The Consequences of Citing Hedged Statements in Scientific Research Articles

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Biologists are taught to collect and analyze data according to practices that have developed in the scientific disciplines over the years, practices collectively known as the scientific method. These established practices serve to validate within the scientific community the credibility of the data. These data and interpretations usually are presented as a research article in a scientific publication and designed to persuade its audience of the soundness of the conclusions. For scientific prudence, when scientists state their conclusions they "must stay within a certain consensus to have anything to say to members of [their] discipline, but must also have a new claim to make to justify publication" (Myers 1989, p. 5). To balance these conflicting objectives, biologists often hedge and add uncertainty to their conclusions.

A hedged conclusion represents an early stage in the evolution of a field's understanding of a particular subject. The fate of a hedged conclusion rests on how other scientists interpret it and on how they incorporate this information into their own work. When citing another scientist's work, one aspect of the reference that a researcher must consider is whether to retain the hedges that are tied to the conclusions of past research.

What are hedges?

Clemen (1997, p. 235) observed that "hedging is achieved primarily by setting utterance in context rather than by straightforward statement." Words and statements that can be considered hedges form a continuum of uncertainty or caution regarding a conclusion or claim.

In their simplest form, hedges are single words, such as adverbs (generally, probably), verbs (imply, suggest), and modal verbs (may, should). Table 1 lists the more commonly occurring hedges in research articles. The following are examples of different hedges used in the classic article by Alvarez et al. (1980):

> WHEN SCIENTISTS CITE AND PARAPHRASE THE CONCLUSIONS OF PAST RESEARCH, THEY OFTEN CHANGE THE HEDGES THAT DESCRIBE THE UNCERTAINTY OF THE CONCLUSIONS, WHICH IN TURN CAN CHANGE THE UNCERTAINTY OF PAST RESULTS

- Hedges as adverbs: "The asteroid impact hypothesis predicts that the *apparently* diachronous timing of the foram-nannofossil and dinosaur extinctions will *eventually* be shown to be incorrect" (p. 1107).
- Hedge as a verb: "The probability of these effects occurring worldwide *seems* less likely than an extraterrestrial origin of Ir" (p. 1101).
- Hedge as a modal verb: "Furthermore, we will show...that [the] impact of a 10-km earth-crossing asteroid...*may* have produced the observed physical and biological effects" (p. 1102).

In linguistic terms, hedges, as well as citations, are modalities, which are any qualifications or conditions placed on a statement. A modality makes the intent of the statement that contains it conditional. Hedges, by definition, cause a state-

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ment to be less certain; a citation indicates that the statement has an element of human intervention in developing the fact, rather than being "an objective fact of nature" (Latour and Woolgar 1986, p. 80).

The latest edition of the CBE manual (1994) does not mention hedges, although the fifth edition (CBE 1983) states that "careful researchers in biology have some degree of doubt about their observations and conclusions. To convey their uncertainty, they hedge" (p. 43). Hedging is the accepted practice in the scientific community (Crismore and Farnsworth 1990, Hyland 1998); moreover, "hedges are a crucial means of presenting new claims for ratification and are a primary factor in developing the research article as a vehicle for new knowledge" (Hyland 1998, p. 6).

Although my concern is with hedges and not with other types of modalities, it is useful to study the effects of hedges within the overall context of modalities that Latour and Woolgar (1986) provide. They broadly classified scientific conclusions as statement types that range from very speculative conclusions (type 1) to well-accepted facts (type 5). As a scientific argument progresses over time and becomes accepted, it moves through the different statement types and is transformed from a contested topic into a taken-for-granted fact, and the degree of certainty it acquires increases accordingly.

Type 1 statements tend to be ungrounded, without backing, and typically occur at the end of a research article or in private discussion. Type 2 statements are tentative suggestions that require further research. Type 3 statements are qualified assertions that are being argued. Type 4 statements are not qualified, do not contain a modality, are accepted in the scientific field, and are commonly found in textbooks. Finally, type 5 statements are accepted knowledge, do not have any qualifiers, and are usually implicit between scientists and made explicit only for outsiders; it is unlikely that one would find a type 5 statement in a research article.

Table 1. Commonly found hedges in research articles (Hyland 1998).

Adjectives and adverbs[1]	Verbs: Judgmental[1]	Verbs: Evidential[2]	Verbs: Modal[3]
about	assume	appear	could
apparent(ly)	estimate	report	may
approximate(ly)	imply	seem	might
consistent (with)	indicate		should
essentially	predict		would
generally	propose		
most	suggest		
partially			
possibly			
presumably			
probably			
relatively			
slightly			
(un)likely			

1. Occurs more than 11 times per 75,000 words in research articles.
2. Occurs more than 1 time per 10,000 words in research articles.
3. Occurs more than 2 times per 75,000 words in research articles.

An example of a type 2 statement is the following conclusion by Alvarez et al. (1980):

> In brief, our hypothesis *suggests* that an asteroid struck the earth, formed an impact crater, and some of the dust-sized material ejected from the crater reached the stratospheres and was spread around the globe...and as a result most food chains collapsed and the extinctions resulted" (p. 1105).

The word *suggests* is a hedge; thus, despite all of the authors' data and personal conviction, there is still room for debate within the scientific community. Because of the pioneering and speculative nature of this causal explanation for the extinction of dinosaurs, this can be considered a type 2 statement. With the discovery of the Chicxulub crater in Mexico and other evidence, scientists were able to make type 3 statements because, while accepting the idea of a bolide impact, they still remain divided on the cause of the extinction of dinosaurs.

Another example of a type 2 statement could be the following: "In summary, we conclude that the anomalous iridium concentration at the C-T boundary is best interpreted as indicating an abnormal influx of extraterrestrial material" (Alvarez et al. 1980, p. 1102). By using the verb "conclude," these authors signal they are very positive about their conclusion, although they retreat some in the level of certainty by including "best interpreted" (which suggests that more research is needed) and the less assertive word "indicating." The statement thus leaves room for debate, even though the research supports its position.

That sentence would be considered a type 3 statement if it were paraphrased thus: The anomalous iridium concentration at the C-T boundary was caused by an abnormal influx of extraterrestrial material (Alvarez et al. 1980). There are no hedges in the sentence, and the only modality is the citation. Because of the attached Alvarez et al. reference, the reader does not accept the statement as an unconditional fact because the statement is attributed to Alvarez et al. By removing the reference, the sentence becomes a type 4 statement, a fact that would be generally accepted within the scientific community.

Because the degree of certainty of a conclusion cannot be accurately measured, Latour and Woolgar's statement types are generally not clear, discrete entities. Yet Toulmin et al. (1979) and Latour and Woolgar (1986) show that scientists can increase or decrease the level of uncertainty according to which modality they select. Verbs such as "appear" and "seem," for example, are much weaker than "demonstrate" and "show" in describing the certainty of a statement. For the sake of simplicity, in this paper, type 2 statements are those that contain a hedge, and type 3 statements are those that do not.

All this care in hedging can get lost or misrepresented when the hedged statement is cited by another researcher. Changing statement types becomes important when an author considers how to cite a hedged statement. Traditionally, scientists paraphrase rather than quote directly from the source texts, because they are more concerned with the idea or conclusion of another author than with the particular words the scientist actually used (Wilkinson 1991). However, by paraphrasing the original statement, scientists can sometimes change the degree of certainty of the statement by omitting the hedge. As Myers (1989) noted, "as soon as the claim [conclusion] is part of the literature, it becomes possible to refer to it without any hedging" (p. 13). This quote itself contains the hedge "possible," indicating that hedges can be either kept or dropped.

By eliminating the hedge, the researcher may knowingly or unknowingly alter the nature of the information (Hyland 1998). Therefore, authors need to carefully consider the ideas and the words of other scientists they are paraphrasing in order to accurately incorporate older information with their new research results.

Several investigators have examined how research information is transferred from one type of publication to another and how this transfer affects hedges. Fahnestock (1986) noted the loss of hedges as information moves from the research article to the popular press, although Crismore and Farnsworth (1990) stated that the amount of hedging remained the same when scientific research was converted for an expanded audience. A reason for this difference could be that the writers for the popular press to which Fahnestock referred were not scientists but rather journalists, whereas Crismore and Farnsworth's article indicated that the writers of the research article and the popular article were the same scientists. Apparently the scientist tends to remain cautious for any audience, but the science journalist presents information without hedges in order to satisfy an audience that wants a clearer—i.e., not hedged—result.

In a research article, the author attempts to build consensus for accepting the results. For science to progress there must be consensus on new information that is added to our knowledge base. The consensus does not necessarily mean that everyone agrees with a conclusion, but rather that a conclusion is either tentatively accepted or tentatively rejected by the scientific community. Including past research through citations is one method for building consensus. Keeping, dropping, or changing the hedge will affect the consensus building that the writer is trying to develop. Dropping a hedge marks the transition of a statement from more to less uncertainty; by retaining, changing, or dropping a hedge, the citing author is actually taking a position vis-à-vis past research. This position will influence how the scientific community views the claims and conclusions of the new article. Authors can better support their conclusions by choosing a particular hedge or omitting a hedge altogether when they use a cited statement.

What an author decides to do with a hedge can be based on the strength of the data that support the conclusion, additional information that has been published since the original statement appeared, or the function of the citation itself. Citations have a number of functions such as supporting the conclusion (Latour 1987, Cozzens 1989, Peters et al. 1995), showing an alternative to the conclusion (Moravcsik and Murugesan 1975), or, secondarily, recognizing the cited author (MacRoberts and MacRoberts 1996). Whether or not a citation is hedged could influence an audience. The following sentence from Alvarez et al. (1980, p. 1107) provides an example of how verbs in a citation can be influential: "Russell (71) has *noted* stratigraphic evidence against a diachrononous extinction in the continental and marine realm." In using "noted," a verb that does not strongly or weakly support the statement, Alvarez et al. paraphrased Russell. Alvarez et al. could have enhanced their argument with Russell's citation by using a stronger verb like "shown" or "demonstrated." The result of using a hedge that reflects more certainty is that if someone disagrees with Alvarez et al., then that person would have to argue more convincingly against Russell also (Latour 1987).

Given the importance of citations, it is unfortunate that references on how to write a research article, such as style guides (APA 1994, CBE 1994) or textbooks (Wilkinson 1991, Day 1998, Penrose and Katz 1998), usually describe only different format styles for a citation. References do not explain how the citation should be worded in order to relate the older research to the current work.

Because of the lack of guidelines for citing, the influence of hedging, and the nature of paraphrasing in biology, I designed a study to examine what happens to tentative scientific conclusions when these claims are paraphrased by other scientists—that is, are citing authors changing type 2 statements to type 3 statements?

Although hedges are found throughout the research article, they are considerably more common in the introduction and discussion than in the methods and results sections (Butler 1990, Hyland 1998). This article compares hedged statements in the discussion section of research articles to citations of these same statements in the introduction and discussion sections of other research articles.

Methods

Original statements came from research articles in the journal *Ecology*, which has an impact factor greater than 3.0. The high impact factor indicates that many journals cite articles from *Ecology* (ISI 1997), which contains articles that usually follow the IMRD (introduction, methods, research, discussion) format. The 1980 volume of *Ecology* was chosen so that 20 years' worth of citations for references could be examined. Starting with the first article in the 1980 volume, any research article with a distinct discussion section and with more than 100 citations was considered. (Four articles with fewer than 100 citations were initially examined but were found to have insufficient citations of an original statement to allow comparisons with one another.)

The *Science Citation Index* (ISI 1980–1990) was used to locate citing articles, a list of which—with eight or nine citations per page—was printed. To randomize the article selection, the pages were shuffled and all the citations on each page were considered, in order, to determine which citations would be used for the analysis in this study. I used the following parameters to determine which citations of the original statement would be considered in the analysis: no self-citations, no citations from foreign journals, none that were included merely as a reference, no citations from the methods or results sections, and none from journals not in the North Carolina State University library. I then compared the paraphrases with the original statements in order to match the citation with the original statement and to assess the accuracy of the paraphrasing. When 10 citations, 5 each from the introduction and discussion sections, were found for a hedged statement, then the search ended for citations for that original statement. Citations for five original statements, each from a different article, were used for the analysis in this study.

The abstract was also reviewed because I discovered during the course of collecting data that some authors use hedges in the discussion section but omit them in the abstract. In dropping the hedges, the authors altered the degree of certainty of their own conclusions, which contradicts the CBE (1994) recommendation that the abstract accurately represent the text. Therefore, if the hedging in the original statement was not included in the abstract, the article was not considered for this report because it was unclear whether the citation came from the statement that was hedged in the discussion or from the statement that was not hedged in the abstract.

The selection of the paraphrases was based on the idea of "cognitive resemblance" (Peters et al. 1995). Cognitive resemblance maintains that publications that share word similarities and have a citation–cited relationship also have content that is significantly more related than those publications without such similarities. The importance of this relationship is that the citation represents content; it is not included for peer recognition or merely as a reference. The citation's content used in this study was therefore closely related to information in the original statements.

An example of cognitive resemblance from this study is the following:

> *Original statement*: "The results we have presented suggest that *learning*, both in terms of habitat use and sampling, could be of great quantitative significance to *foraging* behavior" (Werner et al. 1981, p. 125).
>
> *Citation:* "These costs might include lost *foraging* time or lowered feeding efficiency as a predator *learns* to detect, capture, and handle new prey types" (Schindler 1997, p. 597).

In this example, the use of "learn" and "forage" in both the original statement and the citation qualified this citation for inclusion in this study. However, because scientists paraphrase, some latitude was necessary when comparing word similarities between the original statement and citation. For example, with the original statement above as a reference point, the following adaptation shows how cognitive resemblance was employed for this study:

> *Citation*: "Bluegill *learn* how to *feed* more efficiently within habitats...as they gain experience with habitat structure and habitat-specific prey types" (Ehlinger 1989, p. 643).

"Learn" is in both statements, but in the citation "feed" was equated to "forage" in the original statement to allow the two sentences to be compared. Two or three word similarities were identified for each original statement and its citation. Some differences in the wording between the original statement and the citation might have occurred because scientists took the original statement out of its context. For example, Werner et al. (1981) is primarily concerned with how bluegill feed, whereas Ehlinger (1989) is more interested in where they feed.

Every paraphrase and citation came from a different research article. The citations appeared in the following journals (the number in parentheses indicates the number of times a citation came from the journal, if more than once): *American Journal of Botany*; *American Naturalist*; *Animal Behaviour* (2); *Applied Soil Ecology*; *Aquaculture*; *Canadian Journal of Botany* (5); *Canadian Journal of Fisheries and Aquatic Sciences* (2); *Ecology* (6); *Ecoscience, Environmental and Experimental Botany; Freshwater Biology* (6); *Functional Ecology*, *Global Change Biology*; *Hydrobiologia* (3); *Journal of Ecology* (7), *Marine Biology*; *Oecologia* (9); *Oikos*.

How citations change statement types

Table 2 lists the five original hedged statements used for this article and two sample citations, one with hedging and one without hedging. Here is a typical example of how the original statement and its citation were compared:

> *Original statement*: "The herbivory simulation experiment *suggests* that those branches subjected to larval defoliation abort significantly more fruits than undamaged branches" (Stephenson 1980, p. 62).
>
> *Citation:* "By removing resource availability, through leaf removal, herbivores can increase the rate of fruit abortion" (Niesbaum 1996, p. 2324).

In the citation, Niesbaum changed "larval defoliation" to "removing resource availability, through leaf removal"; but more important, Niesbaum also dropped the hedge "suggests." Stephenson's statement is hedged, and thus has some uncertainty; Niesbaum's citation has no hedge, and thus is read as a fact. (In using Hyland's classification system of hedges, "can" is considered a hedge only in an interrogative or negative situation.)

Table 2. Original statements and examples of citations of the statements used in this study.

Original statement	Hedged citation	Not hedged citation
The results we have presented *suggest* that learning, both in terms of habitat use and sampling, *could* be of great quantitative significance to foraging behavior (Werner et al. 1981, p. 125).	These costs *might* include lost foraging time or lowered feeding efficiency as a predator learns to detect, capture, and handle new prey types (Schindler 1997, p. 597).	Bluegill learn how to feed more efficiently within habitats … as they gain experience with habitat structure and habitat-specific prey types (Ehlinger 1989, p. 643).
Thus the low zone may represent a "better" physiological habitat for these fucoids, which they are *usually* prevented from occupying due to competition from *Chondrus* (Lubchenco 1980, p. 341).	Lubchenco (1980) concluded that *Ficus* is physiologically competent below its normal range and that competition from *Chondrus* likely limits fucoid distribution (Chapman, Johnson 1990, p. 96).	This pattern of trade-offs between stress tolerance and competitive ability, and its implications for zonation, have long been recognized for assemblages of sessile marine organisms (Levine et al. 1998, p. 285).
The consistent growth response of all species except *Carex bigelowii* to N fertilization, with a strong N*P interaction, *indicates* that nitrogen and to a lesser extent phosphorus limited growth of the major vascular species at Eagle Creek (Shaver and Chapin 1980, p. 671).	...nutrient application (N and P) *almost* always increases plant growth *indicating* nutrient limited growth in the Arctic (Graglia et al. 1997, p. 191).	A vital factor limiting growth in the Arctic is nitrogen availability (Oechel et al. 1998, p. 87).
The herbivory simulation experiment *suggests* that those branches subjected to larval defoliation abort significantly more fruits than undamaged branches (Stephenson 1980, p. 62).	...plants *could* abort undamaged fruit as a response to limited resources as shown by Stephenson (Mendoza et al. 1987, p. 552)	By removing resource availability, through leaf removal, herbivores can increase the rate of fruit abortion (Niesbaum 1996, p. 2324).
Thus, it *appears* that N accumulation by microbes on leaves in the control section of Walker Branch was P-limited, while that in the enriched sections was N-limited (Elwood et al. 1981, p. 153).	Evidence from woodland streams also suggest that heterotrophic processes such as leaf litter breakdown can be restrained by nutrient limitations (Robinson and Gessner 2000, p. 258).	While nutrients are known to stimulate leaf litter breakdown (Hill et al. 1998, p. 499).

I determined whether a word was a hedge from lists given in Butler (1990) and Hyland (1998) and according to how it was used in a sentence. Adverbial and adjectival hedges all demonstrated less than absolute conviction in describing the original statement. Verbs were considered hedges if they did not "assert the author's commitment to the attendant proposition" (Swales 1990).

Verbs that were not hedges were those that asserted the most certainty. The following verbs, with their frequency of occurrence in parentheses, are from citations that were not considered hedged: can (1), concluded (1), determined (1), demonstrated (1), is (3), is (are) known (3), learn (1), shown (5), recognized (1), resulted (1).

The verbs "concluded," "determined," "demonstrated," "shown," and "resulted" were considered to assert the citing author's complete commitment to the certainty of the original statement. "Recognized" would be considered a hedge, except that in the citation "have long been recognized" it affirms the certainty of the statement.

The verbs "is," "are," and "known" form definitive statements that directly confirm the certainty of the statement. The citation with "learn" is a paraphrase of the original statement without the hedge.

Of the 50 citations that were compared to the five original statements, 32 citations, 15 from the introduction and 17 from the discussion, kept the hedge (Table 3). The elimination of the hedge suggests that these statements are moving from type 2 statements to type 3 statements and becoming accepted as facts.

Table 3. Number of hedged citations found in the introduction and discussion sections of articles citing the original hedged statement.

Source of original statement	Number of hedged citations, of five statements, in the introduction	Number of hedged citations, of five statements, in the discussion
Stephenson 1980	2/5	3/5
Lubchenco 1980	2/5	4/5
Shaver and Chapin 1980	3/5	3/5
Werner et al. 1981	4/5	5/5
Elwood et al. 1981	4/5	2/5
Total	15/25 = 60%	17/25 = 68%

How citations differ between sections and over time

In comparing citations in the introduction to those in the discussion, I found that hedges were kept 60% of the time in the introduction and 68% of the time in the discussion (Table 3). Biologists apparently drop and keep hedges at about the same rate in the introduction and discussion sections. Butler (1990) found that hedges are used 22% less frequently in the introduction than in the discussion, but he considered only modals. However, Hyland (1998), who looked for specific hedges, found that hedges are used 45% less often in the introduction than in the discussion. Since neither researcher looked at specific sentences containing hedges, the context of the words was not considered, nor did they consider unusual words that one would not typically regard as hedges (e.g., "emphasize"). A more comprehensive examination of hedges by Butler and Hyland might reveal more hedging in the introduction and discussion.

When I compared particular citations, I discovered that authors sometimes cited the same original statement differently in the introduction and discussion sections, as seen in the following citations; both are for the same original statement in Werner et al. (1981).

> *From a discussion:* "A fish *may* learn gradually to exploit new resources" (Jonsson 1989, p. 84).

> *From an introduction:* "Bluegill learn how to feed more efficiently within habitats...as they gain experience with habitat structure and habitat-specific prey types" (Ehlinger 1989, p. 643).

Because these paraphrases were both from 1989, the scientific knowledge, as represented by the *Science Citation Index*, was the same for these authors. Therefore, the difference in the paraphrasing suggests that the authors viewed the original statement differently. Apparently, Jonsson didn't consider the data that support the original statement strong enough to permit him to omit the hedge, whereas Ehlinger did, although Jonssons's type 2 statement occurred in the same year as Ehlinger's type 3 statement.

According to the distribution of the citations by year (Table 4), it does not appear that time was a factor in determining whether scientists kept the original statement hedged. Proportionally, the number of times the original statements remained hedged stayed the same throughout the 20 years covered by the citations ($G = 0.71$, $p > 0.9$ for the introduction; $G = 2.78$, $p > 0.3$ for the discussion). The relatively large number of citations in the introduction during the last 5 years might indicate that the information from original research articles takes longer to be included there than in the discussion, although the small sample size or the sampling method could also account for this trend.

In general, one would expect that as research accumulates about a topic and confirms the topic, the hedges would be dropped because the original statement would have more data to support it. My data show that knowledge is accumulating: Of the 50 citations, only one was for the purpose of rebuttal. This pattern would follow Latour and Woolgar's (1986) progression of statement types, from speculative to certain, with a corresponding decrease in the number of modalities associated with the statement.

This pattern is not invariable, however, as my data show. Citations of the same statement, but from different years, can also show the reverse pattern. Both of the following citations are for the original statement in Stephenson (1980):

> Several reasons for flower and fruit abortion have been determined for other species. These include pollination or fertilization, self-pollination, sexual selection, drought or frost, seed predation, lack of sufficient resources, and defoliation. (St. Pierre 1989, p. 726)

> There is considerable evidence to *suggest* that resources are a major factor in the abortion of fruits. (McCarthy and Quinn 1992, p. 35)

The first citation is a type 3 statement, the latter a type 2 statement, which is a backward movement in the Latour and

Table 4. Distribution of citations according to the year that the citation was published and whether or not the citation was hedged.

	Number of citations			
	Introduction		Discussion	
Year of citation	With hedge	Without hedge	With hedge	Without hedge
1981–1985	3	1	4	1
1986–1990	3	3	4	1
1991–1995	1	1	4	3
1996–2000	8	5	5	3

Woolgar statement scheme. More information could have been added to the scientific knowledge base after 1989 that questions the certainty of the original statement, causing the hedge of the original statement to be reintroduced in the later citation.

Why hedges in citations may be kept or dropped

In their investigation of the process of writing a research article, Latour and Woolgar (1986) stated that the "objective [is] to persuade colleagues that they should drop all modalities used in relation to a particular assertion and that they should accept and borrow this assertion as an established matter of fact, preferably by citing the paper in which it appeared" (p. 81). My research suggests that biologists keep the original statement hedged 60%–68% of the time. These numbers suggest that scientists are conservative in keeping cited statements hedged in the research article, much like the scientists who write for the general audience, as noted by Crismore and Farnsworth (1990).

By selecting different wording and retaining a hedge, the paraphrasing author might nevertheless decrease the uncertainty of the original statement and move the tentative conclusions of earlier work to a higher level of certainty. However, my research did not evaluate the various hedges used by the authors, so this movement is not reflected in my data.

General observations can be drawn from this paper. When biologists keep the original statement hedged or even increase the uncertainty of the original statement by using a less assertive verb, the following could come to pass:

- By maintaining or increasing the uncertainty of the original statement, the citing author could decrease the importance of the original statement if it contradicts the citing author's work.

- By keeping the original statement hedged, the citing author could render an opinion on the certainty of the conclusions of the other author.

On the other hand, if biologists use more verbs to assert the certainty of the original statement and employ fewer hedging verbs and adverbs, the impact of these changes could be as follows:

- By increasing the certainty of the supporting statements, writers would build a stronger case for their conclusions, because anyone attempting to refute the findings would have to also refute the authors of the supporting statement.

- By increasing the certainty of the original statement, the citing author is also rendering a professional opinion regarding the certainty of the conclusions of the other author.

- By removing hedges from the original statement, the citing author changes these statements from type 2 statements to type 3 statements and allows "individual knowledge [to be] gradually converted into generally accepted knowledge" (NAS 1995, p. 3).

As more information is published, scientists can make the conclusions of past research more certain. Adding and deleting hedges are not just stylistic choices. Rather, these choices change the meaning and significance of a conclusion, whether scientists intend to do so or not. Thus it seems important for scientists and authors to be aware of these effects when paraphrasing another scientist's research.

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References cited

Alvarez LW, Alvarez W, Asaro F, Michel HV. 1980. Extraterrestrial cause for the Cretaceous-Tertiary extinction. Science 208: 1095–1108.

[APA] American Psychological Association. Publication Manual of the American Psychological Association. 4th ed. Washington (DC): APA.

Butler CS. 1990. Qualifications in science: Modal meanings in scientific texts. Pages 137–170 in Nash W, ed. The Writing Scholar. Newbury Park (CA): Sage Publications.

[CBE] Council of Biology Editors Style Manual Committe. 1983. A Guide for Authors, Editors, and Publishers in the Biological Sciences. 5th ed. Bethesda (MD): CBE.

———. 1994. Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers. 6th ed. Chicago: CBE.

Chapman ARO, Johnson CR. 1990. Disturbance and organization of macroalgal assemblages in the northwest Atlantic. Hydrobiologia 192: 77–121.

Clemen G. 1997. The concept of hedging: Origins, approaches and definitions. Pages 235–248 in Markkanen R, Schroder H, ed. Hedging and Discourse: Approaches to the Analysis of a Pragmatic Phenomenon in Academic Texts. New York: Walter de Gruyter.

Cozzens SE. 1989. What do citations count? The rhetorical first model. Scientometrics 15: 437–447.

Crismore A, Farnsworth R. 1990. Metadiscourse in popular and professional science discourse. Pages 118–136 in Nash W, ed. The Writing Scholar. Newbury Park (CA): Sage Publications.

Day RA. 1998. How to Write and Publish a Scientific Paper. 5th ed. Phoenix (AZ): Oryx Press.

Ehlinger TJ. 1989. Learning and individual variation in bluegill foraging—habitat-specific techniques. Animal Behavior 38: 643–658.

Elwood JW, Newbold D, Trimble AF, Stark RW. 1981. The limiting role of phosphorus in a woodland stream ecosystem: Effects of P enrichment on leaf decomposition and primary producers. Ecology 62: 146–158.

Fahnestock J. 1986. Accommodating science: The rhetorical life of scientific facts. Written Communication 3: 275–296.

Graglia E, Jonasson S, Michelsen A. Schmidt, IK. 1997. Effects of shading, nutrient application and warming on leaf growth and shoot densities of dwarf shrubs in two Arctic-alpine communities. Ecoscience 4: 191–198.

Hill BH, Herlihy T, Kaufman PR, Sinsabaugh RL. 1998. Sediment microbial respiration in synoptic survey of mid-Atlantic region streams. Freshwater Biology 39: 493–501.

Hyland K. 1998. Hedging in Scientific Research Articles. Philadelphia: John Benjamin Publishing.

[ISI] Institute for Scientific Information. 1980–1990. Science Citation Index. Philadelphia: ISI. (8 November 2001; *www.webofscience.com*)

———. 1997. Journal Citation Reports on CD-ROM (Science edition). Philadelphia: ISI.

Jonsson B. 1989. Life-history and habitat use of Norwegian brown trout (*Salmo-trutta*). Freshwater Biology 21: 711–86.

Latour B. 1987. Science in Action: How to Follow Scientists and Engineers through Society. Cambridge (MA): Harvard University Press.

Latour B, Woolgar S. 1986. Laboratory Life: The Construction of Scientific Facts. Princeton (NJ): Princeton University Press.

Levine JM, Brewer JS, Bertness MD. 1998. Nutrients, competition and plant zonation in a New England salt marsh. Journal of Ecology 86: 285–292.

Lubchenco J. 1980. Algal zonation in the New England rocky intertidal community: An experimental analysis. Ecology 61: 333–344.

MacRoberts MH, MacRoberts BR. 1996. Problems of citation analysis. Scientometrics 36: 435–444.

McCarthy BC, Quinn JA. 1992. Fruit maturation patterns of *Carya* spp. (Juglandaceae)—an intra-crown analysis of growth an reproduction. Oecologia 91: 30–38.

Mendoza A, Pinero D, Sarukhan J. 1987. Effects of experimental defoliation on growth, reproduction and survival of *Astrocaryum mexicanum*. Journal of Ecology 75: 545–554.

Moravcsik M, Murugesan P. 1975. Some results on the function and quality of citations. Social Studies of Science 5: 86–92.

Myers G. 1989. Pragmatics of politeness in scientific articles. Applied Linguistics 10: 1–35.

[NAS] National Academy of Science. 1995. On Being a Scientist: Responsible Conduct in Research. Washington (DC): NAS.

Niesenbaum RA. 1996. Linking herbivory and pollination: Defoliation and selective fruit abortion in *Lindera benzoin*. Ecology 77: 2324–2331.

Oechel WC, Vourlitis GL, Hastings SJ, Ault RP, Bryant P. 1998. The effects of water table manipulation and elevated temperature on the net CO_2 flux of wet sedge tundra ecosystems. Global Change Biology 4: 77–90.

Penrose AM, Katz SB. 1998. Writing in the Sciences. New York: St. Martin's Press.

Peters HPF, Braam RR, van Raan AFJ. 1995. Cognitive resemblance and citation relations in chemical engineering publications. Journal of the American Society for Information Science 46: 9–21.

Robinson CT, Gessner MO. 2000. Nutrient addition accelerates leaf breakdown in an alpine springbrook. Oecologia 122: 258–263.

Schindler DE, Hodgson JR, Kitchell JF. 1997. Density-dependent changes in individual foraging specialization of largemouth bass. Oecologia 110: 592–600.

Shaver GR, Chapin FS III. 1980. Response to fertilization by various plant growth forms in an Alaskan tundra: Nutrient accumulation and growth. Ecology 61: 662–675.

St. Pierre RG. 1989. Magnitude, timing, and causes of immature fruit loss in *Amelanchier alnifolia* (Rosaceae). Canadian Journal of Botany 67: 726–731.

Stephenson AG. 1980. Fruit set, herbivory, fruit reduction, and the fruiting strategy of *Catalpa speciosa* (Bignoniaceae). Ecology 61: 57–64.

Swales JM. 1990. Genre Analysis: English in Academic and Research Settings. New York: Cambridge University Press.

Toulmin S, Rieke R, Janik A. 1979. An Introduction to Reasoning. New York: Macmillan.

Werner EE, Mittelbach GG, Hall DJ. 1981. The role of foraging profitability and experience in habitat use by the bluegill sunfish. Ecology 62: 116–125.

Wilkinson AM. 1991. The Scientist's Handbook for Writing Papers and Dissertations. Englewood Cliffs (NJ): Prentice Hall.