significantly their activity) is usually several months and the analysed posts in selected topics (also known as threads) date to various periods between the years 2006 and 2011. The sources of the (general) physics subcorpus are *PhysForum – Science, Physics and Technology Discussion Forums* (abbrev. *PhF*) and for biology *PhF* as well as *(The) Science Forum – Scientific Discussion and Debate*

(abbrev. *ScF*). Analogously to *PhF* and its biology topics, *ScF* also contains discussion about physics, but these topics were not chosen for my physics subcorpus.

Each of the forums contains dozens of discussion topics, and 5 were selected to build each subcorpus. The (general) physics subcorpus is composed of the topics "Moment of Inertia" (Ph1), "Energy Conservation in Closed Systems, when can we say a system is closed?" (Ph2), "Size of a Photon, what is it?" (Ph3), "Linear Acceleration of an Electron in an Electric Field?" (Ph4) and "Clock on a Spaceship" (Ph5). The biology subcorpus is made up of topics "The Immortals, Aging" (Bi1), "How Did The Woodpecker Skull Evolve?, woodpeckers skull evolution" (Bi2), "Our Primate Cousin Proves His Intelligence" (Bi3), "Dead Humans and Disease" (Bi4) and "Can neurology isolate memory?" (Bi5).

Contributors to both forums are anonymous, using nicknames or combinations of first names with the initial letter of their surnames (if any of these are real). Both forums also provide some information about the contributors to the forum, namely their date of joining, number of posts, group membership, rating of feedback, status within the forum (e.g. Forum Freshman / Newbie, Forum Sophomore, Member, Advanced member, sometimes also humorous – Forum Cosmic Wizard on *ScF*, Moran of the Burning Spear on *PhF*).

From each topic (thread) on the forums were selected 6 posts, making thus the total of 30 posts per each subcorpus. The posts had to be cleared of quotes from other posts, quotes cut and pasted from other texts, invariably used personal information and declarations of writer´s beliefs, etc. The total number of words in the physics subcorpus was 2,285, giving the average of 76 words per post, and the wordcount in the biology subcorpus was 3,982, with the average of 133 per post. However, the resulting figures are highly dependent on the particular selected material (which was selected randomly, virtually on the basis of my interest in the discussed topics) – e.g. the length of some posts in disputes between supporters of the creationist theory and their opponents in Bi2 raised the average; similarly, the forum *PhF* included much shorter but also much longer posts (e.g. in the group Ph2 about energy conservation).

The analysis involved calculating the total number of words in each post, identifying the central cohesive chain (CC), identifying (or tagging) the type of cohesion between each member of the CC and its key term, focusing here on occurrence of lexical cohesion, but distinguishing also instances of grammatical cohesion within the CC. These were counted collectively under the heading of

grammatical cohesion, not specifically as reference, substitution and ellipsis. The figures were then added up for each science (physics vs. biology), and proportions of the total (expressed as percentages) were calculated for each variable. Finally, these results pertaining to SDFs were compared with results gained in my previous, thematically and methodologically similar, study carried out in 2010.

The following two examples demonstrate the items identified as members of several cohesive chains in the examined corpora, along with the tagging marks for individual types of cohesion.

Contributor / Topic	**size of a photon, what is it?**	
plasma guy 13 Oct 2006, 7:31 AM	it (ref) – it (ref) – 100 micron wide photons (rep/spe) – The photon (rep) – a photon (rep) – which (ref) – a photon (rep).	(63 words)
Guest (unregistered) 13 Oct 2006, 1:54 PM	Each photon (rep) – a quantized plane wave (equ) – each photon (rep) – a photon (rep) – plane waves (equ) – plane wave functions (equ/spe) – each wave function (equ/spe) – a photon (rep) – plane wave vector (equ/spe).	(79 words)
Steven A 20 Oct 2006, 7:33 PM	a photon (rep) – a photon (rep) – a photonic interaction (rep/spe) – a photon detection (rep/spe) – it (ref) – a photon (rep) – it (ref) – a photon (rep) – a photon (rep) – the photon itself (rep) – 0 (ell) – a photon (rep)	(160 words)
kaneda 11 Nov 2006, 7:52 PM	Photons (rep) – a wave (equ) – Their size (ref) – their frequency/place (ref) – one photon (rep) – one photon (rep) – like waves (equ) – smaller photons (rep)	(78 words)
teal4two 23 Dec 2006, 7:16 AM	photons (rep) – visible light photons (spe/rep) – microwave photons (spe/rep)	(74 words)

Fig. 1. Cohesive chains for topics in physics in the SDF *PhysForum* (*PhF*) – examples.

Contributor / Topic	**Dead Humans and Disease, This is grinding my gears**	
uaafanblog 15 Jan 2010, 11:05 PM	disease (rep) – disease (rep) – disease (rep)	(90 words)
Granouille 15 Jan 2010, 11:33 PM	infection (rep) – it (ref) – it (ref)	(97 words)

uaafanblog 15 Jan 2010, 11:43 PM	viruses and parasites (equ) – disease (rep) – make one sick (equ) – healthy (ant) – threat to public health (equ) – weren´t healthy (equ) – a public health threat (equ) - 0 (ell)	(209 words)

Fig. 2. Cohesive chains for topics in biology in the SDF *PhysForum* (*PhF*) – examples.

4.2. The findings

The aggregated results from the tagged cohesive chains in 30 posts in the SDF *PhysForum* dealing with physics and another 30 in *PhysForum* and *(The) Science Forum* pertaining to biology have yielded figures which describe the distribution of individual types of cohesive ties within the central CCs of each post, particularly the proportions of each type within the lexical cohesive chains (Tab. 1).

	SDFs – physics	SDFs - biology
Lexical cohesion (in % of the whole chain)	79%	62%
Repetition (in % of LC)	66%	31%
Equivalence (in % of LC)	21%	33%
Generalisation (in % of LC)	4%	10%
Specification (in % of LC)	8%	22%
Antonymy (in % of LC)	1%	4%
Cohesive chain (in % of the total wordcount)	8%	4%
Lexical cohesive chain (in % of the wordcount)	6.5%	2.5%

Table 1. Findings: SDFs - (general) physics vs. SDFs - biology.

The table below (Tab. 2) compares the main results of the analysis of theoretical scientific (TST) and popular scientific texts (PST) from the field of physics (Vogel 2010: 71-72) with the findings of the current examination of SDFs. Particularly the overlap of the province, i.e. physics, contributes to the relevance of such a comparison, although the figures for the biology subcorpus often do not differ dramatically from their parallel subcorpus of posts related to physics. However, the gained data show an obvious similarity between results gained by analysis of popular scientific tests (PST) and those from SDF for physics. The average percentages of distribution of

grammatical and lexical cohesive items within a cohesive chain are almost identical, although e.g. repetition occurred more frequently in SDF for physics and the occurrence of specification is considerably higher in PST and TST (and comparable to the SDFs for biology) than in the SDF for physics (mere 8% items in the LC).

Source / Variable	**Theoretical scientific texts** (TST)	**Popular scientific texts** (PST)	**Scientific discussion forums – physics**	**Scientific discussion forums – biology**
Lexical cohesive chain (LC) as % of total words	4.6 - 10.9%	5.2 - 12.4%	6.5%	2.5%
Gramm. cohesion as % of the CC	ca. 10% (3.7-16.7%)	ca. 20% (0-34.6%)	21%	38%
Lexical cohesion as % of the CC	ca. 90% (83.3-96.3%)	ca. 80% (65.4-100%)	79%	62%
Repetition as % of lexical coh.	ca. 50% (13.3-79.5%)	ca. 40% (17.1-63.6%)	66%	31%
Equivalence as % of lexical coh.	ca. 15% (2.3-53.3%)	ca. 35% (6.8-60%)	21%	33%
Specification as % of lexical coh.	ca. 20% (9.1-30.8%)	ca. 20% (11.4-25%)	8%	22%

Table 2. Comparison of selected findings concerning composition of cohesive chains: SDF - (general) physics vs. SDF - biology vs. theoretical scientific texts vs. popular scientific texts (both in the field of physics).

Lexical cohesive chains consisting of the key words and their repetitions and relexicalisations represented between 4.6% and 12.4% of total wordcount in TST/PST (revealing no obvious TSTxPST difference), 2.5% in SDFs on biology (Bio) and 6.5% in SDF on physics (Phy). The latter figures are substantially lower than those established in scientific texts, but the results in SDF (Phy) correlate with the lower levels of the PST range (dealing with physics as well).

Lexical cohesive devices expressed as a proportion of the total cohesive chain were identified in Vogel (2010) on a range between 65.4% and 100% in TST/PST, usually being around 80%-90% and higher in TST chains. The corresponding values found in SDFs are 62% (Bio) and 79% (Phy), which seems to be a less dominant representation

(however, lexical cohesion occurs more frequently than grammatical even in CCs in SDFs, which appears to be a general property of scientific discourse).

Conversely, grammatical cohesion accounts for around 10-20% of members of cohesive chains in TST/PST, being more frequent in PST (with one text being a 0% exception); in SDFs the proportion ranges from around 20% to 40%.

Repetition (with derivatives) was identified as the most frequent type of LC (between ca. 40-70% of the whole chain) in TST/PST. In SDFs repetition accounts for 31% to 66% of LC; the higher value relates to forums dealing with physics (twice as high as in those dealing with biology in my sample).

Equivalence was more frequent in the PST corpus, in SDFs equivalence ranges from 21% to 33% of LC. It is more typical of SDFs (Bio) and, unlike repetition, it is almost identical with the results found in PST. Equivalence is the second most frequent type of LC.

Lastly, specification, which was established as the second most frequent type of LC in TST/PST and revealed no substantial TST/PST difference, is not represented equally in the corpora of SDFs in this research. Its share is the third most important in SDFs, oscillating between 8% and 22% of LC and being found considerably less frequently in SDFs focused on physics.

4.3. A few notes on informality and expressiveness in SDFs

Johnová (2011: 25) claims that the social status of communicators and the frequency of using swear words are inversely proportional (drawing on Stapleton 2003, McEnery 2006, and Jay 2009). Based on the quoted research, affiliation to social groups works in direct proportion, i.e. the more close-knit and informal the group is, the higher occurrence of expletives may be expected. It may be reasonably assumed that an inverse proportion similar to that which characterises the socioeconomic standing applies also to the level of education achieved by participants of communication. SDFs display a very low occurrence of swearwords (and virtually zero ocurrence of strong swearwords), which is in stark contrast to other discussions in CMC, namely ones on sports, politics and general topics. Neither the anonymity of users seems to encourage them to higher use of taboo expressions, nor does the supposedly prevailing male gender of participants in discussions concerning natural sciences. (Paradoxically,

Johnová´ research (2011: 29) revealed that women had posted more profane words in the analysed British online chat than men.) SDFs are quite strictly focused on the topic and exceptional personal deviations from it are very short and use rather humour, irony and sarcasm than strong swearing.

magpies 28 Sep 2009, 12:51AM (*PhF*, The Immortals)	imo **your mind state has a lot to do with how long you live**…
Michael J 28 Sep 2009, 6:18 AM *[Quote of the post above]*	I guess **we will be saying goodbye to you a little early then** ☺
Dr Fred A Wolf 30 Sep 2009, 7:09 AM	**W T F** has that got to do with a parrot? ……anyhow you´re wrong to suggest only diet and exercise will prolong life – there´s many other factors @ play here, **dumbass**!
AlexG 20 Oct 2010 , 6:51 AM	**Look around for yourself**. That´s what they make search engines for.
DrRocket 13 Mar 2011, 7:28 AM (*ScF*, Clock on a Spaceship)	BTW please ignore Farsight´s posts. **He is a well-known internet crank**, who spreads misinformation.

Table 3. Examples of mild profanity used in scientific discussion forums. (The relevant passages were highlighted by the author of the paper.)

Turn-taking is another feature which has its characteristic modified form in SDFs. Although the medium of discussion forums is written and many aspects of conversation, with which SDFs can be most conveniently compared, are not at play here (viz. possibility of using overlap, signaling by eye contact, body position and movement, pauses – cf. Cook 1989: 52-53), some other work here. There exists a system of turn alternation developing the discussed topic, but – unlike in a spoken conversation – the typical number of participants is bigger than two, so it is a multi-party exchange of ideas, and the pauses between turns may be hours, days, but also weeks or months long. The latter two occur if someone has accessed a sleeping topic, found it interesting and added a post to initiate new discussion.

5. Conclusions

The analysis of scientific discussion forums (although the examined samples were relatively small) has shown some important differences from scientific texts. One of them is a substantially lower density of items constituting a lexical cohesive chain, expressed as proportion of their constituent words in the total number of words of the text. A similarity has been established between SDFs dealing with physics and popular scientific texts discussing issues in the same scientific discipline.

Within cohesive chains, lexical cohesive devices clearly dominate over grammatical ones both in SDFs and scientific texts (popular and theoretical). However, in the analysed samples of SDFs dealing with physics and biology the proportion of lexical cohesive devices is somewhat lower than in scientific texts, with chains in biology discussions being based on lexical cohesion approximately 25% less than in physics. The former phenomenon may be attributed to a higher level of explicitness and narrower focus of scientific texts (research papers, chapters in textbooks, entries in online encyclopedias) compared with discussions forums, which are not so strictly explicit and focused. The latter phenomenon can be explained by a higher specialisation of topics discussed in the field of physics, whereas the discussions in biology obviously verge more closely on everyday issues so that digressions and less explicit coverage of topics is easier and frequent.

Out of the individual types of lexical cohesion, repetition (including words derived from the central lexemes) has been identified as the dominant lexical cohesive type, slighly less represented in SDFs than in scientific texts. This difference can be accounted for in a similar way as the difference between texts and forums in terms of the proportion of lexical cohesion within the whole cohesive chain. Lexical cohesion and repetition seem to correlate positively with the level of explicitness and formality of texts. Biological discourse reveals a lower occurrence of these variables.

The second most frequently used means of lexical cohesion is equivalence, where there seem to correlate theoretical scientific texts and SDFs on physics, and popular scientific texts and SDFs on biology. Specification ranks third and it is quite underrepresented in SDFs on physics. Only a more extensive examination would ascertain whether this is a random deviation or rather a general feature of discussion forums on physics. It can be hypothesised, however, that specification as a reflection of hierarchical lexical configurations does not corespond to the character of physics so

well as to that of biology, characterised by complex taxonomies. The fact that texts dealing with physics did not manifest such a low occurrence of specification as SDFs can be explained by the fact that my corpus of texts (Vogel 2010) included some encyclopedic entries with classifications of subtypes of physical phenomena.

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