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"To our great surprise …": A frame-based analysis of surprise markers in research articles

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ABSTRACT

Although academic discourse has a reputation for its emotionless objectivity, the emotion of surprise is often expressed in scientific writing. Paradoxically, surprise is cognitive in nature and recognized as a knowledge emotion. Given the connection between surprise and knowledge-making, it is surprising that linguistic expressions of surprise (i.e., surprise markers) in academic discourse have received little research attention. This article reports on an empirical study of surprise markers in research articles. Informed by Charles Fillmore's frame semantics, the study identified and analyzed all the surprise markers in a corpus of 320 research articles. A total of 439 surprise markers were found to evoke seven interconnected semantic frames. These semantic frames contained eight conceptually distinct frame elements, five of which were markedly more frequent than the rest and appeared in 12.76–100% of the frame instances identified. Based on the results of the analyses, a genre-specific Surprise frame with five key frame elements was generalized and is presented in this article as a conceptual tool for understanding how surprise and its linguistic expressions partake in the construction of scientific knowledge. Recommendations are made about how the conceptual frame can inform future research.

1. Introduction

This article reports on a corpus-based study that examined the use of linguistic expressions of surprise (hereinafter surprise markers) in research articles (RAs) from the perspective of frame semantics. At first blush, surprise and RAs make strange bedfellows because the former is arguably one of the basic human emotions (Ekman, 1984; Izard, 1977), whereas the latter are traditionally expected to be objective and emotion-free. However, while other basic emotions are almost completely absent in academic writing, surprise markers are not uncommon in RAs (Tutin, 2015). In fact, they have been found to be an important component of attitude markers employed in RAs (Hu and Cao, 2015; Hyland and Jiang, 2018). Given this apparent contradiction, a legitimate question to ask is: What is so special about surprise that privileges its presence in RAs? The answer lies in the nature of surprise as an emotion.

Unlike other basic emotions, surprise is cognitive in nature and results from the discrepancy between an actual experience and an entertained expectation (Scheffler, 2010). As expectations reflect our current schemata for a certain situation based on our prior knowledge, their being violated means the failure of our current schemata to make sense, which makes us aware of

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gaps in our knowledge and demands a revision of our schemata (Meyer et al., 1997). Therefore, when surprise is triggered, we are not only informed of the expectation-experience discrepancy but also motivated to find an explanation for it (Tsang, 2013). In other words, feeling surprised is intrinsically related to the acquisition of new knowledge. To acknowledge its close relationship with knowledge, Silvia (2009) includes surprise in a family of emotions called knowledge emotions, which are "associated with thinking and comprehension" (p.48) because they arise from people's appraisals of prior knowledge, expectations and potentiality for learning, and could "motivate learning, thinking, and exploring, actions that foster the growth of knowledge" (p.49).

Given the intrinsic association of surprise with knowledge-making and the status of RAs as the key genre for knowledge creation and communication (Hu and Cao, 2015), it is indeed surprising that the use of surprise markers in RAs has received little scholarly attention. Although studies on the use of attitude markers in RAs abound (e.g., Abdi, 2002; Crismore and Farnsworth, 1990; Del Olmo, 2014; Dueñas, 2010; Gillaerts and van de Velde, 2010; McGrath and Kuteeva, 2012; Thetela, 1997) and some of them have acknowledged the importance of surprise markers as a subtype of attitude markers (e.g., Hu and Cao, 2015; Hyland and Jiang, 2018), no focal and systematic attention has been extended to surprise markers used in RAs. We believe that this lack of research attention may have resulted in part from the unavailability of an analytic framework for linguistic expressions falling in the same semantic field. The existing analytical frameworks for linguistic features employed in written discourse are largely functionally oriented, classifying them by their metadiscoursal (Hyland, 2005a) or appraisal (Martin and White, 2005) functions. While these frameworks handle linguistic markers well at the metafunctional level and have offered useful insights into characteristics of academic English, they do not distinguish linguistic markers at the semantic level. For linguistic expressions sharing the same semantic field such as surprise markers, a finer-grained, semantically-oriented analytical framework is needed to capture their key semantic features so that a comprehensive and systematic understanding of their use in RAs can be obtained. In this regard, frame semantics (Fillmore, 1976, 1985) provides the basis for developing a semantically-oriented framework for analyzing surprise markers in academic discourse. Drawing on a specially compiled corpus of RAs, this study aims to explore the potential of applying frame semantics to the analysis of surprise markers in academic writing.

2. Previous research

2.1. Surprise markers as evaluative resources

Linguistic expressions of an emotion are qualitatively different from its physiological expressions (Frijda, 1986; Scherer, 1984). While the latter are spontaneous reactions to stimuli and "adaptive mechanisms for a more efficient interaction with the environment" (Soriano et al., 2015, p. 436) developed in the course of human evolution (Ekman, 1984), the former involve a deliberate evocation of selected emotions and the author's strategic choice in showing, feigning or even hiding his/her feeling (Kövecses, 2015). To characterize this unique property of linguistic expressions of emotions, Caffi and Janney (1994) term their use in written discourse as emotive communication, commenting that such communication is "inherently strategic, persuasive, interactional, and other-directed" (p. 329). Clearly, surprise markers are part of emotive communication, and their use in RAs constitutes an authorial effort to engage with and persuade the intended readers. Research tangentially investigating the use of surprise markers in RAs has been mainly conducted within two theoretical frameworks: metadiscourse (Hyland, 2005a) and appraisal theory (Martin and White, 2005).

Hyland (2005a) defines metadiscourse as "the cover term for the self-reflective expressions used to negotiate interactional meaning in a text, assisting the writer (or speaker) to express a view point and engage with readers as members of a particular community" (p. 37). Such self-reflective expressions can serve an "interactive" and an "interactional" function. Interactive metadiscourse is more information-oriented as it "helps readers understand a text by explaining, orienting and guiding them through the information" (Hyland, 2005a, p. 75), whereas interactional metadiscourse is more interaction-oriented and comprises such metadiscoursal resources as hedges, boosters and attitude markers that can be deployed to show authorial stance and engage with readers (Hyland, 2005b). From a metadiscoursal perspective, surprise markers are an important component of attitude markers and are closely related to three other categories of interactional metadiscourse discussed by Hyland (2005a): hedges, boosters, and self-mentions. According to Hyland (2005b), "attitude markers indicate the writer's affective, rather than epistemic, attitude to propositions, conveying surprise, agreement, importance, frustration, and so on" (p. 180). Hedges and boosters can be employed to modify the degree of surprise, as illustrated by *somewhat surprising* and *very surprising*. Self-mentions could explicitly mark the experiencers of surprise, for example, *to my surprise*. Surprise markers are also conceptually related to interactive metadiscourse, such as transitional markers (e.g., *however* and *in contrast*) and evidential markers (e.g., *unlike X's study* and *in view of the findings reported in Y*), which can introduce sources of violated expectations.

Similarly, surprise markers also feature in the appraisal system developed by Martin and White (2005). Martin and White's appraisal system has three sub-systems: attitude, graduation, and engagement. Surprise markers are intrinsically related to the first two. First, surprise markers can fall into all three "attitude" categories: affect, judgment, and appreciation. As an affective response, surprise can signal "insecurity", a type of affect, as illustrated by *I was astonished to find a hole in my pocket*. Surprise markers can also be used to make a judgment on people or their behavior, indicating "unusuality" (Martin and White, 2005), for instance, *Surprisingly, he did not say a word*. Furthermore, surprise markers are capable of expressing appreciation, that is, "our 'reactions' to things" (Martin and White, 2005, p. 56), as in *This finding is somewhat surprising*. Surprise markers

are intimately connected with the "graduation" subsystem too because surprise can be expressed in varying levels of intensity or sharpness through two types of "graduation" resource. The first type, "force" resources, can be used to raise or lower the degree of evaluation (e.g., *to our great surprise* and *somewhat unexpectedly*). The second type, "focus" resources, deals with the centrality or prototypicality of an attitude or a phenomenon, as can be seen in *I am really surprised* (i.e., sharpened focus) and *I am kind of surprised* (i.e., softened focus).

Although both the metadiscourse and appraisal frameworks incorporate surprise markers as evaluative resources and address them under multiple categories, they are not treated as a separate category in either framework. This is understandable because both frameworks revolve around the textual and interpersonal metafunctions of language (Halliday and Matthiessen, 2013) and are thus functionally oriented. In such functional systems, surprise markers do not deserve special attention precisely because they do not have a unique, monolithic, and designated function in service of the metafunctions. Consequently, empirical studies informed by the frameworks have tended to focus only on the broad category of attitude markers without paying further attention to any specific type of attitude, in our case, surprise. However, since surprise is cognitive in nature, a fine-grained examination of how surprise markers are used in RAs has the potential to reveal deep-seated knowledge-making practices across disciplines and changes of epistemological assumptions over time. Furthermore, because knowledge is intrinsically semantic, there is a need to develop a semantically-oriented framework for analyzing surprise markers. Frame semantics provides the conceptual apparatus for this task.

2.2. Frame semantics and research articles

Frame semantics is a theory of linguistic meaning developed by Charles Fillmore (1976, 1977, 1985). The basic idea undergirding this theory is that an individual linguistic item can only be understood against an entire range of background knowledge related to this linguistic item. This essential knowledge structure for understanding a linguistic item is called a semantic frame, which is a collection of facts that specify "characteristic features, attributes, and functions of a denotatum, and its characteristic interactions with things necessarily or typically associated with it" (Riemer, 2016, p. 55). For example, Stimulate_emotion is a semantic frame that allows us to understand the emotion of surprise as exemplified by *Given the consistent values reported in previous research, these empirical results surprised us greatly, necessitating a scrutiny of the experimental setup for a possible cause of the observed discrepancies*. In this example, a Stimulus (*these empirical results*) provokes a particular emotion (i.e., surprise) in an Experiencer (*us*) to a certain Degree (*greatly*); an Explanation (*Given the consistent values reported in previous research*) provides the reason why the Stimulus surprises the Experiencer; and the Result of the Stimulus affecting the Experiencer (*necessitating a scrutiny of the experimental setup for a possible cause of the observed discrepancies*) is also indicated. Thus, a semantic frame is linguistically defined by both lexical units (i.e., words evoking the semantic frame, such as *surprise* in this example) and the frame elements (i.e., Stimulus, Experiencer, Degree, Explanation, Result, etc.) conceptually related to the lexical units (Fillmore and Baker, 2010). Frames can share various relationships with each other. For example, the Stimulate_emotion frame is said to use an Emotions frame, which is in turn inherited by an Emotions_by_stimulus frame and perspectivized in an Experiencer_focused_emotion frame.

As demonstrated above, frame semantics links linguistic semantics to encyclopedic knowledge. Although essentially a theory of semantics with a focus on language understanding, frame semantics is fully compatible with discourse analysis because of their common focus on contextualized meaning, embodied experience, and cultural influence. According to Fillmore and Baker (2010), there are four major ways in which humans gain access to different types of frame: (a) "living on the earth"; (b) "being human"; (c) "being members of a particular culture, where we consciously or unconsciously respond to its institutions, symbols, artifacts, and values"; and (d) "being a part of the specific speech community that supports and is supported by the culture" (p.314). While the first two ways involve embodied experiences, the last two are culturally bound and discourse community-defined. Therefore, similar to what a discourse analyst pursues, a major task of frame semantic research is to "understand what reason a speech community might have found for creating the category represented" by a certain linguistic item and explain its meaning "by representing and clarifying that reason" (Fillmore, 1982, p. 112). Surprisingly, research endeavors to apply frame semantics have rarely looked beyond the sentence level. A possible contributor to this narrow focus could be the exclusive emphasis of FrameNet on local (i.e., intrasentential) constituents as frame elements for identified frames, which in turn is influenced by the emphasis of frame semantics on the central status of verbs and their valency (Ruppenhofer et al., 2016).[1] Among the few studies analyzing academic discourse from the perspective of frame semantics, Paltridge (1997) tried to identify the "core characteristics" of a genre prototype by examining "the interactional and conceptual frames that might be associated with the particular texts" (p. 63). This ambitious goal notwithstanding, the study was more functionally than semantically oriented because the "examination of linguistic characteristics of the collection of texts drew on a systemic functional perspective on language description" (Paltridge, 1997, p. 65).

Recent applications of frame semantics to the construction of academic knowledge are a series of studies conducted by Faber and her colleagues (Faber, 2011, 2012; Faber et al., 2006a,b; Faber et al., 2009) to capture the dynamics of specialized

[1] FrameNet is a human- and machine-readable lexical database of English created by Charles Fillmore and housed in the International Computer Science Institute in Berkeley, California. Containing over 1,200 semantic frames linked to each other through various frame relations and to over 200,000 annotated sentences, FrameNet is a major resource for researchers who conduct research informed by frame semantics (Ruppenhofer et al., 2016).

knowledge representation in frame-based terminologies. Focusing on terminologies specific to a scientific field, these studies aimed to create a comprehensive map of frames and frame relations for the representation of specialized knowledge by drawing on frame semantics and the methodologies developed within the FrameNet project (Ruppenhofer et al., 2016) to analyze linguistic and/or graphic descriptions of the field's specialized concepts. In another study taking a similar approach, L'Homme and Robichaud (2014) produced a map for the frames in the field of Environmental Studies and defined the relations between the frames to build field-specific conceptual scenarios. Despite the light that these studies shed on disciplinary knowledge representation, it should be noted that they were more conceptually than discursively oriented.

It can be seen from the review above that the few extant applications of frame semantics to academic discourse have tended to focus on a macro level, trying to characterize academic fields/texts by their knowledge/rhetorical structure. Little attention has been given to questions such as how a specific frame is represented in a text, whether it shares epistemic functions with other frames, what frame elements occur in the frame, how these elements are distributed, and what attributes the frame elements possess. These questions have been inspired by Tutin's (2015) study of the use of surprise markers in a corpus of French social science articles. The study identified a "surprise routine" consisting of a four-sequence scenario: scientific expectation → observations of facts → non-congruence with expectation → explanation of surprise. We believe that frame semantics provides a conceptual tool for understanding such a scenario, that is, how surprise as an important knowledge emotion (Silvia, 2009) partakes in the construction of knowledge in the academically privileged genre of RAs. To this end, we conducted the exploratory study reported on here. The study was guided by the following research questions:

1) What semantic frames can be evoked by surprise markers used in a corpus of RAs? What frame elements can be found in the identified semantic frames?
2) How are the identified semantic frames related to each other?
3) Can a Surprise-specific frame be generalized from the conceptually related frames?

3. Methods

To address the research questions presented above, we compiled a corpus of RAs as part of a larger project designed to compare the use of surprise markers between two disciplines (Applied Linguistics and Counseling Psychology), two research paradigms (quantitative and qualitative research), and two historical periods (1981–1985 vs. 2011–2015). The RAs were randomly sampled from four top journals each in the disciplines of Applied Linguistics (i.e., *Applied Linguistics, Modern Language Journal, TESOL Quarterly*, and *Language Learning*) and Counseling Psychology (i.e., *Journal of Counseling Psychology, Journal of Clinical and Consulting Psychology, Journal of Abnormal Psychology*, and *Professional Psychology: Research and Practice*). The corpus consisted of 320 full-length RAs, totaling approximately 2 million words. Table 1 presents descriptive statistics on the corpus.

Table 1
Descriptive information on the corpus.

Measure	Applied linguistics				Counseling psychology				Total
	Quantitative		Qualitative		Quantitative		Qualitative		
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	
No. of RAs	40	40	40	40	40	40	40	40	320
Total words	150900	313869	216027	308388	168851	258895	153658	289714	1860302
Average words/RA	3773	7847	5401	7710	4221	6472	3841	7243	5813

Following the method adopted by FrameNet that takes lexical units (LU) as the focus of analysis (Ruppenhofer et al., 2016), we also employed a lexical approach to identify surprise markers in our corpus (Kövecses, 1986). First, we prepared a comprehensive list of synonyms and antonyms of *surprise* and all their derivative forms based on *Roget's International Thesaurus* (Kipfer, 2010) and WordNet (Fellbaum, 1998). The antonyms were included because they could be made synonymous with *surprise* through various types of negation, for example, *expectedly/unexpectedly*, *anticipated/least anticipated*, and *assumption/contrary to assumption*. The items in the compiled list were then used as search words to identify surprise markers in the RA corpus (see Appendix for the complete list of search words). All the hits were manually checked to remove those lexical items that did not express surprise, for example, *shock* in *electric shock*. Next, the surprise markers identified in the corpus were grouped according to the semantic frames they are assigned to in FrameNet. If a surprise marker was not found in FrameNet's LU list, it was assigned to a frame based on its semantic similarity to other surprise markers found in FrameNet's LU list.

Distinct frame elements associated with the semantic frames found in the RA corpus were extracted from FrameNet to develop a coding scheme. It was then used to identify and classify all the frame elements occurring in the instances of the surprise-related frames found in our corpus. Although the identification of frame elements in FrameNet focuses on only

intrasentential constituents, we found it necessary to extend the analysis beyond the sentence level to include larger stretches of discourse. For example, the Result (i.e., the outcome of the expressed surprise) for the Stimulate_emotion frame often occurred outside the sentences where the frame-evoking surprise markers appeared. Similarly, the Explanation (i.e., the reason why an emotion is evoked) was sometimes found to be several sentences away from the frame-evoking lexical unit.

The relations between the identified surprise-related frames were also determined by checking the relevant "frame--frame relations" found in FrameNet. There are several possible relations between two frames. The most relevant ones to our data are Inheritance, Using, Perspective_on/Perspectivized_in. Inheritance is a frame-to-frame relation whereby anything true of a more abstract frame (i.e., the parent frame) also holds true for a more specific frame (i.e., the child frame), as illustrated by the relation between the Getting frame and the Commerce_buy frame (Ruppenhofer et al., 2016). Using is a relationship in which "a part of the scene evoked by the child [frame] refers to the parent frame", as can be seen in the Volubility frame and the Communication frame, with the former describing "a quantification of communication events" (Ruppenhofer et al., 2016, p.83). Perspective_on and Perspectivized_in describe the relation between a neutral frame (e.g., the Begin_employment frame) and a frame with a specific perspective (e.g., the Get_a_job frame), where the former is perspectivized in the latter, which reciprocally provides a perspective on the former (Ruppenhofer et al., 2016). Frame–frame relations, together with frame element mappings and lexical units, provide a useful basis for identifying key attributes of frames and making cross-frame generalizations.

4. Results and discussion

4.1. Surprise-related frames, frame elements, and frame relations

Eight-three different surprise markers were identified in our corpus, including nouns, verbs, adjectives, adverbs, and phrases/structures (e.g., *contrary to expectation* and *not as expected*). Altogether, there were 439 occurrences of these surprise markers in the corpus. Notably, six of them – *unexpected, unusual, striking, surprising, surprisingly*, and *remarkably* – occurred more than 20 times in the corpus, accounting for 44% of all occurrences. Table 2 provides the complete list of surprise markers found in the corpus and their frequency.

Table 2
Surprise markers: categories and frequencies.

Category	Surprise marker
Noun	*amazement* (1), *astonishment* (2), *discrepancy* (1), *shock* (4), *surprise* (14), *unexpectedness* (1)
Adjective	*amazing* (2), *astonishing* (1), *astounding* (3), *disconcerting* (3), *exceptional* (8), *extraordinary* (5), *impressive* (6), *jolting* (1), *remarkable* (14), *staggering* (3), *startling* (1), *strange* (10), *striking* (32), *sudden* (12), *surprising* (31), *unannounced* (1), *unanticipated* (4), *uncharacteristic* (1), *uncommon* (5), *unexpected* (46), *unforeseen* (2), *unpredictable* (13), *unprepared* (2), *unusual* (34)
Adverb	*amazingly* (1), *exceptionally* (3), *remarkably* (22), *strikingly* (3), *suddenly* (7), *surprisingly* (27), *unexpectedly* (7), *unpredictably* (1), *unusually* (7)
Verb	*amaze* (3), *astonish* (3), *marvel* (1), *shock* (2), *startle* (1), *strike* (11), *surprise* (12)
Phrase/structure	*against expectation* (2), *although somebody expect …* (1), *anticipate…but…* (1), *assume … but not borne out* (1), *belie expectation* (1), *beyond expectation* (1), *comparative + than anticipated* (3), *comparative + than assumed* (2), *comparative + than expected* (9), *comparative than somebody expect* (1), *comparative + than usual* (2), *contrary to assumption* (1), *contrary to expectation* (6), *contrary to prediction* (2), *counter of … predicted* (1), *counter to assumption* (2), *deviation from anticipated …* (1), *expect…but…* (2), *expect … not borne out* (1), *expect…not happen…* (2), *expectation not born out* (2), *fail to show expected …* (2), *fail to support expectation* (1), *failure to obtain the expected …* (1), *lack expected …* (2), *lack of predicted …* (1), *least anticipated* (1), *not anticipate* (1), *not as expected* (2), *not common* (1), *not conform to assumption* (2), *not expect* (2), *not expected* (1), *not show expected …* (1), *opposite to what somebody expect* (1), *reversal of what was anticipated* (1), *violate expectation* (1)

The 439 surprise markers were found to evoke seven semantic frames listed in FrameNet. Table 3 summarizes the frames and the distributions of the surprise markers across them.

Table 3
Frequency distribution of surprise markers in terms of frames.

Frame	No. of surprise marker	% of all frames
Expectation	157	35.76
Stimulus_focus	117	26.65
Typicality	96	21.87
Just_found_out	36	8.20
Emotion_directed	15	3.42
Desirability	13	2.96
Stimulate_emotion	5	1.14

Expectation, the most frequently occurring frame in our corpus, contains words that "have to do with a Cognizer believing that some Phenomenon will take place in the future" (FrameNet). It was typically evoked in our corpus by lexical units such as

unexpected, unpredictable, and various phrases containing *expectation* (see Example 1 below).[2] The Stimulus_focus frame, on the other hand, involves a Stimulus and an Experiencer: "In this frame either a Stimulus brings about a particular emotion or experience in the Experiencer or saliently fails to bring about a particular experience" (FrameNet). According to FrameNet, when the Stimulus is characterized by the experience likely to be evoked in the Experiencer, the latter is rarely present (see Example 2). In our data, the frame was often evoked by *surprising* and *striking.* As illustrated by Example 3, the Typicality frame, evoked by lexical units such as *unusual, strange,* and *(not) common,* describes "a State_of_affairs [which] is generally, or with regard to a particular Feature, representative of its class, which may be narrowed to a specific Comparison_set" (FrameNet). In the Just_found_out frame, "an Experiencer, Expressor, or State can be described as having a surprised emotion as evoked by a Stimulus or concerning a Topic" (FrameNet), as reflected in such nouns and adjectives as *shock, surprise,* and *surprised* (see Example 4). Adjectives and nouns (e.g., *astonished, shocked,* and *astonishment*) in the Emotion_directed frame "describe an Experiencer who is feeling or experiencing a particular emotional response to a Stimulus or about a Topic" (FrameNet). Example 5 illustrates this semantic frame and its key elements. Evoked by words such as *exceptional* and *extraordinary,* the Desirability frame "concerns an Evaluee being judged for its quality, i.e. how much it would probably be liked" and "in many cases, the Evaluee is implicitly judged good or bad relative to other instances of its type" (FrameNet), as can be seen in Example 6. Finally, in the Stimulate_emotion frame evoked by nouns and verbs like *surprise, shock,* and *startle*, "some phenomenon (the Stimulus) provokes a particular emotion in an Experiencer" (FrameNet), as shown in Example 7.

(1) An UNEXPECTED^{Target} benefit of this situation is [$_{Phenomenon}$ that it is relatively easy for non-native speakers to acquire the ability to give and to interpret compliments in American English]. [$_{Cognizer}$INI]
(2) [$_{Stimulus}$That such widespread conversational phenomena should be ignored in the teaching of vocabulary] is ASTONISHING^{Target}.
(3) One STRANGE^{Target} [$_{State_of_affair}$use of the pronoun system in English] is the reference to people present in the speech situation by the third person pronoun.
(4) [$_{Degree}$Much] to [$_{Experiencer}$her] SURPRISE^{Target} and that of [$_{Experiencer}$her class], [$_{Stimulus}$an elderly male colleague going past her door caught sight of her and walked right in].
(5) Reading Rosier and Holm (1980), [$_{Experiencer}$one] is STRUCK^{Target} [$_{Stimulus}$by the fact that they give effects of the program on scores on English tests of reading and arithmetic].
(6) They also benefit from what I consider to be an EXTRAORDINARY^{Target} [$_{Evaluee}$growth in vocabulary], a growth which I have not found as evident in courses which use nonfiction essays as prose models or stimuli for topics of papers.
(7) [$_{Stimulus}$The success of DDI certainly] has SURPRISED^{Target} [$_{Experiencer}$me].

Notably, the three most frequently occurring frames accounted for about 85% of all frame instances. These distributions were not surprising and had to do with the sources of surprise. Previous research has shown that although surprise is more likely to arise from a striking contrast between expectation and reality than from the low probability of an event, both are important sources of the emotion (Teigen and Keren, 2003). This explains why the Expectation frame occurred almost twice as frequently in the corpus as the Typicality frame, and yet both frames were among the most frequent of the seven frames. The findings that the Stimulus_focus frame was the second most frequent and that the Experiencer was rarely present in the instances of the frame were consistent with Tutin's (2015) observation that RAs tend to omit the Experiencer when expressing surprise.

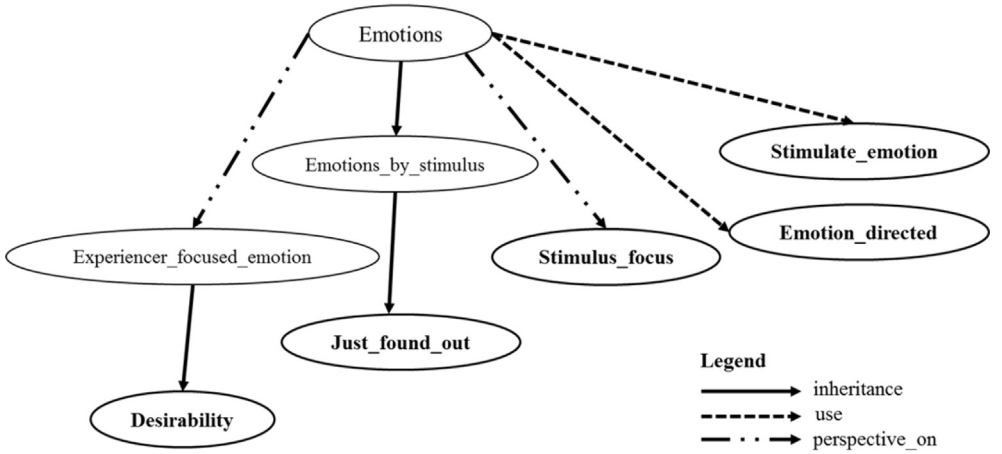

Fig. 1. Frame interconnections.

[2] Examples 1–7 from our RA corpus are presented in the annotation format adopted in FrameNet. INI in Example 1 stands for Indefinite Null Instantiation, indicating that the Cognizer is omitted but is conceptually salient (Ruppenhofer et al., 2016).

The connections among the seven identified frames were examined by drawing on FrameNet's network of frame–frame relations. Except the Expectation frame and the Typicality frame, all the frames are interconnected with each other through various types of frame–frame relation. As can be seen in Fig. 1, all five frames relate to each other via the Emotions frame, which provides a perspective on, is inherited or used by the relevant frames. For example, the Desirability frame connects with the other four identified frames by inheriting the Experiencer_focused_emotion frame, which provides a perspective on the Emotions frame. The latter is, in turn, inherited by the Just_found_out frame via the Emotions_by_stimulus frame, perspectivized in the Stimulus_focus frame, and used by the Emotion_directed frame and the Stimuate_emotion frame. Similarly, the Just_found_out frame relates to the Stimuate_focus, Emotion_directed, and Stimulate_emotion frames via the Emotions_by_stimulus and Emotions frames. Finally, both the Emotion_directed frame and the Stimulate_emotion frame use the Emotions frame, which is perspectivized in the Stimulus_focus frame. Although the Expectation frame and the Typicality frame do not have frame–frame relations with the other five identified frames, they share the critical attribute of cognitive incongruence, that is, a lack of epistemic alignment between a phenomenon or a situation and current knowledge. Such conceptual overlap among the frames motivated our effort to generalize a surprise-specific frame for the RA genre.

Using the coding scheme described in the previous section, we identified all the frame elements contained in the seven frames in our corpus. Table 4 summarizes the coded frame elements and their distributions. The first frame element in the table is named differently by FrameNet for different frames, for example, Stimulus for the Stimulate_emotion frame, Phenomenon for the Expectation frame, Evaluee for the Desirability frame, and State_of_affair for the Typicality frame. It was the most frequent frame element in our data, occurring with all the surprise markers identified in the corpus. Result was the second most frequent frame element and occurred in slightly over a quarter of the instances of the identified frames. The third most frequent frame element, Explanation (named Reason in the Emotion_directed frame and Circumstance in the Stimulus_focus frame), appeared in slightly less than one quarter of the frame instances. Both Degree and Experiencer (also referred to as Cognizer in the Expectation frame and Affected_party in the Desirability frame) were markedly less frequent, and the remaining three frame elements – Comparison_set, Feature, and Topic – were rare in our corpus. Given their relative frequencies, it would seem reasonable to include the five most frequent frame elements in a generalized Surprise frame.

Table 4
Frame elements and their distributions.

Frame element	Raw frequency	% of frame instances[a]
Stimulus	439	100.00
Result	117	26.65
Explanation	104	23.69
Degree	77	17.54
Experiencer	56	12.76
Comparison_set	5	1.14
Feature	4	0.91
Topic	3	0.68

[a] Percentage of all instances of the seven identified frames.

4.2. A genre-specific surprise frame

Given the conceptual overlap among the seven surprise-related frames and based on an analysis of the most frequently occurring frame elements in our corpus, we have developed a generalized Surprise frame for the academic genre of RAs. The frame, together with its key frame elements, is presented in Fig. 2. In what follows, we explain the frame, define and illustrate its main frame elements, provide their distributions, and discuss what the distributions can tell us about RAs in social sciences.

4.2.1. Trigger

This element evokes the emotive response of surprise. It is a core element because it "instantiates a conceptually necessary component of [the] frame" (Ruppenhofer et al., 2016, p.23). As we have seen earlier, it has been given different names in FrameNet depending on the semantic frames involved. To avoid terminological complexity, it is named Trigger in our generalized Surprise frame. Four types of Trigger were identified in our corpus. As illustrated by Example 8, the first type of Trigger includes relationships between research variables, between findings yielded by the same study or between findings from different studies that evoke the emotive response.[3] Attributes, as another type of Trigger, comprise characteristics of research participants, research methods or research objects, as shown in Example 9. As the third type of Trigger, behaviors

[3] In the examples presented below, the target frame elements are underlined, and the surprise markers are in bold. All the examples come from our RA corpus.

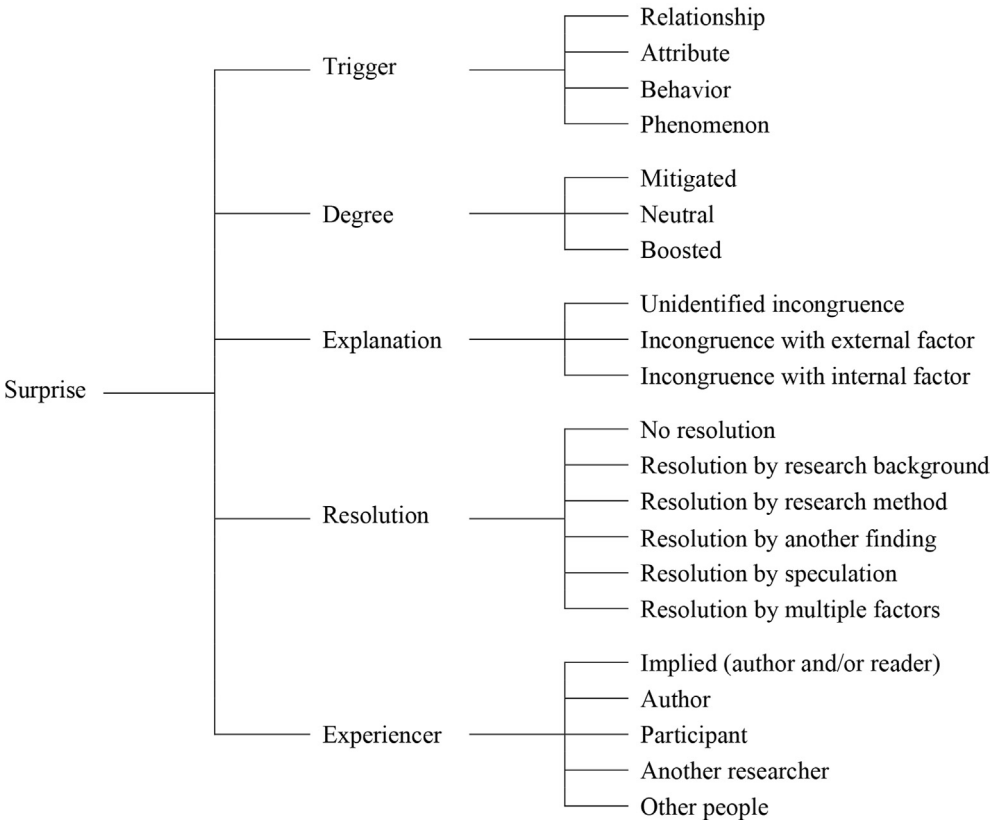

Fig. 2. The Surprise frame.

consist of physical, verbal, and mental behaviors (see Example 10). Finally, phenomena refer to all happenings and entities that do not belong to the first three types of Trigger (see Example 11).

(8) However, an **unexpected** finding was that, on average, the low-anxiety group produced a significantly larger proportion of mazes (21.46%) than did the moderate-anxiety group (18.96%), meaning that the moderate-anxiety group's performance was, on average, more comprehensible than that of the low-anxiety group.

(9) Since the Advisory Panel members were well aware of the importance of education and, consequently, had proactively expanded the scope of the educational activities in the Project, they were somewhat **surprised** at the extent and vehemence of objections raised by their professional colleagues.

(10) When the representative uttered the words "uncollected dog feces", the mouth of the first author literally fell open with **astonishment.**

(11) Considering the large numbers of adult L2 learners and the variety of programs organized for them, it is **surprising** that the possibility of age constraints upon L2 achievement has received so little attention.

Although verbal, physical, and/or mental behaviors are the very objects of study in Applied Linguistics and Counseling Psychology, they were the least frequent type of Trigger in our data (accounting for 18% of Triggers found), compared with phenomena (35%), attributes (27%), and relationships (20%). This seemingly unexpected result actually conforms to our understanding of surprise as arising from conceptual incongruence (Kövecses, 2015). As pointed out by Teigen and Keren (2003), the low probability of an event does not necessarily cause the Experiencer to feel surprised. It is the high contrast between expectation and reality that is more likely to evoke a feeling of surprise. Frequent contact and greater familiarity with all kinds of human behaviors can conceivably decrease the likelihood for applied linguists and counseling psychologists to be surprised by such behaviors. The distributions of the Trigger types are consistent with this cognitive pattern.

4.2.2. Degree

This frame element refers to the degree to which a Trigger evokes the feeling of surprise. It is a peripheral frame element because it does "not uniquely characterize a frame, and can be instantiated in any semantically appropriate frame" (Ruppenhofer et al., 2016, p.24). A surprise response can be mitigated (i.e., weakened) in some way, as illustrated by Example 12, left neutral (i.e., neither intensified nor weakened), as shown in Example 13, or boosted (i.e., intensified), as can be seen in Example 14. A great majority (82%) of the surprise markers found in our corpus fell in the "neutral" category, whereas 8% and 10% were boosted and mitigated, respectively. When the emotional responses evoked by the surprise markers were

mitigated, *somewhat* was the most frequent hedge (Examples 12 and 15), followed by epistemic modal verbs such as *may* and *might* (Example 16). Where surprise responses were boosted (Examples 14 and 17), there was a greater diversity of boosting devices. The finding that the intensity of surprise responses could be modulated in various ways may have reflected the authors' consciousness of the need to show academic prudence in scholarly writing, avoid becoming "overemotional", and maintain a textual image of authority and credibility as disciplinary experts (Hyland, 2005a). Interestingly, when modulated surprise responses, especially boosted ones, appeared in sentence-initial positions, they appeared to serve an attention-catching rhetorical function.

(12) Somewhat **surprisingingly**, while observations indicate that Maria received explicit writing instruction from teachers in high school – though not frequently – she did not mention their pedagogical guidance as a resource she drew upon to write.
(13) **Unexpectedly**, social-relevant behavior related negatively and significantly to solitary relevant behavior.
(14) To our great **surprise**, and we feel we should report this to our colleagues, the most difficult part of this work, and the part we have spent the most time one, has been the working out of a methodology for analysing IL texts in a comparative fashion across contexts.
(15) Somewhat **unexpectedly**, they were not unusually low on GATB aptitude scores.
(16) These findings may seem **surprising**, as overachievers excelled in rote learning, which was generally considered mechanic, but not in tasks that demanded higher level processes, such as integrating multiple sources of information in a sentence or in a discourse context.
(17) I certainly **did not expect** to be dealing with a suicidal person over a computer terminal.

4.2.3. Explanation

While a Trigger tells us what is surprising, an Explanation makes clear why something is surprising. In other words, the Explanation gets to the bottom of the emotional response, that is, a violated expectation, or incongruence between what was expected and what is found. As such, it is a core frame element according to Ruppenhofer et al.'s (2016) criteria for coreness. In scientific research, incongruence may exist between a finding of one's study and one's expectation based on external factors, namely findings of previous studies or characteristics of the research context, as can be seen in Example 18. Epistemic incongruence may also exist with internal factors, such as other findings obtained in the same study and attributes of research participants, as illustrated by Example 19. While incongruence in Examples 18 and 19 was indicated intra-sententially (i.e., in the same sentences where the surprise markers concerned were found), over 46% ($n = 48$) of the incongruence-identifying Explanations in our corpus were presented extra-sententially. Although surprise is inevitably the result of conceptual incongruence (Casti, 1994), researchers may choose to present the incongruence explicitly or say nothing about it because the use of surprise markers in academic writing is a strategic choice made by an author rather than a spontaneous physical reaction to a stimulus (Caffi and Janney, 1994). Example 20 shows an instance of a Surprise frame where the incongruence in question is not identified explicitly.

(18) This is **surprising** given research that shows unemployment is negatively related to an individual's well-being (Paul and Moser, 2009).
(19) The lack of knowledge of the APA Model is **surprising** considering many of the participants who made up this survey's sample are considered leaders within the field (psychology licensing board members, state psychology association members, and faculty of doctoral programs).
(20) Also, despite the **striking** uniformity in the developmental profile of different learners, there are variations in the overall course of development that learners follow.

Our data revealed that in most cases (i.e., 76%), the authors of the RAs chose not to identify the sources of surprise explicitly, in comparison with 10% and 15% of the cases where incongruence with internal and external factors was identified, respectively. Since experienced surprise results from epistemic incongruence (Kövecses, 2015), the non-identification of incongruence sources in most instances of expressed surprise may have stemmed from a tendency of researchers to assume shared knowledge among members of a disciplinary community. It might be hypothesized that the extent to which shared knowledge can be assumed may differ from discipline to discipline and change with time. For example, authors of RAs in hard disciplines (e.g., natural sciences) may have greater shared disciplinary knowledge than their counterparts in soft disciplines such as the humanities do (Cao and Hu, 2014; Hu and Liu, 2018), and consequently may leave sources of incongruence unidentified more frequently in their expressions of surprise. It is also reasonable to hypothesize that RAs of a discipline in its infancy would be more likely to identify incongruence for expressed surprise because the shared knowledge base has not been established. With suitable corpora, these hypotheses can be tested empirically. Apparently, such research can contribute a more fine-grained understanding of how the collective cognition of a disciplinary community may influence its academic discourse in subtle ways.

4.2.4. Resolution

This core frame element overlaps conceptually with Result found in the emotion-related frames and deals with how the epistemic incongruence giving rise to the emotion of surprise is straightened out. Faced with something surprising or unusual, it is human nature to find a resolution, and the resolution, sometimes easily available and sometimes hard won, could update one's schema about a specific situation, provide guidance for future action, or both. In this process, new knowledge is generated, at least for the person who has experienced the surprise and managed to resolve it. This is the main reason why surprise, along with interest and confusion, is regarded as a knowledge emotion (Silvia, 2009). Since the RA is the key genre for the construction and dissemination of scientific knowledge (Authors, 2015), it provides an excellent site for investigating how researchers resolve surprising findings. A close look at our data revealed that 27% of the expressed surprises were

resolved in various ways, whereas the incongruence underlying the remainder was unresolved. In our corpus, 106 (i.e., 90.60%) of the 117 Resolutions identified were provided extra-sententially. In some extreme cases, the resolutions could be pages apart from the surprise markers. For example, in some articles, surprise at a finding was expressed in the Result section, but its resolution appeared in the Discussion section.

In our corpus, surprising scientific results were resolved mainly in five ways. First, a surprising finding reported in an RA was found to be consistent with relevant research background, that is, findings of some previous studies or situational characteristics. This type of resolution accounted for 2% of all instances of incongruence and is illustrated by Example 21. Second, some instances (about 4%) of incongruence were resolved with reference to the specific research methods employed, as shown in Example 22. Third, as Example 23 demonstrates, there were also cases (4%) in which a surprising finding was explained by another finding obtained in the same study. Fourth, when no resolution could be found from the above three sources, researchers could attempt to resolve their surprising observations by speculation, that is, by offering their tentative explanation or putting forward a new hypothesis. This type of resolution accounted for 15% of all instances of incongruence and is illustrated by Example 24. Obviously, this is the most important type of resolution because it generates new knowledge rather than appealing to existing knowledge. Finally, about 2% of the identified instances of incongruence were resolved by considering multiple factors (see Example 25). Notably, not every surprise expressed in an RA needed to be resolved. There were cases where surprise was expressed to justify other actions described in the RAs or simply to provide background information. In these cases, surprise was presented as "given" information that was supposed to motivate further research rather than to be explained (see Example 26).

(21) These findings may seem **surprising**, as overachievers excelled in rote word learning, which was generally considered mechanic, but not in tasks that demanded higher level processes, such as integrating multiple sources of information in a sentence or in discourse context. Nevertheless, the findings may actually reflect the paradoxical role of context in reading literature. Even though it is generally agreed that context facilitates constructing meanings for unknown words, some researchers have pointed out that relying on context does not always produce better word learning (Cunningham, 2006; Nation, Angell and Castles, 2007). Overreliance on context may even lead to negative effects in word learning because context draws learners away from attending to word-specific properties (Landi et al., 2006; Stuart, Masterson and Dixon, 2000).

(22) Considering that in the literature early response is often associated with shorter treatment length (e.g., Haas et al., 2002), this finding might be a **surprise.** This could be a result of the structured nature of this treatment, which was designed for a relatively short period of 11 sessions.

(23) These return-to-work rates were **higher than anticipated** on the basis of prior research, primarily with older women, for whom the return rate was reported as closer to 60%…. Previously studied factors related to returning to work – such as type of treatment, work support, and physical demands of the job – were overridden by participants' financial or insurance needs in the current study.

(24) As noted above, New Zealanders tend to play down expertise; it would be **most unusual** to hear someone elaborate their experience in the detail provided here by Andrei… Andrei's two narratives indicate that he regards it as important in this initial phase of his internship to supply evidence of his experience and competence, and that the appropriate amount of such information and the explicitness with which it is described is much greater from someone of Russian origins than for a New Zealander.

(25) **Contrary to prediction**, however, no main effects due to the generality dimension were found on the expectancy of control measure, and the internal-external dimension appeared to exert a significant influence on anagram performance…. There seems to be several possible explanations for these discrepant results. The first and most parsimonious explanation is that …. An alternative explanation follows from the observation that …. A somewhat related explanation suggests that ….

(26) Given the centrality of materials in a very wide range of language teaching situations, it is somewhat **surprising** that there has not been more empirical classroom-based research on the role(s) that materials play in the totality of processes of language teaching and learning that comprises classroom interaction.

4.2.5. Experiencer

This frame element concerns who feels surprised. The evoking of a surprise response presumes an Experiencer. However, our analysis of the RAs revealed that for an overwhelming majority (i.e., 83%) of the expressed surprises, the Experiencers were not explicitly stated, as can be seen in Example 27. These unstated experiencers were, by implication, the RA authors and, in many cases, their intended readers as well because the latter were expected to share the former's emotive reactions. Tutin (2015) found a similar pattern of implied Experiencers and pointed out that "surprise is more source-oriented than experiencer-oriented" (p.431). She went on to question "the status of surprise as an affect in scientific writing" because "it seems to be more a state of consciousness associated with the observation of complex facts expressed in stereotypical rhetorical scenarios" (p. 432). Based on our findings, we agree with Tutin (2015) and Caffi and Janney (1994) that surprise markers participate in emotive communication rather than emotional communication. This tendency of leaving the Experiencers unstated contributes to the desired objective presentation of scientific facts in academic writing even when attitudes are addressed. Thus, Experiencer is a peripheral element of the Surprise frame.

(27) When analysing the data in detail, what is immediately **striking** is that, as far as the amount of negotiation of particular topics and issues is concerned, students of higher proficiency are significantly more verbose.

Among those cases where the Experiencers were given, four categories were identified. They are the author(s) of the RA (4% of all instances of the coded frames), research participant(s) (11%), another researcher (1%), and other people (Experiencers not falling into the aforementioned three categories; 1%). Examples 28–31 illustrate these four categories of Experiencers in the order presented above.

(28) I certainly **did not expect** to be dealing with a suicidal person over a computer terminal.
(29) Understandably, ESL students are **astonished** to see their own words printed in a teacher's journal.
(30) Schlesinger (1968) was **surprised** to learn that his subjects performed about as well on sentences that were structurally complex as on those that were less complex.
(31) The learner is called on to repeat structures and lexicon in ways that either **strike** the native speaker as unnatural, or create implicatures unintended by the authors.

5. Conclusion

Applying a frame semantic analysis to linguistic expressions of surprise in a corpus of 320 RAs from Applied Linguistics and Counseling Psychology, we have generalized a surprise-specific semantic frame (i.e., a conceptual framework that integrates key attributes of surprise-related frames). This Surprise frame has extended frame semantics in at least three important ways. First, it abstracts seven related semantic frames and their variously labeled frame elements found in FrameNet into a single frame and a uniform set of frame elements. This generalized frame is not only well suited to account for the linguistic and cognitive properties of surprise markers in our RA corpus but also enables a more conceptually parsimonious and coherent frame-based analysis of surprise as a cognitive emotion (Meyer et al., 1997), making it easier to compare its expression across disciplinary contexts or over time. Second, the generalized Surprise frame redefines the core/peripheral status of the frame elements associated with the seven semantic frames as originally characterized in FrameNet. For example, while FrameNet characterizes the status of the three conceptually overlapping frame elements of Reason in the Emotion_directed frame, Explanation in the Stimulate_emotion frame, and Circumstance in the Stimulus_focus frame differently (i.e., the first one as a core element and the last two as peripheral ones), their conceptual equivalent (i.e., Explanation) in the Surprise frame is regarded as a core element. Similarly, although Experiencer and its variants are treated by FrameNet as core elements in all the emotion-related frames except the Stimulus_focus and Desirability frames, our Surprise frame assigns a peripheral status to it across all contexts of use. Such status re-characterizations allow us to capture the most salient cognitive characteristics of surprise as a knowledge emotion (Noordewier and Breugelmans, 2013). Third, frame elements are intra-sentential "syntactic dependents" in frame semantics (Ruppenhofer et al., 2016, p.8), but some of them (i.e., Explanation and Resolution) have the option of taking extra-sentential positions. Such conceptual extensions make it possible to apply frame semantics to the analysis of language beyond the sentence level.

Although frames are conceptualized in frame semantics as large classes of concepts that are genre-independent, we have characterized the Surprise frame as genre-specific for two reasons. First, the nature of surprise appears to differ in everyday and academic discourse. As Tutin (2015) points out, the expression of surprises in RAs is qualitatively different from emotional communication in non-academic contexts, where surprise is often viewed as one of the basic emotions that can have both positive and negative valence, "depending on whether the cause of the surprise was in itself positive (e.g., a gift) or negative (e.g., a tax assessment)" (Noordewier and Breugelmans, 2013, p.1326). Surprise as a knowledge emotion in academic discourse is fundamentally cognitive and has conceptual affordances such as facilitation of curiosity, learning, and epistemic (re)appraisal (Meyer et al., 1997; Noordewier and Breugelmans, 2013). Thus, it is necessary to restrict the scope of application for the Surprise frame to academic genres (e.g., RAs) rather than non-academic ones (e.g., everyday conversation). Second, that the Surprise frame has been established exclusively with a corpus of 360 RAs means that it is not clear whether it is applicable to other academic genres such as conference presentations and textbooks. Because of the uniformity of our database, the Surprise frame has to remain RA-specific for the moment. However, its potential relevance to other genres of academic discourse is an empirical research question that merits further attention.

While the Surprise frame proposed in this article needs to be verified with RAs from other disciplines, it has generated meaningful findings in the aforementioned larger research project on which this study is based. For example, cross-disciplinary differences have been found in the incidence of mitigated surprises, behaviors as Triggers, and resolution of incongruence by research method and by speculation, whereas cross-paradigmatic differences (i.e., quantitative vs. qualitative research) have been found in the occurrences of all four types of Trigger, boosted surprises, unidentified incongruence, incongruence with external factors, and resolution of incongruence by research method. Furthermore, time-related differences have also been uncovered in the frequencies of attributes as Triggers, mitigated surprises, unidentified incongruence, incongruence with external factors, unresolved incongruence, and implied Experiencers. These differences are interpretable in terms of fundamental disciplinary assumptions, epistemological characteristics of the research traditions involved, and historically evolving philosophies of science. In view of such findings, there is good reason to believe that the Surprise frame presented in this article provides a promising conceptual tool for understanding surprise as a knowledge emotion. Further research can apply the conceptual framework to RAs from different disciplines, different research genres, and academic writing in different languages to reveal how surprise and its expressions are fundamentally involved in the construction of scientific knowledge.

Appendix. The complete list of search words used to identify surprise markers

Category	Part of speech	Search words
Surprisingness/ inexpectation	Verb	*surprise, amaze, astonish, shock, strike, astonish, impress, astound, flabbergast, stun, floor, explode a bombshell, ball over, blow out, take aback, marvel*
	Noun	*surprise, astonishment, amazement, bombshell, shock, wonder, wonderment, admiration, stupefaction, surprisingness, unexpectedness, inexpectation*
	Adjective	*surprising, startling, astonishing, astounding, remarkable, alarming, shocking, amazing, disconcerting, disturbing, surprised, startled, astonished, astounded, shocked, amazed, unexpected, amused, unusual, uncommon, intriguing, exceptional, incredible, extraordinary, stunning, unforeseen, unpredictable, sudden, unannounced, unheralded, unpredicted, unanticipated, unlooked-for, unhoped, unhoped for, unthought, unthought of, unprovided for, jolting, uncharacteristic*
	Adverb	*surprisingly, amazingly, astonishingly, remarkably, unusually, unexpectedly, extraordinarily, incredibly, uncommonly, uncharacteristically, exceptionally, alarmingly, suddenly*
Unsurprisingness/ expectation	Verb	*expect, anticipate, predict, assume, suppose, presume, take for granted, hypothesize, theorize, reckon, await*
	Noun	*expectation, expectancy, anticipation, prospect*
	Adjective	*expected, unsurprising, anticipated, awaited, hoped-for, expectable, foreseen, foretold, predicted, matter-of-course, supposed, assumed, usual, common, predictable*
	Adverb	*expectedly, unsurprisingly, expectably, supposedly, usually, commonly, expectably, predictably*

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