CHANGES IN THE USE OF THE PASSIVE VOICE

OVER TIME: A HISTORICAL LOOK AT THE

AMERICAN JOURNAL OF BOTANY AND THE

CHANGES IN THE USE OF THE PASSIVE VOICE

FROM 1914-2008

By

LAURA MARIE DUMIN

Bachelor of Science in Interdisciplinary Studies
Virginia Tech
Blacksburg, VA
1999

Master of Arts in English
Radford University
Radford, VA
2001

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Dissertation Approved:

Dr. Richard Batteiger

Dissertation Adviser

Dr. Ronald Brooks

Dr. Rebecca Damron

Dr. Michael Palmer

Dr. Mark Payton

Dean of the Graduate College

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CHAPTER I

INTRODUCTION

At some point during the mid-20th century, scientific writing came under fire from English teachers and others who were outside of the community for the writing style (or, as some might argue, the lack thereof) and choice of verb voice used by many of its authors. Two main camps have formed in this debate – those who think that passive voice serves a purposeful function in scientific writing, and those who think that passive voice should be banished forever. There is also a third, smaller group of academics who are interested in determining if the passive voice has been a part of scientific writing since the start of the Royal Society, or if it is a new addition, begun only within the last hundred years or so[1]. Wilkinson (1991) notes that although the passive voice is a common feature in scientific writing, scientists often face criticism for using it (p. 70). It would seem, then, that while the passive voice is a well-known feature of many scientific disciplines, it may still be an unwelcome linguistic feature for many readers.

In order to teach new scientists about writing within their disciplines, we, as writing teachers, need to be aware of the advice about writing that already exists within those disciplines, and we also need to understand why that advice might work for one community better than it might work for another. We cannot just assume that science

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[1] For an in-depth discussion of the historical changes of science writing, see D. Ding (1998), Rationality reborn: Historical roots of the passive voice in scientific writing (in J. Battalio (Ed.), *The study of scientific discourse: Methods, practice, and pedagogy*. Stamford, CT: Ablex). Ding covers parts of pre-1900 writing that there was not a place for me to cover in this project.

writers are bad writers who are unaware of how using language affects the message. It is

only once we begin to approach science writing as a distinct type of communication

(including sub-fields for each discipline), with reasons and rules for writing, that we can

begin to understand how best to teach our students to write for their intended disciplines.

At that point, we can help young scientists learn to write well for their audiences, instead

of learning to write well in a general sense that may ignore the reasons behind why

scientists present their information in the ways that they do.

Within the last century, both main sides of the passive voice debate have made

strong arguments for their cases. On the side of the debate that wishes to banish passive

voice[2], many studies bemoan its use as a cumbersome grammatical style, claiming that

the use of the passive voice causes readers to have to think harder about the topic at hand

or that the passive voice obscures the real agent of the sentence. On the other side of the

debate, studies show that the use of the passive voice does not actually obscure or

convolute anything; *choosing* to use the passive voice is just that, a stylistic[3] and

rhetorical choice[4] (used to control how the reader approaches the writing), often made for

the purpose of reporting cold, hard facts and observations. The "who" behind the

experiment matters much less than the "why" or the "how."

Scientists may prefer to write in the passive voice because it has the advantage of

highlighting the experiment at the beginning of the sentence (Merrill, 1954, p. 269) and

moving the agent of the experiment either to the end of the sentence or out the door

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2 See Chapter 2 for more discussion of what the sources say about the passive voice.
3 See Strunk & White's (2009) *The elements of style* (50th anniversary ed.) (New York: Pearson Longman), for an in-depth discussion of how style decisions can affect how a reader approaches a text.
4 For further discussion of rhetorical choice, see Angela Petit's (2003) The stylish semicolon: Teaching punctuation as rhetorical choice (*The English Journal, 92*(3), 66-72).

completely. Writers can control how readers understand a sentence by using either a full

passive construction or a truncated passive construction (Rodman, 1994, p. 312). In the

full passive construction, the agent is mentioned toward the end of the clause through the

use of a *by*-phrase. In Example 1, "John" is the agent who performs the action of

painting the car.

      Example 1: The car <u>was painted</u> **by John**.

Interestingly, full passive sentences give us the same information that would be found in

active sentences, but the focus of the sentence switches from the agent to the action,

suggesting that the action is more important than the agent is.

      In the truncated passive construction, the agent is not mentioned and the focus

remains on the "thing" being acted upon, as shown in Example 2.

      Example 2: The car <u>was painted</u>.

In this case, the agent has been removed from the sentence, leaving the reader to infer

from the surrounding sentences who it was that painted the car. Removing the agent

from the sentence effectively depersonalizes the situation because the "who" is no longer

included in the sentence.

      Harwood (2005) supports the idea of using the truncated passive voice when he

suggests that if the agent (the author) can avoid the use of personal pronouns when

explaining his/her experiment and findings to the audience by using the passive voice, the

audience may not react as strongly (either positively or negatively) to the claims that the writer is making[5].

There are further (and possibly more feasible) grammatical benefits to using the passive voice when discussing something that has occurred. The potentially most important benefit is that the experiment gets linguistically foregrounded (Connatser, 2004; Dignan, 2005; Dixon, 1991; Harmon, 1992; Houp, Pearsall, and Tebeaux, 1995; Larkins, 2001; Matthews, Bowen, & Matthews, 1996). As previously stated, the passive voice demotes the agent from its position as the main topic of the sentence. This could occur because the agent is unknown (Givón, 1993) as in Example 3 where who killed John is unknown and may not be important to the information being given.

Example 3: "John <u>was killed</u> overseas."

Another grammatical benefit to using the passive voice is that the agent may already be obvious based on the previously given information (Givón, 1993). As Example 4 shows, we know from the first sentence that it was Barbara who broke the window; therefore, it is not important to repeat the agent information in the second sentence.

Example 4: "Barbara accidentally threw the ball through the window. It <u>was broken</u> beyond repair."

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[5] For an in-depth look at how and when writers use the personal pronouns "I" and "We," see Nigel Harwood's (2005) article 'We do not seem to have a theory . . .The theory I present here attempts to fill this gap': Inclusive and exclusive pronouns in academic writing (*Applied Linguistics, 26*(3), 343-375). His study examined a corpus of 40 journal articles to determine when authors were using personal pronouns, and whether those pronouns were intended to be inclusive or exclusive.

The passive voice also can be used when the agent is predictable or stereotypical based on the information given in the sentence (Givón, 1993). In Example 5, we do not need to read "by the surgeon" at the end of the sentence because it is predictable that a surgeon would be an obvious choice as an agent in this situation.

Example 5: "The operation to repair his heart <u>was completed</u> successfully."

Another grammatical function of the passive voice can be to protect the author from having to take the blame for something. Example 6 is a form that we see often after a company has been in some sort of legal trouble. While the agent might be of interest to the reader, by not listing the agent a company is better able to protect individuals from lawsuits. Also, the use of the passive voice in Example 6 deflects the focus from "who" made the mistakes and allows the writer to instead put the focus on how the mistakes will be fixed.

Example 6: "Mistakes <u>were made</u>."

As the above examples show, there are a number of times when using the passive voice to describe something makes sense. Not all instances of the passive voice are meant to obscure information. In fact, as Examples 4 and 5 show the passive voice keeps the author from adding unnecessary information and bulk to the sentences.

Aside from the grammatical benefits to using the passive voice, there are also some practical benefits as well. Kuhn (1996) notes that scientists share a set of "rules and standards for scientific practice" (p. 11), which allow for relative agreement among them about how things will be done in the field. Hyland (2004) points out if writers want

to be published they will use the grammar and style that are considered to be "normal" in their fields. Writers who ignore the dominant language choices risk not being published, losing credibility, missing out on job promotions, having trouble gaining positions of power within their fields, etc. Being a good writer means paying attention to community norms and knowing when to follow those norms, or knowing when it is acceptable to go against them for a purpose. Along with writing in the dominant style of the field, Gross (1996) thinks that selection theory helps to explain why the use of passive voice might become more frequent over time. Gross writes that "such change is a consequence of the social pressures that shape scientific prose in conformity to a worldview that has material objects rather than people at its center of interest" (p. xxix). As science is predominantly concerned with determining how the world works and not with how people manipulate that world, it makes sense that scientists might prefer the passive voice to foreground their experiments and results.

How the advice about the passive impacted my research question

It is because of the differences of opinion about when to use the passive voice that I became interested a few years back in the debate surrounding the use of passive voice in science writing as a general field. I noticed that most people (English teachers and other academics) I talked with either loved or hated the passive voice—there were few people who were interested in just studying it—and they wondered if the it had been a consistent feature of modern scientific writing (1700s – present time). According to Ding (1998), the use of personal pronouns and references to the scientist himself doing the work

became less usual from the 18th to the 19th centuries (p. 123). Instead, the passive voice, along with the use of "impersonal active subjects" became a main feature of science writing slightly before 1900 (p. 123).

Ding (1998) thinks that the rise of the passive voice "grew out of the concept of 'rationality and reason'" (p. 123). Ding goes on to discuss why rationality and reason came to be important, noting that in the 17th century Francis Bacon became concerned that when scientists used only deductive reasoning to understand their world, they were not fully understanding how things worked (p. 124); "failure to adapt method to subject reduced learning to 'empty and barren generalities'" (p. 124). John Locke was influenced by Bacon and thought that it was more important to use reason when seeking the truth than to use sensation (Ding, 1998, p. 124) The idea of rationality encompasses "seeking knowledge through observation" (Ding, 1998, p. 125) and the willingness of scientists to cooperate to form a public body of knowledge (Ding, 1998, p. 125). As science moved away from being concerned with understanding how things fit into God's plan and toward understanding how the world worked outside of God's overarching influence, rationality and reason became tools for evaluating the world in a more critical way. Atkinson (1996) agrees that rationality and reason are important ideas behind the language change in scientific writing; he thinks that the passive voice became more prevalent as the author-centered science writing of the late 1600s (as seen in the *Philosophical Transactions of the Royal Society*) changed in the 1800s and early 1900s to become more concerned with *experiments* and less concerned with *who* performed them.

Most of the scientists I spoke with in passing could not imagine writing their experiments completely (or even mostly) in the active voice, even though they were often

quick to agree that it was not always easy to read articles written in passive voice[6].

Bostian and Thering's (1987) survey notes that for the most part, scientists actually prefer to read documents written in the active voice. Anecdotal discussions over the past ten years with other English teachers suggest that they like to vilify the passive voice as a poor grammatical (not stylistic) choice, alluding to the convoluted, dense prose that would often arise because of the passive voice. If these English teachers considered the passive voice to be a choice at all, they certainly only considered the possibility that the choice was a poor one – one to be drilled out of students with the same fervor as should be used in teaching students how to use traditional forms of American English grammar, regardless of the dialect they might speak at home. I found all of this anecdotal information interesting; the lack of consensus by style guides[7] and the love/hate relationship that I noticed from scientists and English teachers alike led me to wonder what was really happening with the passive voice. Was it becoming more prevalent as so many writers argued[8]? Had it been a feature of science writing for the last 300 years that people had overlooked until recently? Was the passive voice truly a bad stylistic and rhetorical choice, or could it serve useful functions in science writing? How exactly was the passive voice being used in science writing anyway? These questions formed the basis for my study.

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[6] While my information is merely anecdotal, others have begun to test for how the use of the passive voice affects the readers. See Eva Bardell's 1978 article Does style influence credibility and esteem? (*The Communicator of Scientific and Technical Information, 35*, 4-7) for a pilot study on the effect of passive voice, dense prose, and scientific language on the readability of science articles and on readers' perceptions of the author based on the style of writing that was used.

[7] I go into detail about the confusing advice to authors in Chapter 2.

[8] See D. Ding (1998, p. 119), Rationality reborn: Historical roots of the passive voice in scientific writing (in J. Battalio (Ed.), *The study of scientific discourse: Methods, practice, and pedagogy*. Stamford, CT: Ablex), for a concise discussion of a number of studies showing that passive voice is quite prevalent in scientific discourse.

What I learned through performing both my background and my primary research helped me to understand the passive voice in a new light. I came to view the passive voice not as a poor grammatical choice, but instead as a stylistic choice made by scientists whose main purpose was to perform and report about experiments. Some authors, like Ding, think that using the passive voice allows for greater objectivity on the part of the scientist. Ding (1998, 2002) thinks that the scientists are not as important as the information that they are reporting and that they understand that their experiments need to be repeatable and falsifiable. Even though using the passive voice does not guarantee that someone else will be able to come along and repeat the experiment, it does allow scientists to "show their beliefs in [the] falsifiability of science" (Ding 2002, p. 148). The use of the passive voice also removes the scientist who originally performed the experiment from the position of "privileged observer" (Ding 2002, p. 147) and instead allows other scientists to come in and observe further iterations of the experiment for themselves. And, the use of the passive voice allows writers to use a common language structure (i.e., the passive voice), which may facilitate the sharing of information (Ding, 2002, p. 140)[9], because readers will already have an understanding of the linguistic features used in the passive voice and will not have to learn a new way of understanding the information.

This all seems to put a lot of pressure on the passive voice to create objectivity out of thin air. When a scientist reports on an experiment, he chooses certain words to foreground or downplay the results based on what he hoped to find and what he actually

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[9] Ding is not the only person to question if the language used to report the results of an experiment affects the perceived validity and objectivity of that experiment. See also Maria Tarantino's (1991) English for science and technology: A quest for legitimacy (*English for Specific Purposes, 10*(1): 47-60).

found. Dixon (1991) agrees that scientists most likely use the passive voice as a way maintain "an illusion of total objectivity" (pp 299-300), even though what the scientist thinks and is capable of doing play a major role in what he chooses to study and how he chooses to study it (pp 299-300). Given that we can never fully explain what happened or how and why something happened, can scientists truly be objective when they write about their experiments regardless of the voice they chose to employ? It appears, then, that the perceived objectivity of the passive voice may in fact be one of those ideas that often goes unchallenged because it has become part of what North describes as *lore* – information that is passed on from teacher to teacher without any data to prove that the concept is real or works like the teachers think it does (North, 1987, p. 27). North (1987) thinks that this "House of Lore" is a house where new rooms are added while some rooms are closed off or built a second time in a different place because people forgot that the first room existed (p. 27). As ideas (such as that the passive voice is bad) are rarely ever discarded from the House of Lore, it just continues to grow.

Harmon (1992) takes a slightly different view than Ding does on the impersonal nature of science and the passive voice, believing that it is erroneous to think that scientists use the passive voice in order to appear to be "totally disinterested observers in pursuit of the truth" (p. 29). Instead, Harmon (1992) thinks that knowledgeable readers will not be taken in by the impersonal nature of the passive voice, and if the information being reported is faulty, the reader will still be able to determine who is behind the report because the authors' names are on the paper. Therefore, the perceived objectivity of the writing become just that, perceived. Each scientist, regardless of his word choice, needs

to have the science and the results to support his theories. Otherwise, no amount of passive voice makes a bad theory seem more valid.

Let's return for a moment to the idea of the passive voice helping scientists to focus on the *events* that are occurring (the experiments) and not the *agents* who make the experiment happen (the scientists). Dear (1985) points out that the passive voice was used in the Royal Society to give a "recipe-like" set of instructions for repeating a procedure, but that the active voice was used when describing the unique event that occurred – "the procedure could always be repeated; the event could never be" (p. 153). From this, we learn that the passive voice has been around since the early days of the Royal Society and had a historical purpose for its inclusion in early papers.

Here we come to the idea of using the passive voice as a way to make scientific reporting accessible to other scientists. There is no need for a specific "I" (or agent) in order for an experiment to be repeated or for an experiment to have been completed in the first place. In fact, Ding (1998) thinks that using "I" is not appropriate for scientific writing "because it implies the topic is about 'I', the writer, not about the various objects in the research" (p. 120). From what I have read, this may or may not be a valid point, but seems to be one that continues to survive. The agent becomes the easiest item to remove from the sentence, leaving behind only the important experimental information and results. Atkinson (1996) notes that while the passive voice had begun to take over in the *Philosophical Transactions* by 1875, active-voice/author-centered writing still had a purpose and a place, namely for descriptions, introductions to articles, and places in the text where the author was uncertain about "his/her unique position" (p. 340).

Definitions

In order to clarify and further narrow my topic, I wish to begin with a few definitions to help avoid confusion. I have narrowly defined both an *article* and the *passive voice* so that readers would understand why and how I examined my corpus.

Definition of an *article*

For this study, I defined a journal *article* in the following manner. An article must have a specific author(s) (i.e. – not be anonymous), describe original research using technical language appropriate for an expert lay audience (an audience who already has some understanding of the field, but may still be new to it), have a clear scientific purpose, be peer reviewed, be edited, and incorporate outside references to show how it is grounded in other research being done in the field. Day & Gastel (2006) support this definition noting that scientific papers must be peer-reviewed and published in peer-reviewed journals in order to be valid scientific publications. The articles that I analyzed for this study are shown in Table 1 in the *Methods* chapter.

Definition of *passive voice*

I defined *passive voice* in the following manner, based on how others have defined passive voice: 1) the verb needed to contain a form of *to be* (*be + verb + -ed*) (Castle 2001, p. 28; Jaderstrom & Miller, 2003, p. 29) and 2) the verb had to be used in a sentence so that the object became the subject, i.e. "The ball *was kicked* by John," where the thing being acted upon, "the ball," became the main focus of the sentence and the agent, "John," became less important.

Dixon (1991) points out that not all verbs can be used as a passive, such as certain transitive verbs, because "for many verbs, [the] ability to passivise depends on the nature of the object" (p. 298). For example, you can say *I approached the train*, but you would not say, "*I was approached by the train*, because all I am talking about is the geometry of two positions" (Dixon, 1991, p. 298). Also, there are three key times where English will not allow a verb to become passive: 1) when a verb refers to an activity that relates equally to two entities and either one could be the subject (symmetrical); 2) when the verb in question "contain, cost, weigh," etc. indicates a non-changing relationship between two items (static); or 3) when the focus is meant to be on the subject and occurs with verbs such as annoy, posses, know, believe, and join (Dixon, 1991, p. 307). Verbs that are more likely to be used in the passive are verbs "whose object is likely to be human, or else something with specific reference that is being particularly focused on" (Dixon, 1991, p. 305).

For my research, I focused on the *be* verbs *am*, *is*, *was*, *were*, *are*, and *been*. These verbs can all be used to obscure the agent with the help of a past participle, or can make the agent the least important part of the sentence such as in Examples 7 and 8 where "John" and "he" are less important than the actions that they were performing.

Example 7: The ball <u>was kicked</u> by John.

Example 8: It <u>is said</u> that he left.

As a way of continuing to narrow my focus, I did not mark the extremely rare *get* (Bibber, Johansson, Leech, Conrad, & Finegan, 1999) or *have* passives. Biber et al. (1999) note that "*get* occurs only in conversation, except for an occasional example in

colloquial fiction. Even in conversation, the *get* passive accounts for only about 0.1% of

all verbs, and so is even less common than *be* passives" (Biber et al., 1999; see also

Dixon, 1991). I also did not mark "whiz-deletions," where "subordinate clauses are often

introduced by such words as 'which is,' 'who was,' 'that are,' etc." (Lutz, 2005). By

focusing only on the *be* passives and the past participles that occurred with those *be*

verbs, I hoped to be able to come to some specific conclusions about how the passive

voice was being used and if that use had changed, while leaving room for future study

into other aspects of the passive voice within a specific discipline. Throughout this study,

the past participles that occur with the passive *be* verbs will be referred to as *verbs*.

The purpose of my study

After determining that there are no hard and fast rules for when to use the active

or passive voice, and finding that so many of the style guides contradict not just each

other, but also themselves, I was left wondering in which direction I should proceed. As

I thought that examining the entirety of science writing would be too large of a subject to

tackle at this point, I decided to focus specifically on the *American Journal of Botany*. I

narrowed my focus to one discipline to further the work begun by Tarone, Dwyer,

Gillette, and Icke (1981). They were concerned with journal articles in astrophysics, and

stated that more work needed to be done in other fields to determine if their conclusions

would hold for all disciplines (p. 125). Baron (1989) is also concerned with the lack of

"accurate information on syntactic frequency" which makes it difficult to determine

"whether the passive is spreading or declining in specialized types of writing, or in

writing in general" (p. 22). My dissertation hopes to further the findings of Tarone et al. about the rhetorical functions passive voice by focusing on a single scientific discipline.

To further the work that has been previously done, I decided to take a historical approach[10] to a single, longstanding journal (the *American Journal of Botany*) to see if, and how, the use of the passive voice has changed over time. In order to keep my corpus manageable and to avoid picking articles at random, I examined the first article of each of the first 5 years of the journal (1914-1918), the middle 5 years (1962-1966), and the most recent 5 years of the journal (2004-2008). For my research, I have chosen to accept that scientists do, in fact, use the passive voice when writing articles[11]; I have also chosen to argue neither for nor against the use of passive voice. Instead, I wanted only to observe if/how the use of the passive voice has changed over the past 100 years. While I would have loved to have examined the entire body of the *American Journal of Botany*, this study is, instead, a pilot study to determine if further time should be invested in studying the historic trends of passive voice use within a single journal or discipline.

I was interested determining if the following things had changed during the lifespan of the *American Journal of Botany*:

- were authors using the passive voice more or less often in the newer articles as compared to the older articles,

- was the location of the passive voice different between the older and newer articles (i.e. *Introduction*, *Methods*, etc), and

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[10] For an in-depth discussion of the historical changes of science writing, see D. Ding (1998), Rationality reborn: Historical roots of the passive voice in scientific writing (in J. Battalio (Ed.), *The study of scientific discourse: Methods, practice, and pedagogy.* Stamford, CT: Ablex). He covers parts of pre-1900 writing that there was not a place for me to cover in this project.

[11] See D. Ding (1998, p. 119), Rationality reborn: Historical roots of the passive voice in scientific writing (in J. Battalio (Ed.), *The study of scientific discourse: Methods, practice, and pedagogy.* Stamford, CT: Ablex), for a concise discussion of a number of studies showing that passive voice is quite prevalent in scientific discourse.

- were the instances where the authors were using the passive voice different between the older and newer articles (Spaces, Full or Truncated, Agents, etc.).

 If any of these had changed, I hoped to be able to make suggestions as to the reasons for those changes.

The other part of my research idea came from Alan Gross (1996) and his previously mentioned ideas about how selection theory is at work in the change from scientific articles being written in active voice to being written in passive voice. Gross thinks that social pressures have changed the scientific article to allow the reader easier access to the information contained in the articles and that selection pressures suggest that the use of the passive voice will become more frequent over time. While at first, these two pressures (social and selection) might seem to be at odds, I think that they are able to work together to increase the scientific community's access to the information by providing a common way of discussing experiments. Selection pressures can be seen when a scientist makes the rhetorical choice (whether consciously or because of an ingrained understanding of how the rest of the community writes) to use the passive voice instead of the active voice. Instead of saying "I combined *beaker A* and *beaker B* to get *liquid C*," writers changed to saying something like "*Liquid C* was obtained from the combination of *beaker's A* and *B*." The theory that selection pressure is involved in scientists changing their language use over time makes sense to me, because if a scientist wants to be published in his field, he will quickly learn to use the standard forms of writing and presenting that others in the field are also using. For me, this seemed like an area where further study would definitely be useful.

CHAPTER II

REVIEW OF LITERATURE

Does the use of passive voice in science writing (specifically in botany) serve a specific purpose beyond being one of a handful of stylistic and/or rhetorical choices that authors have available to them? The main answer that kept coming up in my research suggests that writers use the passive voice instead of the active voice to report their scientific experiments and results because passive voice and its "impersonal active subjects[12] . . . emphasize *what* was done instead of *who* did something" (Ding, 1998, p. 117; see also Gilpin & Patchet-Golubev, 2000). In this way, the scientist fades into the background as an unimportant piece of the puzzle, and the experiment or results becomes the star of the show. Gross (1996) argues that the passive voice has a very real purpose in scientific writing because

> at its deepest semantic levels, scientific prose requires an agent passive before the
>
> only real agent, nature itself . . . . [T]hrough style its prose creates our sense that
>
> science is describing a reality independent of its linguistic formulations (p. 17).

With or without the use of the passive, though, it would seem that reality <u>does</u> exist outside of its "linguistic formulations." While language choices can change how a reader

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[12] Ding (1998), in Rationality reborn: Historical roots of the passive voice in scientific writing (in J. Battalio (Ed.), *The study of scientific discourse: Methods, practice, and pedagogy*. Stamford, CT: Ablex) references a number of studies showing "that the majority of active subjects in scientific discourse refer to non-human subjects" (p. 120). These non-human subjects work in conjunction with the passive voice to focus the writing on things instead of people, thereby reinforcing the use of passive voice in scientific articles.

interacts with an idea, the language choice does not necessarily change the idea itself. And as mentioned in the previous chapter, language choices may help to maintain the illusion of objectivity, but the reality of the experiment and its outcomes remain the same, regardless of the language used to describe the methods and results. It would seem, then, that the purpose of scientific writing has long since moved away from focusing on the importance of the writer himself, as was the case when the Royal Society began (Dear, 1985), and moved instead toward focusing on the validity of the results as the main point of reporting information.

Shifting to the idea of scientific writing as a rhetorical choice, Campbell (1975) thinks that scientific writing/experimenting is a rhetorical action because it rewards some behaviors and punishes others (p. 393). Viewed in this light, the decision to use the passive voice can be seen as an adopted behavior that is rewarded. Scientists who understand the rhetorical situation and the demands of their audience(s) are rewarded with more publications, whereas scientists who (whether accidentally or purposely) shun the use of current conventions (such as the passive voice) in their writing are punished with a lack of publications, or with publications that people do not quote because the information does not meet the presentation standards of the rest of the "group." Perhaps my earlier question about the purpose of the passive voice in science writing is not so easily answered, as the passive voice seems to serve multiple functions (grammatical, rhetorical, and as a way to maintain the illusion of objectivity) for scientists. Instead of examining the passive voice as an either/or situation it would appear that the use of passive voice is both a rhetorical decision and a useful tool for describing the situation without overusing the "I." Now I'd like to shift to a brief discussion of the background of

how the passive voice came into being in science writing, some of the reasons why

scientists seem to keep returning to the passive voice, using passive voice as a tool for

community-building, issues with cognitive processing in relation to the use of passive

voice, and arguments against the passive voice.

A semi-brief history of the passive voice[13]

While it might seem that the arguments surrounding the use of the passive voice

has "always" been at the forefront of scientific writing, that is not the case. Over the past

400 years, scientific writing, as a broad category encompassing a multitude of disciplines,

has undergone a number of changes in the accepted style. Change is driven by those

people who are in power at the time when the change occurs – "Historically, early

science employed a dialogic form and argued much the same as theology and philosophy

had argued previously; today's rhetorical conventions have emerged from very different

earlier practices based on author-centred genteel conduct and virtual witnessing of

experiments" (Hyland, 2004, p. 175). According to selection theory, the trend toward

passive voice becoming more prevalent in science writing is due to social pressures from

"the highly charged competitive environment that . . . constitutes science" (Gross,

Harmon, & Reidy, 2002, p. 217), which pushes writers toward privileging objects above

people (Gross, 1996, p. xxix). What follows is a brief discussion of how scientific

writing has gone from being letters written among friends and colleagues at the beginning

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[13] For a more in-depth look at the history of the scientific "voice" and how it has changed over the past 10 centuries, see Scott Montgomery's (1996) *The Scientific Voice* (NY: The Guilford Press). His detail far surpasses what I can explain in the limited amount of space that I have here.

of the Royal Society, to the reports that we are familiar with today which serve to highlight the knowledge of the researcher and to push their ideas to the top of the pile.

The Royal Society, founded in November 1660 (The Royal Society, n.d.), is often credited with being the first legitimate and widely attended forum in modern history for scientists to share their knowledge and ideas. In 1665, the Royal Society's first issue of *Philosophical Transactions (PT)* (the oldest continuous science journal) was published, marking a fundamental change in how science information was presented to an audience. No longer were scientists only explaining experiments to small groups of interested people or circulating letters about their experiments just between friends/rivals; now, the dissemination of information was becoming more widespread. The original publication of *PT* started out as letters to other scientists and minutes of the Royal Society's meetings. Atkinson (1996) notes that "an active author/researcher and his activities had a central place in the 17th and 18th century *P.[hilosophical] T[ransactions]*; he is typically characterized as a full participant in the events being related" (p. 360). Also, the use of first person pronouns and the active voice gave a feeling of credibility to the early "gentleman-scientists" (Atkinson, 1996, p. 363). As these men were describing their own actions and experiments, often in demonstrations to a group, using the active voice made sense.

The early 17th century marks a shift in scientific writing from the "self-absorbed, soliloquy-like concentration of sounds, luxurious phrasing, and literary play for its own sake so characteristic of Elizabethan writing" (Montgomery, 1996, p. 80) toward a "greater awareness of the reader" (Montgomery, 1996, p. 80) and the reader's needs. The author-centered approach also makes its appearance in the 17th century (Atkinson, 1996, p. 340). Scientists were noting and accepting the shift from science as a personal

endeavor to science as a community subject. Robert Boyle also championed the concept

of the author/experimenter in the 17th century telling the reader about his direct

interactions and experiences with events, such as the experiments he performed

(Atkinson, 1996). Boyle thought that "science should make itself accountable to its

readers" by relating detailed descriptions of the experiments in a historical way, using the

"I" to recount the events, because this would allow the reader to come as close to the

experiment as possible without having been there (Montgomery, 1996, p. 93). At this

point in the 17th century, the use of "I" in science writing was still quite common. Instead

of turning to the passive voice as a way to remove the scientist from the work, these

writers were turning to the active voice as a way to prove that they had, in fact, been the

ones to perform the experiment, and that they were knowledgeable about the details of

the experiment. Science was also still being written in essay form, not in report form. It

was not until the late 17th century that the modern scientific article, although not quite in

the same form that we know today, began to emerge (Harmon & Gross, 2000).

Throughout much of the 18th century, the goal of natural philosophy, including

physics, chemistry, biology, botany, etc., was to try to understand the natural world. "As

both the generator and observer of these actions, the scientist was himself an actor in

these movements of nature, and [was] acted upon by their effects" (Montgomery, 1996,

p. 99). We see here the continued need of the scientist/author to prove to his audience

that he knew what he was writing about because he had been there; the use of the author-

centered active voice was a way of proving that the experiment was valid and that the

scientist really had performed the experiment about which he was writing. Also,

scientists were slow to move from the eloquent language that they were used to, to the

more modern, technical language that we would now expect to find in a scientific article (Montgomery, 1996, p. 99). The use of language as a spoken tool instead of as a written tool was still popular in the early part of the 18th century.

As the 18th century progressed, the language for reporting scientific experiments began to change. The language was becoming simplified and passive voice was being used more often, though still not as widely as the active voice (Atkinson, 1996; Montgomery, 1996). Newton's flair for direct and concise language was beginning to have a large impact on how British science was being written (Montgomery, 1996, p. 100). There was an interest by the scientific community to find a uniform language, although even as the passive voice was becoming more prevalent, "many successful researchers still wrote with an individual flair, with sufficient confidence to admit humility, humor, and personal confession into their texts" (Montgomery, 1996, p. 100). The uniform language of today was not yet in place in the reports that were being written at this time. However, some form of standardization was not far off. In his study of science writing, Ding (1998) noted that he found personal features, such as personal pronouns referring to the author, less often as he moved from the 18th to the 19th centuries, noting that the passive voice became a dominant feature just before the 1900s (p. 123). It seems that the scientific community may have been struggling to move from the style of writing essays about things that they had done—experiments—to the style of reporting those experiments with less regard for their own part in the results.

By the beginning of the 19th century, roughly around the time of Lyell, the "actor-I" (Montgomery, 1996, p. 106) began to disappear and the "'literary nullification of the self' had begun" (Montgomery, 1996, p. 106). The idea that writing should give the

maximum amount of information in the minimum number of words had come into being, and the job of the scientist "was to uncover, carefully and methodically, a precise fragment of the 'Divine plan,' whose essence was reason and order. It was no longer to insert himself into this order" (Montgomery, 1996, p. 106). "[L]anguage was now to be used as a tool" (Montgomery, 1996, p. 106) whose purpose was to describe the experiments and what had occurred. As long as an experiment was replicable and based on sound science, the person performing the experiment was no longer as important. Also, methodologies had become relatively standardized by the early 19th century, removing the need for lengthy (and active-voiced) descriptions of the processes (Atkinson, 1996, p. 366). This allowed the experiment to begin to overtake the active I-experimenter as the important idea in writing, giving way to the use of thing-centered, non-narrative, passive voice language.

In the early 19th century, scientists still routinely used quotations from classical philosophy, the Bible, poets, etc. to enhance their writing, and this sort of literary addition to the text was expected by the audience (Montgomery, 1996, pp 26-7). Darwin especially employed this sort of literary strategy, writing prose for both the lay and specialized audiences, as that was still considered technically valid during his time (Montgomery, 1996, pp 26-7) despite, or because of, his use of outside "authorities." He was writing "at a time when literature and science borrowed equally from each other's storehouse of persuasion" (Montgomery, 1996, pp 26-7). Hyland (2004) points out that "science . . . did not become a professional activity oriented towards original discovery until the late nineteenth century, and it is only in this century (20th) that scientists have been able to speak as professional experts" (p. 176). As scientists moved away from merely reporting

about how the world worked to discovering new "facts" and "truths" about the world, the language choices and the style of reporting needed to change to keep up.

Between the 1830s and the 1880s, the use of "moral-ethical language [was] declared 'nonscientific' and [would] never again find regular appearance within the professional language of scientists" (Montgomery, 1996, p. 109). The use of the Bible as a source for the results that scientists obtained from their experiments was no longer considered to be valid. Henry Cavendish helped to further this change, allowing the writing of the 18th century to make the leap to the style of foregrounding the "thing" (or experiment) and changing the scientist from a narrator to a recorder of events (Montgomery, 1996, p. 106). According to Atkinson (1996), by 1875, if writers were using author-centered prose, it was for specific rhetorical purposes and was "confined to specific textual locations in reports" (p. 340), or was used to show where the writer was uncertain about some aspect of his experiment (p. 360-1). For the most part, discussions of other scientist's work and the use of object-centered prose were becoming the norm (Atkinson, 1996, p. 340). This use of object-centered prose seems to naturally lead writers to use the passive voice.

By 1880, the insertion of literary style into technical papers was regarded as outdated and a sign of an amateur writer (Montgomery, 1996, p. 112). The audience for technical papers had shrunk from lay readers who might have some interest in a subject to professional scientists (Montgomery, 1996, p. 112). Scientists were no longer going out into nature to just observe the world; science had moved either into the laboratory or "to portions of the external world transformed into technical documents: maps, diagrams, charts, tables, and so forth. Knowledge had become both more abstract and detailed"

(Montgomery, 1996, p. 112). As the profession became more standardized, it makes sense that the language would have quickly followed.

By the late 19th century, science and scientific writing had almost completely moved away from the gentleman experimenter and a new standard for scientific writing was emerging – one in which the scientist no longer needed to prove that he had performed the experiment in order for the results to be viewed as valid. Moving to a greater use of the passive voice was fine because readers would assume that whoever had written about the experiment was probably the one to perform it. The science was able to speak for itself without having to be backed by a human agent.

The period between the 1880s and the 1930s saw an enormous simplification in scientific writing, "equivalent in a general way to the change that occurred between the early and the later 1600s" (Montgomery, 1996, p. 110). The format of the science article became more standardized; the Baconian model of Induction, and eventually the IMRaD (*Introduction*, *Methods*, *Results*, and *Discussion*) model, became the standard format (Gross, 1985; Gross, Harmon, & Reidy, 2002[14]; Harmon & Gross, 2000). The essay form of the scientific report was almost dead. Montgomery (1996) thinks that "by 1920, Darwin, Lyell, and Gilbert . . . were stylistic relics; they would have been hard pressed to find a publisher" (Montgomery, 1996, p. 112). The literary form of writing about scientific experiments was all but dead. And Atkinson (1996) thinks that the highly passive style found in the *Philosophical Transactions* during this time correlates "with the 19th – 20th century development of a strong object-centeredness" (p. 361).

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[14] See Gross, Harmon, & Reidy's (2002) book *Communicating science: The scientific article from the 17th century to the present* (Oxford: Oxford UP) for an in-depth look at specific features of science articles that have changed over the past 400 years. This study examines hundreds of articles to determine how certain stylistic features had changed and morphed into what we know about scientific articles today.

When the use of the passive voice was still becoming the dominant voice in science writing, it was seen as a way to standardize the writing. But by the 1940s, the passive voice came to be associated not just with a general wordiness and sense of meandering, but also with the negative idea of trying to hide the truth about who performed the actions in the experiment (Baron, 1989, p. 19). At about this same time, in the late 1940s and early 1950s, the older scientific professionals began to notice a severe decline in the writing abilities of their younger colleagues (Montgomery, 1996, p. 116). This was also the time that writing guides began to be published in earnest, research papers were more often written by multiple authors, and publishing was no longer strongly linked with the opportunity to display your learning and culture. Instead, publishing was more concerned with the race for status, tenure, or grant money (Montgomery, 1996, p. 116). And, by the second half of the 20th century, there was little variation in the stylistic features that authors were using in science writing, according to a study performed by Gross, Harmon, & Reidy (2002, p. 172). This standardization in the language and presentation style were thought to have helped to improve the efficiency of communication, perhaps as a way to compensate for the ever growing complexity of the information being presented (Gross, Harmon, & Reidy, 2002, pp 172-4).

However, the use of the passive voice has not completely fallen out of favor with academics. In his discussion of grammar, Dennis Baron (1989) spends a few pages discussing the history of advice about using the passive voice starting in the late 1800s and running through the mid-1980s[15]. He ends the chapter with these words: "we may

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[15] For an in-depth discussion of how the use of passive voice and the suggestions for the use of passive voice have changed over the last 100+ years, see D. Baron (1989), The passive voice can be your friend (*Declining grammar and other essays on the English vocabulary* (pp. 17-22). Urbana, IL: National Council of Teachers of Education). He writes a concise literature review of this historical

argue that the multitude of passives in the writing of nonprofessionals indicates the naturalness of the construction" as opposed to it being a non-natural state of grammar (p. 22). "To view the passive as unnatural or inappropriate is to accept uncritically the myth that twentieth-century commentators have spread about the voice. Apparently the passive is alive and in some cases it may even be well, despite the poor press it has been given" (p. 22). The need to now defend the passive voice as both valid and useful is very different from the desire of Royal Society fellows to demonstrate, through the use of passive voice, that their personal role was minimal in the final results of an experiment.

Finally, we see that something amazing has happened to technical discourse and scientific writing over the past 100 years.

The final product [of current scientific writing] has come to achieve something close to Sprat's own vision of 'primitive purity' or Wilkins's 'greatest plainness'– except, of course, that it is accessible only to a trained few, something that the early members of the Royal Society would have found unfortunate, scandalous, regressive, even self-defeating. At present, however, this discourse, stands at the end point of a long, historical process of vaporization, to the point where it now seeks to read like a proteinous extract from the logos itself (Montgomery, 1996, p. 118).

The personal nature of science reporting has changed; no longer is the use of first person active voice the dominant style of reporting about science[16]. Now, in many disciplines,

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information. Instead of reinventing the wheel, I refer you to his text to see exactly how the ideas on passive have shifted from William Swinton's *School manual for English composition* (1877) advising students to use the passive voice to add variety to their writing, to authors in the mid-1980s who push for the use of active voice instead.

[16] For more on the changes in the use of passive voice over time, see D Atkinson's (1996) article "The *Philosophical Transactions of the Royal Society of London,* 1675-1975" (*Language in Society 25*, 333-371).

the passive voice is king, and I wanted to determine if this would hold true for botany.

What do the style guides advise?

The range of functions that the passive voice can perform makes it seem like writers would have an easy enough time understanding when to use the passive voice based on the information they are writing about and the situation at hand. However, when scientists decide to turn to style manuals or books about science writing for help in deciding whether active or passive voice would be the best choice overall and for their particular situation, they have a hard time finding a consensus, even within the same text. Instead of being clear-cut, the information regarding when to use active and passive voice is often murky at best and contradictory or unhelpful at worst, because the multitude of available advice does not always agree.

Sometimes authors argue for both the active and the passive, depending on the situation. According to Swales and Feak (2004), writers should use the passive when they "are describing a procedure or process" (p. 17; see also Ding, 2002). However, if the writer is discussing "natural processes that take place outside of direct human intervention" (Swales & Feak, 2004, p. 98), using the active voice, or a mix between active and passive, may be the best choice. And, sometimes authors seem merely to contradict themselves when advocating for both the active and the passive, as is the case with Bush. Bush (1981) gives varying advice to writers, stating on the one hand that "[t]he passive is weak, evasive, convoluting, confusing, tentative, timid, sluggish, amateurish, obscene, and immoral" (p. 19). But he then goes on to say, "The passive voice can be used constructively . . . to add unity, logic, and coherence—and action" (pp

19-20). Interestingly, Bush's advice seems to be based more on his own personal opinion of how articles written in the passive voice sound than on any hard evidence that the passive voice is hard to read. With a lack of clear guidance, even within the same book or article, it is no wonder that sometimes writers are left without a clear understanding of the preferred voice within their discipline.

Other authors argue almost exclusively for one voice, but are able to see the merit in using the other. Kacel (2000) thinks that most readers prefer the active voice because the sentences are "more powerful, involving, . . . [and] interesting, and that boring writing often features a lot of passive sentences" (para. 2). I find it interesting here that Kacel equates the passive voice with boring writing. It appears that he may be letting his own personal opinion fuel his advice. However, Kacel goes on to qualify the use of passive voice in certain specific situations such as when the agent is unknown, when the emphasis of the sentence should be on the object being acted upon instead of on the agent, if there is no other easy way to write the sentence, or if the sentence just sounds better in the passive form (para. 8-13). Of course, this leads me to question, "For whom does the passive voice *just sound better*?" If the focus is on the editors (who make the final decision) and not the writers or the readers, then maybe using the passive voice does sound better. It is this point that seems to be at the center of the debate over the use of the passive voice—anecdotal discussions of the use of the passive voice seem to far outweigh any formal studies to determine if the passive voice is a valid and valuable way of writing. At the end of his article, even though Kacel agrees that there are times when the passive voice can be used effectively, he still thinks that *good* writers will use the active voice as much as possible.

Day and Gastel (2006) also seem to share in the understanding that the passive voice has merit when used in certain places within an article, noting that even as writers are advised to keep the use of the passive voice to a minimum, there is a place where it makes a lot of sense to use the passive voice—the *Methods* section (p. 64). In the *Methods* section, <u>who</u> did the experimenting is mostly unimportant, and readers are much more interested in finding out <u>what</u> was done. Using the passive voice in this instance is a good way to foreground the "what" that the audience expects to find. This sort of advice, while more helpful than some, still leaves the choice on voice up to the authors, asking them only to use their best judgment as to whether or not the passive voice will work in that particular sentence or section.

Some authors argue almost exclusively for the active voice. Pruitt's (1968) article to research writers has the most forceful opinion of the authors that I read, believing that the passive voice has the potential for hedging and hiding information. Pruitt has two main complaints against using the passive voice. First, Pruitt thinks that using the passive voice is akin to intellectual dishonesty because the "use of passive voice in objective reporting of research is both illogical and unstylistic" (p. 461). To clarify this, Pruitt thinks that the passive voice is illogical because in English, sentences usually are constructed as *subject + verb + object*, telling a story of sorts (pp 461-2). But the passive voice turns this around, giving the reader the "what" first, followed, maybe, by the "who." His second point is about style; Pruitt thinks that using the passive voice is poor style, and that the passive voice hinders the transfer of information from the writer to the reader (p. 463). While I can agree that there are times when using the passive voice might seem illogical based on the rhythm of the "story" being told, I do not agree that it

is always illogical, or that giving the "what" before the "who" is always a poor choice. As science writing tends to focus on the "what," telling the story of the experiment through the use of the passive voice and through the foregrounding of the "what" instead of the "who" often makes sense.

Interestingly, Pruitt (1968) backs off slightly before returning to his vilification of the passive voice by acknowledging that there are times when using the passive voice makes the most sense given the context (p. 463). However, he quickly returns to his endorsement of the active voice, stating that

> if the design of the research is sound, if the conduct of the research has been thorough and honest, what is sacrificed by letting the author stand accountable for his own work? And, if the research is poor, why should the reporter be allowed to hide his errors behind a rhetorical device (pp 463-4).

Sadly, advice like this only helps to promote the concept of the passive voice as a tool for obscuring the truth.

Gilpin and Patchet-Golubev's (2000) book *A Guide to Writing in the Sciences* also argues almost exclusively for the active voice. However, they do not just suggest times when authors should use a specific voice; their advice is more like a set of commands. Gilpin and Patchet-Golubev write, "Use active, not passive, verbs and the past tense to report findings" (p. 24); and "When . . . a sentence is awkward or unnatural because of the passive voice, change the verb from the passive to the active form" (p. 88). While this type of unflinching black and white advice about when to use the active voice might be helpful for writers who are new to the field, it may not be as helpful to writers

who have been publishing in their field for some time and who are comfortable with their writing style and the demands of the discourse community.

Joseph Williams (2005) takes a different approach to the matter of voice. In *Style: Ten Lessons in Clarity and Grace*, he has writers ask themselves some questions before making the decision to use either active or passive voice:

- "Must your reader know who is responsible for the action" (p. 59)?

- "Would the active or passive verb help your reader move more smoothly from one sentence to the next" (p. 60)?

- "Would the active or passive give your readers a more consistent and appropriate point of view" (p. 60)?

After asking themselves these important questions, Williams goes on to suggest that the passive has some perfectly acceptable uses. These instances are not significantly different from what other passive voice advocates have noted, such as when the "who" of the action is unimportant (either to the reader or the writer), the "who" is unknown, putting the simple information at the beginning of the sentence and the complex information at the end makes more sense, or you want to shift your readers' attention to someone or something besides the main agent (p. 61). He then finishes his advice on the passive voice by singling out science writers; "Writers of scientific prose use this pattern [passive voice] so often, however, that it has become standard usage in their community" (p. 64). It seems that, as far as Williams as concerned, while the passive voice might be standard fare in scientific writing and while it may have some useful purposes, the passive is still something to be wary of using.

Although the above advice straddles the fence when it comes to telling writers whether to use the active or the passive voice, it is far better than giving writers advice that is so strict it requires a grammar-checking program to determine. Painter (2005) thinks that the "passive voice should be limited to 18 percentage of your document" (para. 6). I think that when writers see "help" like this, they begin to think that there truly are hard and fast rules for when and how to use the passive voice, and then writers begin to lose their ability to determine whether the active or passive voice best suits their needs.

Narrowing the scope of advice to that meant specifically for the biological sciences gives further examples of ambiguous advice coming from the same source. McMillan (1988) likes the passive voice because it shifts the readers focus from the writer back to the experiment itself (p. 111). She notes that when writers shun the passive voice completely, the writing can easily become "'I-heavy' and monotonous" (p. 111). However, she is also concerned that many writers rely too heavily on the passive voice, which gives scientific writing "the reputation of being dry, pompous, and boring" (p. 111). McMillan goes on to note that the biological sciences have no hard and fast rules for when to use the active or the passive voice, but that the active voice is often more effective (p. 112). However, she does not give much evidence for why the active is more effective, suggesting only a test for determining if the active or passive voice is the better choice. If you write a sentence in the passive voice, could you "express it more exactly and concisely in the active voice" (p. 112)? If so, the active voice is the better choice. By the end of this section, writers may be ready to throw up their hands and admit defeat, especially in light of the statement that there are no firm guidelines for the use of passive voice.

The *ACS Style Guide* (Dodd, 1986) seems pretty clear with its suggestions for writers at first glance: Strong verbs are necessary for clear writing; "Use the active voice whenever possible" to avoid wordiness and ambiguity" (p. 3). Katz (1985) agrees that writers should use the active voice whenever possible (p. 16). Of course, the problem with "whenever possible" is that this leaves a lot up to the writer and the editor. While the writer may think that the *Methods* should be written in passive voice as early advice in this chapter suggested, the editor may have a different interpretation and think that the *Methods* should use a mixture of both active and passive, and that the mixture percentage should be determined by the editor, not the writer.

In *The Art of Scientific Writing*, Ebel, Bliefert, and Russey (1987) takes the stance that the active voice is better, going so far as to say, "Passiveness is the antithesis of action" (p. 361). Ebel et al. continue by bemoaning the fact that scientists often prefer using an impersonal style, which commits them to writing in the passive voice (p. 361). By injecting their opinion so clearly into their advice, they make both the writer AND the passive voice seem like they are bad.

As this small sample of advice begins to illustrate, science writers have many options for who to listen when it comes to the use of the passive voice, and few of the style manuals agree with one another on all points about when or why to use either the active or the passive voice. Scientists have a number of style guides that they might choose to consult when preparing to write a paper; they might consult a general book such as the *Scientific Style and Format* by the Council for Science Editors, or they might turn to something more specific like the *ACS Style Guide* from the American Chemical Society or *The Chemist's English* by Schoenfeld. This difference of opinion about when,

where, and how to use the active or passive voice leads to confusion and side-taking from writers and editors in all disciplines of sciences. And all of this confusion can make it rather difficult for us to understand how to teach scientists to write effectively.

What brings scientists back to the passive voice?

By using the passive voice, scientists may think that they are allowing the readers to come closer to experiencing the experiment themselves. As some of the previously mentioned authors note, the passive voice can give the illusion that there is no visible person standing in-between the reader and the results. Also, the language used with the passive voice can seem to the reader to be less biased and more transparent because it removes the agent as stated before. Ding (2002) thinks that the passive voice helps scientists to think that they sound more credible (p. 145). Whether or not the passive voice really does help the writer to sound more credible, it is still a convention used by the scientific community as a way to present information.

Part of the purpose of reporting what has occurred and how the experiment was performed is to allow for future repetition of an experiment. The use of the passive voice presumably allows scientific experiments to be accessible to other scientists (as they are all writing in the same sentence form) so that they can validate or invalidate the original experiments (Ding, 2002, pp 139–140), or at least plays to the idea that science is repeatable and that the world can be understood through science (Gross, 1991) by either demoting or removing the agent from the sentence altogether. However, as stated before, using the passive voice to describe an experiment does not guarantee that the experiment can actually be reproduced. It merely suggests that scientists understand the need for

experiments to be repeated in order to prove or disprove their theories and results (Ding, 2002, p. 146).

While the active voice does not deny access to the experiments or make them seem any less valid, the active voice does imply that a specific agent (the scientist who performed and wrote up the experiment) may be required in order to recreate the experiment and the results (Dear, 1985, p. 152; Ding, 2002, pp 147 & 149). Dear (1985) makes this point more clear when he writes about Robert Boyle's experiments and write-up's for the Royal Society, noting that Boyle's use of the first person, active voice makes it seem like he (Boyle) is a central part of the experiments (p. 152). Interestingly, the language for reports from the Royal Society often went back and forth between active and passive, with the active voice describing the unrepeatable "experience" and the passive voice describing the repeatable how-to "recipe" of the experiment (Dear, 1985, p. 153). This seems like it would have been the precursor to our current *Discussion* and *Methods* sections, respectively.

Aside from the previously mentioned reasons to use the passive voice, there is an argument in favor of the passive voice as a common style of writing because without a common style (in this case, the use of the passive voice) scientists would need to spend valuable time learning how to read each new person's writing and wading through the unrepeatable experiences of other scientists—valuable time that could otherwise be spent reproducing experiments—to determine their validity. This common style may then lead to a common knowledge base (Ding, 2002, p. 150), allowing scientists to communicate in similar manners to facilitate the spread of scientific knowledge. This argument may be somewhat weak, though, as audiences tend to be able to quickly adapt to a writer's style

without spending too much time learning how to process the writing. Another flaw with this argument is that any sort of common writing style will make it easier for those who are within the discourse community to understand what is being written; this is not unique to the passive voice. If the writing style is clear, whether passive, active, or a mix of both, the reader should be able to understand what is being presented.

Passive voice as community-builder (for better or worse)

As with any community, in order to communicate effectively in science, a writer has to learn the expected norms and language conventions, and then has to be able to apply them. In order to fit into the scientific community, young scientists have to learn to sound like they belong. Every discourse community (biology, chemistry, psychology, the arts, pop culture, etc.) has a unique way of presenting arguments that requires writers who are new to the community to adjust their writing to meet the standards that are already in place (Ding, 2002, p. 138; Hyland, 2004, pp 145-6). And, while there are usually no hard and fast rules for how to approach the writing, there are strong suggestions and guidelines that writers who are new to the discipline can use (Bazerman, 1988, p. 323). Viewing academic writing as something that cannot be imparted through a few classes or textbooks "is relevant here because in acquiring disciplinary knowledge and skills students simultaneously encounter a new and dominant literacy, often finding their own writing practices to be marginalised by the academy and regarded as failed attempts to approximate standard forms" (Hyland, 2004, p. 146). Even when young scientists want to write in the active voice, they are often guided back to using the passive voice because that is what reviewers and editors want to see. Hutto (2003) uses the

example of Chuck, a CDC employee, who resists the use of passive voice but has been guided back into it because of reviewer comments. Chuck says, "I would rather write in active voice, but it's very difficult to do that in science. Although people keep advising you to do it, it's impossible" (Hutto, 2003, p. 214).

This idea of scientists writing in the particular style dictated by their audience and by the rhetorical situation in which they are writing is not new, nor is it confined to the sciences. Even in the early days of the Royal Society, contributors were expected to present their information in a specific fashion in order for the information to be considered valid (Dear, 1985, p. 152). Fellows of the Royal Society were expected to report on actual experiences that they had had with the world around them. Even Newton made the choice to conform to the dominant style of his day, as mentioned before, in some cases taking years of work and synthesizing it into one discreet experience instead of writing about the multiple smaller steps (over a large time span) in the greater learning process (Dear, 1985, pp 154-155). Understanding the expected community norms is an important part of belonging to a community.

The various disciplines and discourse communities that make up our modern scholarship are more than just intellectual cornerstones of understanding, they are instead "ways of being in the world" (Geertz, 1983, p. 155). According to Hyland (2004) "this implies the uses of specific ways of conceptualising problems, devising taxonomies, selecting data and presenting claims through established genres" (pp 149-50). The use of a specialized language (in this case, passive voice) shows proof of belonging to a group and allows the exclusion of those readers who do not have the same background and training as the writer (Hyland, 2004, pp 150, 168). Also, presenting to influential groups

and publishing in prestigious journals allows the writer to take on the persona of prestige given to the journals themselves (Bazerman, 1988, p. 138). By using the passive voice to convey information about their experiments, scientists show that they understand the rhetorical situation and discourse community that they are a part of—in order to appear as though they are authoritative members of the scientific community they <u>must</u> employ the writing style and language choices of the rest of the community. "Writing is . . . seen as helping to create a view of the world" and as producing disciplines (Hyland, 2004, p. 3). The use of passive voice is a subtle key from the writer to the rest of the community that says, "I <u>know</u> what I'm talking about and how to state that information for the rest of you. I am one of you."

When scientists use passive voice, they can exert power in other ways as well. Haberer (1972) thinks that politics and scientific Truth have been linked for some time now, noting that "science is an institution rooted in society and as such inevitably becomes politicized" (p. 714). While scientists may need to be aware of the politics of the day and how that changes what/how they report their experiments, the idea of scientific Truth (with a capital "T") may be just an illusion. Most scientists would argue that experiments need to be repeatable so that knowledge can grow. Assuming scientific Truth instead of truth takes away the ability of science to continue progressing as new concepts are proven or disproven.

Haberer goes on to point out that in the later part of the 19th century, as science transformed from a smaller, peer-to-peer Cartesian enterprise to a larger, interest-group (community) to interest-group (community) Baconian society, politicalization was seen as inevitable; science became too large of a social institution to remain free of politics

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and political uses (pp 714-5). Even as the scientific community stands behind the concept of the "international and universal nature of science" (Haberer, 1972, p. 715), the actual uses of science reflect the non-neutral nature of data application. However, returning briefly to the notion of objectivity, (Hyland, 2004) argues on the one hand that science writing can present knowledge as neutral, with the facts speaking for themselves (in this case through the use of the passive voice), and on the other that it is impossible for disciplinary discourses to actually be neutral because as scientists report information, they are trying to push an idea onto the public (so the choice of voice doesn't really matter) (pp 161-62). Science, no matter how neutral it might seem, has a great influence on policy and decision-making; also, all experiments are performed by and reported by people. As such, science cannot be neutral even if the language and information choices that writers use to report scientific data (vocabulary, citation[17], and passive voice) all play a part in this argument toward a seeming neutrality of purpose.

Social interactions in academic writing do more than just show that the author is knowledgeable and credible; these social interaction also are a source of power—the power to make yourself heard, to engage in conversation with others both inside and outside of your field, and after a time in the field, the power to change your field and to make a difference (Hyland, 2004, p. 168). Even if a scientist chooses not to write in the passive voice for a first draft of a journal article, by the time the article has gone through the peer-review process and has been edited, the odds are that the language used in the

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[17] Harmon, 1992, performed a study to determine 1) what made scientific papers successful and 2) what explanations might exist to explain current literary form and style of scientific papers. Within this study, he looked specifically at the use of citations as an indicator for the usefulness and credibility of particular papers from Eugene Garfield's top 100 most cited papers from 1945-1988.

Also, see Bazerman's (1988) article *Shaping written knowledge: The genre and activity of the experimental article in science* (Madison, WI: University of Wisconsin Press) for further information on the rhetorical use of citations in science writing.

paper will have been changed to conform to the community's norms, whether or not the

scientist agrees with the changes. Refusing to conform to the desired community

language only ensures that information that might be useful or interesting to the

community will not easily or broadly see the light of day.

Cognitive processing of the passive voice

For many readers, information presented in the passive voice may be confusing if

they are not used to the format because the sentence structure does not follow the

standard "subject + verb (+ object)" or "agent + action = thing done" format that readers

have come to expect in English sentences (Gopen & Swan, 1990). "Readers expect a

grammatical subject to be followed immediately by the verb" (Gopen & Swan, 1990, p.

552), but this is the opposite of how passive voice sentences are constructed, with the

subject either appearing toward the end of the sentence, or in the case of the truncated

passive, not appearing at all. Part of the reason for the use of passive voice is, no doubt,

that scientists tend to write reports/journal articles in a style that makes them easily

understandable only to other scientists – employing the passive voice, specific

vocabulary, and the use of citations (Harmon, 1992) – to show that they are aware of their

audience and what their audience expects. This use of a specialized writing style shows

that the scientists understand that they are insiders in a discourse community.

Although technical language and the passive voice may be the expected norm for

many science journals, these techniques do not necessarily equate with either easier or

harder to read writing. As noted in the previous chapter, anecdotal evidence against the

use of the passive voice abounds because people think that it convolutes the ideas being

presented and makes the writing altogether less readable. I wanted to see if I could find

proof of this in prior cognitive research. Unfortunately, while I was able to find some

cognitive studies that focused on the passive and active voice, a number of the studies

that I found treated the passive voice and the use of nominalizations as similar, tending to

focus more on the use of nominalizations[18], or combining the use of the passive voice

with some other transformations, making the results difficult to use here. Connatser

(2004) notes that it is hard to find much real research on the difference in how reader's

process and understand the active and the passive voice, as much of what we hear about

people favoring the active voice may just be "intuition or misplaced logic" (p. 271). It

seems that the lore surrounding the use of the passive voice may be more interesting than

the actual research to find definitive answers to this question.

I was able to find some experiments that examined the processing differences

between passive and active voice, although they were not easy to find. DeVito (1969)

ran three readability/ comprehension tests using different variations of sentences written

in either the active or the passive voice and determined that the advice to avoid the

passive voice because it is harder to understand is "a gross simplification of the facts" (p.

406). His results were mixed; DeVito found that his subjects were more easily able to

recall sentences written in the active voice when given a prompt of the initial noun

phrase, but he also found that sentences written in the passive voice were easier to

remember verbatim when subjects were given the opportunity to fill in the missing words

for those sentences (p. 406). DeVito concluded that based on recall, readability formulas,

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[18] See Bostian & Thering (1987) *Scientists: Can They Read What They Write?*; E. B Coleman (1964) *The Comprehensibility of Several Grammatical Transformation;*, and Jacques Mehler (1963) *Some Effects of Grammatical Transformations on the Recall of English Sentences* for some examples of how passive voice is lumped in with other variables in practical studies.

and cloze scores, neither the active not the passive voice won out at being the better choice as they both had their strong and weak uses (p. 406). As his results were mixed, I was interested to see what other studies had shown.

In a write-up of their (then) forthcoming conference presentation, Spyridakis and Isakson (1998) noted that they had found two studies (Coleman 1964[19] & 1965) that "reliably examined active and passive voice constructions in paragraphs" (p. 259). Coleman's (1964) study showed that textual recall was the same whether the active or the passive voice was used, whereas Coleman's (1965) study showed that in general, the active voice was retained better than the passive voice and that "significantly more passives were retained as actives . . . than vice versa" (p. 337). Coleman's (1965) study also notes that writers tend to use the passive voice "to emphasize the 'object of action'" (p. 337), but that this is not as effective as if the writer left the object of action as the "direct object of the active version" (p. 337). However, the difference between remembering the active versus the passive was not statistically significant, and the writer could make the object of action even more obvious by omitting the agent or the prepositional phrase with the agent (Coleman 1965, p. 337).

Bostian (1983) comments that "the bulk of previous research shows readers find [the] active [voice] easier to comprehend and recall" (p. 636), but only points to a limited number of studies, some of which (for example the DeVito, 1989 article mentioned above) did not show any significant differences. In his own study, Bostian found that the subjects read the active voice sentences faster than the passive voice sentences, but that the comprehension scores were not significantly different. Bostian theorizes that this has

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[19] This article by E. B Coleman (1964), The comprehensibility of several grammatical transformations (*Journal of Applied Psychology, 48*(3), 186-190), would be more helpful if Coleman had treated passive voice as its own variable instead of combining the passive voice with nominalization.

to do both with the subjects being "university students with considerable experience in processing passive . . . styles" (p. 639) and with a flaw in the testing design, but that the similar comprehension scores would not hold in the general population. A year later, Bostian and Byrne (1984) assert that the "passive . . . style [is] difficult to process cognitively because the grammatical structure does not reflect the semantic reality . . . . [and] the reader must work harder to decipher 'who did what'" but they do not cite any previous studies to give proof of this statement. Instead, they seem to be relying on the conventional wisdom surrounding what "everybody" knows about using the passive voice and the results of their second study.

In the above mentioned study, Bostian and Byrne (1984) performed an experiment similar to the one Bostian had performed the year before, but this study used the Cloze[20] procedure to determine if sentence blanks were easier to fill in when written in active or passive voice. The results of this study showed that freshmen and sophomore college students who were already well acquainted with technical and scientific writing "comprehend[ed] an active style better than a passive . . . style" (p. 678). The difference in reading time between active and passive sentences was not significant though (p. 678). I find these results to be interesting, especially in light of Bostian's failure to produce significant results the year before, but I have some hesitations. As this population was so limited, I am not sure that the results would translate back to scientists who have completed at least a BS degree and who have had more experience with reading and writing the material in their field.

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[20] According to Bostian and Byrne (1984), "In Cloze procedure, subjects perceive the whole by filling in the missing words in blanks, as if they were not missing at all" (p. 677).

With such limited and mixed results, I am not surprised that the debate over the whether or not to use the passive voice rages on. Because Connatser (2004) was not able to find much data about the differences between using active and passive voice, he proposes that writers should use passive voice when:

- "The object (receiver of the action) is actually the topic of the sentence,

- The action is more important than the actor,

- The actor is unknown,

- The actor is insignificant,

- The actor is known, but the repetition of the actor would distract the reader from the intended focus,

- Using active voice creates a left-branching series that puts too much information between subject and verb" (p. 271)

This list seems to agree with the other advice that has been written about when and where to use the passive voice.[21]

A potential problem with the using the passive voice occurs if the language used to describe something is not clear or is hard to follow. In that case, the reader may not be able to make a clear decision as to the most important point(s) and may not know what information they should ultimately take away from what they have read. However, as the above studies show, using the passive voice does not necessarily equate with more difficult or convoluted writing. If an audience is aware of the community norms, it appears that the overall processing times between the active and passive voice may be negligible.

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[21] See Dignan, 2005; Dixon, 1991, p. 299; Harmon, 1992; Houp, Pearsall, and Tebeaux, 1995; Larkins, 2001; and Matthews, et al., 1996 for other lists about when to use the passive voice that are similar to this one.

Arguments against the passive voice

In order to present both sides of the issue, it seems only fair to discuss some of the major arguments against the use of the passive voice. Bostian (1983) claims that readers pass judgment on documents written in the passive voice; they automatically assume that the passive voice is worse than the active voice because sentences written in the passive voice usually contain more words and because the agent is often missing (p. 635). Bostian continues his push for the active voice by stating that the "active voice is especially advantageous when subject matter is dull or unfamiliar" (p. 640). And, in what sounds more like a fit of anger than a helpful piece of advice, Boring (1936) writes, "The passive irritates the reader who wants clear direct diction" (p. 458). While I am sure that there are many readers who would argue that much science writing is rather dull or unfamiliar to them, they are most likely not the intended audience. Therefore, the idea of needing to use the active voice to keep from boring the reader seems to be less valid when the intended audience is taken into consideration.

Alley (1996) thinks that many people in the scientific community share the misconception that the passive voice is the better mode for writing documents. However, he calls this a misconception because he thinks that the main goal of scientific writing "is to communicate" (p. 105) efficiently, and therefore the active voice would be the better choice because the active voice is more straightforward, in his opinion. For Alley, almost all uses of the passive voice are "needless." He also thinks that writing in the active voice is more "natural," and that using the "unnatural passive voice" saps the life out of the writing (p. 106). Unfortunately, Alley neglects to qualify what he means by "natural," and neglects to acknowledge that each language has a preferred word order.

By asserting that the active voice is more "natural," Alley is privileging the "subject + verb + object" style of English that we are taught as children and neglecting the idea that anything else can be right or used well.

Mathews et al. (1996) agree with Alley on both of these points, believing that scientists overuse the passive voice more as a "matter of tradition" than because of any formal requirements (p. 97). Mathews et al. go on to say that "the active voice is more precise and less wordy than the passive voice. It is the natural voice in which most people speak and write" (p. 98). He also thinks that using the active voice energizes scientific writing and requires the writer to know exactly what they want to say, and then to say it (p. 98). Finally, Mathews et al. think that using the passive voice causes the truth to be obscured and can cause a writer to sound arrogant (p. 98). Given all the negatives here, it is hard to understand why anyone would chose to write in the passive voice. However, as the above sections show, the passive voice might not be as detrimental to good scientific writing as these authors might have us think.

As this chapter demonstrates, the advice to writers is neither clear-cut not in agreement with itself. Instead, the differences of opinion on voice and the lack of formal studies to understand how the passive voice affects readers leave writers in the dark about the "best" language choices for their given situation. In the end, writers are left to do their best given how others in their field write and what editors suggest they do. It is up to us as teachers to help young scientists navigate all of the advice and to come to a writing style that works both for them and for their intended discipline.

CHAPTER III

METHODS

For this study, I examined *The American Journal of Botany*, choosing five articles (one per year) from each of three time periods, 1914-1918, 1962-1966, and 2004-2008, giving me a corpus of 15 articles in total. I wanted to work within the genre of the scientific article because this seemed to afford me the ability to find a rich amount of data, while limiting my scope somewhat[22]. While having an *Abstract* (which did not become a feature until after the 1910s) and/or a *Conclusion* were helpful, they were not required for an article to make the cut. However, the articles did need to contain an *Introduction*, *Methods* of some sort, *Results*, and *Discussion* (in some cases, two of these sections were combined) in order to make it into this corpus. Because this was a pilot study, I limited the data-set by choosing the first article (as defined in the Introduction) of the first issue in each volume in the three different time periods, explained above, through 2008, when this study began. To illustrate, I chose articles in the following manner: Vol 1 – Iss 1; Vol 2 – Iss 1, etc., moving through the issues as necessary to find the first article in each year that fit the requirements.

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[22] Lilita Rodman (1994) examined the genre of the scientific article in four vastly different journals and areas. I chose to narrow my focus to only one journal so that the results might be more uniform. It would seem that in order to draw conclusions about science writing as a whole, we must first focus on individual sciences to see how each one uses linguistic features. Only after we understand the individual sciences can we begin to understand science writing as a whole category.

I chose *The American Journal of Botany*, a professional journal (professional determination is based on language/jargon use, statistics presentation, and information presentation), because it is a well-respected journal with a long history of publication. I wanted to be sure that I had ample historical data to examine and that the data was coming from an important journal in the field, so that the data might be seen as applicable to the rest of the field. I stayed within the same journal for the textual analysis so that differences in style requirements between journals would not be an issue.

My first goal was to determine if the use of *be* + *verb* + *-ed*, or passive voice (finite passives), had changed over time. More specifically, I wanted to see if the use of *be* passives had changed since the beginning of the journal in the following ways: 1) were authors using the passive voice more or less often in the newer articles, 2) was the location of the passive voice different between the older and newer articles (i.e., *Introduction*, *Methods*, etc), and 3) were the times/items under discussion where the authors were using the passive voice different between the older and newer articles[23] (i.e., discussion of the experiment itself versus discussion of prior research. I refer to these as "spaces" and define them further on in the chapter.)

As a second goal, I was also interested in learning if some verbs were used more often with *be* verbs than others were, and if any verbs were more likely to appear in certain 5-year periods than in others. The term "verb" will be used throughout this study to refer to the past participles that occur with the *be* verbs. As "a sentence containing an intransitive verb cannot have a passive form" (Schoenfeld, 1985, p. 156), I focused on

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[23] See D Atkinson (1996) for an in-depth discussion of how the use of passive voice changed through the lifespan of the *Philosophical Transactions* of the Royal Society. He discusses the reasons why authors use passive voice in some instances versus active voice in others.

identifying the transitive verbs throughout the articles to see how many of them occurred in passive voice sentences.

Setting up the study

In order to determine how to scan the articles and identify the *be + verb + -ed* constructions without reinventing the wheel, I examined the Methodology sections from Tarone et al. 1981 and 1998 (both articles have almost the same methodology) to understand what they were trying to learn from the use of the passive voice in their small studies. Tarone et al. (1981) examined the frequency of the active and passive voice in two astrophysics journal articles "in order to determine whether writers in [astrophysics] prefer[red] the passive over the active" voice (p. 124). They also were interested in the "rhetorical functions" of the different verb forms (Tarone et al., 1981, p. 124). Whereas Tarone et al. were interested in examining the functions of the active and the passive voice as well as the use of first person plural pronouns with the active voice, I wanted to focus more closely on only the passive voice in this study. This allowed me to gain a more in-depth understanding of the rhetorical purposes of the passive voice within my corpus. Tarone et al. were concerned that they were not able to find any other studies that performed a rhetorical analysis of the passive voice to determine its systematic functions within a text as a whole[24]. This seemed like it would be a good place for my study to fit in with prior work.

I used what Tarone et al. did with their studies as a starting point and added a few

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[24] Tarone et al. (1981, 1998) note that Lackstrom, Selinker, and Trimble (1970) and Widdowson (1981) all argued for an analysis of the passive voice in terms of its rhetorical function (p. 124).

further things as were necessary for my own study. Here are the highlights of their studies:

- They were interested in learning about the "the frequency of occurrence of the active and passive forms of the verb in two journal papers in the field of astrophysics" (Tarone et al., 1981; p. 124). This was the idea that helped me begin to frame my own study and to determine what to look for in my corpus.

- They wanted to better understand "the rhetorical function of the passive" (Tarone et al., 1981; p. 124) in their two-paper corpus.

- They counted only finite verb phrases, ignoring "bare *-en* participles such as 'figures *given*'"[25] (Tarone et al., 1981; p. 125). I too chose to ignore the bare *-en* participles in order to focus my study further.

- They chose to ignore any verbs that occurred in footnotes and captions. They also chose to ignore any symbols such as "=," even if they seemed to function as a verb (Tarone et al., 1981; p. 125). I agreed with this approach and also ignored any verbs that occurred in these spaces, as well as any verbs that occurred in headers, titles, graphics, and equations. This helped to ensure that I would be counting only the main text instead of including peripheral information.

- They chose to count all verbs as passive if they appeared in the "*subject + be + verb + -ed* form, regardless of whether they were true passive or stative"[26]

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[25] See Swales, J. M. (1981). The function of one type of participle in a chemistry textbook (In L. Selinker, E. Tarone & V. Hanzeli (Eds.), *English for academic and technical purposes: Studies in honor of Louis Trimble* (pp. 40-52). Rowley, MA: Newbury House) for an excellent discussion of bare *–en* participles.

[26] Stative constructions do not describe processes, whereas passive constructions do. See Lackstrom, J., Selinker, L., & Trimble, L. (1970), Grammar and technical English (In R. C. Lugton (Ed.), *English as a second language: Current issues*. Philadelphia, PA: Center for Curriculum Development) pp 122-130, for more information about stative constructions.

(Tarone et al., 1981; p. 125). Tarone et al. felt that it was too difficult in some cases to distinguish between the two types of verbs, and so they did not attempt to separate them. I also took this approach and did not attempt to differentiate between true passives and stative verbs.

After taking into consideration what Tarone et al. (1981) were attempting to ascertain about the rhetorical functions of the passive voice, I adapted my methodology to expand their research for my needs and my larger corpus. The following sections discuss how I came to focus my study, how I modified Tarone et al.'s 1981 and 1998 methodologies, and how both words and passives were counted.

Articles used

As stated above, I examined *The American Journal of Botany*, choosing five articles (one per year) from each of three time periods, 1914-1918, 1962-1966, and 2004-2008—for a corpus of 15 articles in total. The articles used are shown in Table 1.

Table 1: List of articles used in study

Year, Volume (Issue)	Author(s)	Title
1914, 1 (2)	McDougall, W. B.	On the mycorhizas of forest trees
1915, 2(1)	Ehlers, J. H.	The temperature of leaves of Pinus in winter
1916, 3(5)	Appleman, C. O.	Relation of oxidases and catalase to respiration in plants
1917, 4(4)	Mains, E. B.	The relation of some rusts to the physiology of their hosts
1918, 5(1)	Ludwig, C. A.	The influence of illuminating gas and its constituents on certain bacteria and fungi
1962, 49(1)	Holton, R. W.	Isolation, growth, and respiration of a thermophilic blue-green alga
1963, 50(1)	Knobloch, I. W. & Britton, D. M.	The chromosome number and possible ancestry of Pellaea wrightiana
1964, 51(1)	Wiens, D.	Chromosome numbers in North American Loranthaceae: (Arceuthobium, Phoradendron, Psittacanthus, Struthanthus)
1965, 52(1)	Nichols, H. W.	Culture and development of Hildenbrandia rivularis from Denmark and North America

Year, Volume (Issue)	Author(s)	Title
1966, 53(1)	Penny, P. & Galston, A. W.	The kinetics of inhibition of auxin-induced growth in green pea stem segments by actinomycin D and other substances
2004, 91(1)	Stark, L. R., Nichols, II, L., McLetchie, D. N., Smith, S. D., & Zundel, C.	Age and sex-specific rates of leaf regeneration in the Mojave Desert moss *Syntrichia caninervis*
2005, 92(1)	Effmert, U., Große, J., Röse, U. S. R., Ehrig, F., Kägi, R, & Piechulla, B.	Volatile composition, emission pattern, and localization of floral scent emission in *Mirabilis jalapa* (Nyctaginaceae)
2006, 93(1)	Caris, P. L., Gueten, K. P., Janssens, S. B., & Smets, E. F.	Floral development in three species of *Impatiens* (Balsaminaceae)
2007, 94(1)	Tepe, E. J., Vincent, M. A., & Watson, L. E.	Stem diversity, caline domatia, and the evolution of ant-plant associations in *Piper* sect. *Macrostachys* (Piperaceae)
2008, 95(1)	Marazzi, B, & Endress, P. K.	Patterns and development of floral asymmetry in *Senna* (Leguminosae, Cassiinae)

Article sections

Not all of the articles that I used contained all of the sections (*Abstract*, *Introduction*, *Methods*, *Results*, *Discussion*, *Conclusion*). As stated before, I was mainly concerned with finding articles that contained an *Introduction*, *Methods*, *Results*, and *Discussion*, although in some cases the *Methods*, *Results*, and *Discussion* had fuzzy boundaries. Table 2 shows a breakdown of all of the article sections in the 15-year

Table 2: Article sections by year

YEARS	Abstract	Introduction	Methods	Results	Discussion	Conclusion
1914		xxxx	xxxx	xxxx	xxxx	xxxx
1915		xxxx	xxxx	xxxx		xxxx
1916		xxxx	xxxx	xxxx		xxxx
1917		xxxx	xxxx		xxxx	xxxx
1918		xxxx	xxxx	xxxx	xxxx	xxxx
1962	xxxx	xxxx	xxxx		xxxx	
1963	xxxx	xxxx	xxxx	xxxx	xxxx	
1964	xxxx	xxxx	xxxx	xxxx		
1965	xxxx	xxxx	xxxx	xxxx	xxxx	
1966	xxxx	xxxx	xxxx	xxxx	xxxx	

YEARS	SECTIONS					
	Abstract	*Introduction*	*Methods*	*Results*	*Discussion*	*Conclusion*
2004	xxxx	xxxx	xxxx	xxxx	xxxx	
2005	xxxx	xxxx	xxxx	xxxx	xxxx	
2006	xxxx	xxxx	xxxx	xxxx	xxxx	
2007	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
2008	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
Totals	10	15	15	14	12	7

Note: An "xxxx" indicates that the section was present in the given year.

corpus and, in the cases of fuzzy boundaries, how I classified those sections. In cases where the boundary was fuzzy, I used the title of the section as well as the information contained in the section to determine whether the main focus was on the methodology, the findings, or a discussion of the findings.

How I focused my study

As stated above, I was interested to see if the following things had changed in the lifespan of *The American Journal of Botany*:

- were authors using the passive voice more or less often in the newer articles as compared to the older articles,

- was the location of the passive voice different between the older and newer articles (i.e. *Introduction*, *Methods*, etc),

- were the instances where and how the authors were using the passive voice different between the older and newer articles, i.e., were the "spaces" different, and

- what were the most prevalent verbs being used after the passive *be* verbs.

In order to accomplish these goals, I focused my research on this small sample of published journal articles as a pilot study to determine if the above issues merited further

investigation. I used only published material in order to keep the pilot study manageable, taking a cue from Ken Hyland's (2004) study, *Disciplinary Discourses: Social Interactions in Academic Writing*. Hyland used published writing instead of pre-edited/reviewed writing because of the easy access to the information (published articles are public information, and their use did not require him to interview writers) and also "because [he] felt this was the high stakes area which would yield the best examples of social interactions about which [he] was curious" (p. 139). Although I see merit in using pre-edited/ reviewed writing, I think that would work better in a future study. Hyland also notes that published articles have already "gained status as accredited disciplinary artefacts [*sic*] . . . . They [the articles] are what disciplines most obviously produce" (p. 139). Because of the legitimacy and the visibility of published journal articles, they seemed like a good place to start a research project.

Next, I decided to take a historical approach to my research in this study because, as Hyland (2004) points out, historical studies give us important insight into how a target genre may have changed in "response to the needs, conceptions and practices of the many writers who contributed to its evolution" (p. 141). I also thought that what Atkinson (1996) was doing, examining the *Philosophical Transactions of the Royal Society* over its complete lifespan, was immensely helpful in identifying the trends that scientific writing had undergone in the past 400 years. Atkinson's study helped to guide my ideas for examining *The American Journal of Botany* through a historical lens.

Part of the reason that I went this route—examining only journal articles in a specific field over a long span of time—is because of Tarone et al.'s (1998) previously mentioned observation of a gap in the studies of passive voice. They also note that

Lackstrom, Selinker & Trimble (1970) and Widdowson (1981) have argued for such an analysis in terms of rhetorical function (p. 114). Because of this presented gap, I felt that my study would work well to further the knowledge of how and why the passive voice is actually used in Botany journal articles.

Finally, I focused on the *be + verb + -ed* constructions only, as *have* and *get* passives are not used nearly as frequently, with the *get* passive being used primarily in spoken English.[27]

Furthering the methodology from Tarone et al. 1981, 1998:

After reading how Tarone et al. (1981; 1998) had focused their studies to examine both the use of the passive voice as a rhetorical function and the use of plural first person pronouns within the passive voice, I felt comfortable examining the *American Journal of Botany* to continue the study of passive voice use as a rhetorical function. In order to facilitate my counting of total *be* verbs, passives, total words, and verbs that occurred with the *be* verbs, I converted each of the article's PDF files to text files so that I could use *MonoConc Pro, v 2.2* to scan through the articles. I then broke each article into the following sections as they were available, *Abstract*, *Introduction*, *Methods*, *Results*, *Discussion*, and *Conclusion*. These sections each became their own text files that I imported into *MonoConc*. I searched each section for the following *be* verbs: "was," "were," "is," "are," "be," and "been," and counted the instance of each verb twice, once to count <u>all</u> of the *be* forms and once to count only the passive voice instances of the *be*

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[27] For more information on the *get* and *have* passives, please see Marianne Celce-Murcia & Diane Larsen-Freeman's (1999) book *The Grammar Book: An ESL/EFL Teacher's Course*, 2nd ed, Chpt 18 "The Passive Voice" (Boston, MA: Heinle & Heinle.). They do a good job of explaining when and how the *get* and *have* passives are used in English grammar.

forms. I entered all of this data into a spreadsheet so that I would be able to see if any patterns were forming.

After counting all of the *be* verbs per section in both their passive and non-passive forms, I also counted the number of words in each section, as well as the number of words in each section per 5-year period (i.e., the *Introduction* for 1914 had 532 words; the *Introductions* for the 1910s 5-year period had 8,711 total words). Once I had this information I was able to calculate 1) the total number of *be* verbs/total number of words for each section by year and by 5-year period, 2) the total number of passives/total number of words for each section by year and by 5-year period, and 3) the total number of passives/total number of *be* verbs by year and by 5-year period. This allowed me to determine if there were any noticeable patterns in how often the passive voice *be* forms were being used as compared to the total *be* verbs in over time.

I then scanned through each article a final time to determine if the passive voice sentences contained a *by*-phrase that indicated who or what had completed the action indicated in the sentence. I was interested to learn how many passive sentences were "truncated" (did not contain an agent) or "full" (agent was listed). I was also interested to find out what sorts of agents were being used in the full passives; were they human or non-human, concrete or abstract, etc.

How passive voice verbs and total words were marked/counted

Although some of these items were briefly discussed in the above section on Tarone et al.'s (1981; 1998) methodologies, I give further details about my methodology for counting verbs and words here. In order to count the total words and the verbs, I used the following criteria:

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1) Hyphenated words, such as "sub-population," counted as one word;

2) Symbols such as "+", "-", "&", "%", and ">" did not count;

3) Parenthetical citations did not count;

4) Section headings and table/figure/chart captions did not count, nor did the information that was contained in the tables, figures, and charts;

5) Typos were counted as printed, i.e.: "all so" counted as two words versus "also" which only counted as one word;

6) two *be* verb phrases that occurred next to each other counted as two separate verbs, i.e.: "The period during which the plants <u>are hydrated</u> <u>is counted by</u>…";

7) a verb phrase counted as one verb, i.e.: "has been linked to;"

8) compound verb phrases counted as one verb phrase, i.e.: "The rubber connections between tubes <u>were</u> … <u>wired</u> and <u>paraffined</u>" (Ludwig, 1918);

9) footnotes and/or endnotes did not count; and

10) verb phrases that were split by non-verbs counted as one verb, i.e.: "Oxidase measurements **were** <u>then</u> **made** in the juice thus prepared" (Appleman, 1916; emphasis mine).

I scanned each article with *MonoConc* multiple times, as I was searching for different things each time. (This redundancy in going over the texts also had the added benefit of helping me to eliminate coding errors, as I had multiple contacts with the texts.) The first time through, I circled every *be* verb, regardless of voice. On the second reading, I colored each of the passives green, so that I could quickly distinguish the passives from the non-passives. On the next reading, I tweaked the text file versions of the articles as I went through, as I will now explain. To that end, I read each article again

and added a "z" to the end of any *be* verb that was not passive. This allowed me to still

get accurate word counts for each section while keeping the non-passive voice verbs from

showing up in the passive voice verb counts. On the final reading of each article, I

searched for *by*-phrases, marking each of them in yellow, to determine if the use of the

full passive versus the truncated[28] passive was worth discussing.

Examining the verbs

Once all of the *be* verbs were counted in both their passive and non-passive

forms, I scanned each article section again to see what verbs occurred most frequently

with any passive *be* verbs (i.e., *be prepared, is prepared, were prepared)* to see if there

was a pattern by verb or by set of 5-year timeframes. I was still concerned with which *be*

verbs were included here as I wanted to see if there was a pattern in which verbs occurred

with which *be* verbs. I narrowed my focus to the *Methods*, *Results*, and *Discussion*

sections because those sections contained the largest percentage of *be* verbs overall as

illustrated by Table 3. Narrowing my focus allowed me to more deeply explore what was

occurring with the use of the passive and the changes over time and section.

Table 3: Number of passives per section by 5-yr period, and total # for each section

Sections	1910s *# of occurrences*	1960s *# of occurrences*	2000s *# of occurrences*	Total # of occurrences	% of Total overall occurrences
Abstract	N/A	19	15	34	1.49%
Introduction	191	32	101	324	14.19
Methods	522	89	156	**767**	**33.60**
Results	334	141	136	**611**	**26.76**
Discussion	187	52	248	**487**	**21.33**
Conclusion	49	N/A	11	60	2.63
Totals	*1283*	*333*	*667*	*2283*	

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[28] Biber, et al., (1999) refer to these as long and short, respectively, instead of full and truncated.

In order to have a manageable list of verbs, I wanted to determine the top ten verbs in each section for both the 5-year and 15-year periods. As I was concerned with finding the most frequently occurring verbs and determining any patterns with those, this seemed like a good list to work with. Within each 5-year period, I made a list of the verbs that occurred in each of the *Methods*, *Results*, and *Discussion* sections, and then determined the top ten verbs for each 5-year period within each section. After determining the top ten verbs for each 5-year period, I then determined the top ten verbs for the total 15-year corpus. This allowed me to determine if there were any patterns in how the verbs were being made passive over time (i.e., was "used" a verb that continued to be made passive throughout the 15-year corpus).

In order to determine the top ten verbs, I loaded each section of the articles into *MonoConc* by 5-year period (i.e., all of the *Methods* sections from 1914, 1915, 1916, 1917, and 1918 were one searchable group). Then I searched for the verbs by *be* verb in order to get a complete list of verbs that occurred in the "*be + verb + -ed*" form. Once I had the lists separated by *be* verb, I combined all of the verbs, regardless of which *be* verb they occurred with (I only used the *be* verbs as a way to find the verbs that occurred with them), and counted how many times each verb occurred—I removed the *be* verbs from consideration at this point because I was only concerned with how often the verbs occurred and to what section they belonged. (For example, in the 1960s corpus of the combined *Methods* sections, the verb "used" occurred 8 times in 7 different forms: 1) **used**, 2) **used** by, 3) **used** in, 4) **used** throughout, 5) **used** to, 6) occasionally **used**, 7) successfully **used**.) Then, I marked the most often occurring verbs in red on the main spreadsheet and listed them in a separate spreadsheet. (For further information about the

overall top ten verbs, the sections to which they belong, and the phrasal units that

occurred in each sections and spaces, see Tables A1-A10 in Appendix A.)

When marking the top ten verbs for each section, if there was more than one verb

that had the same number of occurrences they were all counted as a tie and were then

listed in alphabetical order (i.e., in the 1910s combined *Discussion* sections, more than 10

verbs appear on the Top 10 list because a number of verbs occurred 4 times. As they all

had the same frequency of occurrence, all of them made it onto the list.)

There was one anomaly in marking the verbs that occurred in the 1960s combined

Discussion sections—as there were only seven verbs that occurred more than one time,

only seven verbs appear on the Top 10 list. I did not want to list all of the verbs that

occurred in the 1960s *Discussion* sections on the Top 10 list, as that seemed to defeat the

purpose of marking the most common verbs.

After determining the top ten verbs for each section in each 5-year period, I

moved those verbs to a separate spreadsheet and marked the top ten verbs for the total 15-

year corpus, combining *Methods*, *Results*, and *Discussion*. To be as accurate as possible,

I used all instances of a verb from the 5-year period, even if that verb did not make it into

the Top 10 list for that section. (For example, when examining all of the sections from

the 1910s, "made" was in the Top 10 list for the *Methods* and *Results* sections, but not the

Discussion sections. There were three other instances of "made" in the *Discussion*

sections that I added to the 51 instances of "made" that occurred in the Top 10 lists. This

gave me 54 total instances of "made" in the 1910s. (See Table 4.) (By including all

instances of the verbs, some of the verbs that seemed like they should have made it onto

Table 4: Top ten verbs by 5-year period

Years	Rank	Overall	Subtotal	Not from top 10 list, but still in the data for the 5-yr period[a]	Total[b]	Comments
1910s	*1*	**found**	79		79	
	2	**made**	51	+3	54	
	3	**placed**	41	+7	48	
	4	**used**	40	+6	46	
	5	**obtained**	33		33	
	6	**shown**	25	+2	27	
	7	**kept**	22	+1	23	
	8	**produced**	20	+3	23	
	9	**taken**	19	+1	20	
	10	**carried**	19		19	
1960s	*1*	**used**	15	+1	16	
	2	**observed**	9	+1	10	
	3	**determined**	6	+3	9	
	4	**made**	8	+1	9	
	5	**found**	6	+2	8	
	6	**seen**	7		7	
	7	**removed**	6		6	
	8	**detected**	5		5	
	9	**noted**	5		5	
	10	**pretreated**	4	+1	5	
		formed	4		4	*doesn't make it*
2000s	*1*	**initiated**	37	+1	38	
	2	**observed**	16		16	
	3	**used**	8	+4	12	
	4	**arranged**	11		11	
	5	**found**	9	+2	11	
	6	**deflected**	10		10	
	7	**collected**	7	+2	9	
	8	**determined**	6	+1	7	
	9	**estimated**	6		6	
	10	**involved**	5	+1	6	
		deposited	5		5	*doesn't make it*
		examined	5		5	*doesn't make it*
		excluded	5		5	*doesn't make it*
		fixed	5		5	*doesn't make it*
		related	5		5	*doesn't make it*
		selected	5		5	*doesn't make it*

[a] The ***Not from top 10 list*** column shows how many extra occurrences of a verb were in the complete data to add to the occurrences that made it onto the Top 10 lists.
[b] The ***Total*** column includes the verbs from the Top 10 lists as well as the extra occurrences of the verb that did not make it onto the Top 10 lists.

the overall Top 10 list were then pushed off, as indicated in Table 4 by the words

"doesn't make it" in the *Comments* column.)

Marking the spaces

I was also interested to determine if the "spaces" where the most frequently

occurring verbs were being used changed or shifted section location over time. I

continued to focus only on the top ten verbs here due to the pilot nature of this study.

Using Hyland's (2002)[29] analysis, I divided the verbs into categories based on how they

were being used in the text—these became the "spaces" into which the verbs were

categorized. Hyland (2002) refers to *reporting verbs*, which he then breaks into three

distinct categories: Research (Real-World) Acts (activities performed by the researcher

that usually occur in the findings section), Cognition Acts (based on the mental processes

of the researcher), and Discourse Acts ("linguistic activities and . . . verbal expression of

cognitive or research activities") (p. 118). The Cognition Acts did not appear to be useful

for this study, but I did see the Research and Discourse Acts as a place to begin

determining the categories of my spaces. Based on Hyland's concepts, I came up with

the following categories and sub-categories, listed in alphabetical order, to fit my data.

The first category is *citation* verbs, which cite other research, including the

author's own previous work within the current article. Example 9 shows how **used** is

used as a *citation* verb because the author of the previous work is referenced

parenthetically in the sentence.

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[29] See also Thompson & Yiyun's (1991) Evaluation in the reporting verbs used in academic papers
(*Applied Linguistics, 12*(4), 365-382) and Thomas & Hawes' (1994) Reporting verbs in medical
journal articles (*English for Specific Purposes, 13*(2), 129-148) for more information on the
classifications of reporting verbs.

Example 9: This latter chemical had been successfully **used** [emphasis added]

previously (Knobloch, 1953) in shortening long somatic chromosomes (Knobloch

& Britton, 1963, p. 52).

The second category is *fact* verbs, which are commonly found information, other

knowledge, or other facts outside of the article in question. Example 10 shows **found**

being used as a *fact* verb because the author is telling the reader that the

"pseudoparenchymatous tissue" is found in many lichens.

Example 10: This instead of being made up of easily distinguishable filaments,

consists of a pseudoparenchymatous tissue, such as is **found** [emphasis added] in

many lichens (McDougall, 1914, p. 55).

The third category is *natural process* verbs, which have to do with natural

processes for which there was not an identifiable agent other than Nature. Example 11

shows **initiated** being used as a *natural process* verb. In this example, the plant is growing

as it normally would, without any outside help. ("Initiated" was the verb most likely to be

used as a *natural process* verb, although it was not the only verb to be used in this way.)

Example 11: The median abaxial sepal is first **initiated** [emphasis added]

(Marazzi & Endress, 2008, p. 29).

The fourth category is *prior work* verbs, which refer to work that has been done in

the past, but does not refer to this work in a citation manner. These verbs might be used

like **used** in Example 12 where there is not a reference to a specific agent, or the verbs might refer to "past workers," "other researchers," etc.

> **Example 12:** A number of other antiseptics have been **used** [emphasis added], such as H_2SO_4, $CuSO_4$, H_2O_2, phenol, HNO_3, etc., none of which have been found generally or uniformly successful (Mains, 1917, p. 198).

The fifth category is *research* verbs, which have to do with manipulating the plants in some way or running the experiments. Example 13 shows **found** being used as a *research* verb because it refers to what the authors learned as they were performing their experiments.

> **Example 13:** On digging up these mushrooms, twenty-two in number, a cluster of fresh young mycorhizas was **found** [emphasis added] immediately below each one, while in three separate cases an actual connection between the mycelium of the mushroom and that of the mycorhizas was easily demonstrated (McDougall, 1914, p. 56).

The *research* verb category is further broken into three subcategories that are distinctly separate from the main category, but are identified as belonging to a specific group within the *research* verbs. These categories are *data* verbs, *hypothetical* verbs, and *tools* verbs. If verbs are coded as *data, hypothetical*, or *tools*, they are not also coded as *research*. The same holds true in reverse.

Subcategory one is *data* verbs, which refer to calculations done within the research. As Example 14 shows, **obtained** is being used to discuss temperature values that were calculated by the authors.

Example 14: The values are **obtained** [emphasis added] by adding the differential temperature to the air temperature (Ehlers, 1915, p. 53).

Subcategory two is *hypothetical* verbs, which refer to work that could be done in the future, including gap statements about ways to further the current research. In Example 15, **found** is used to refer to work that might occur in the future and findings that might happen. This is a hypothetical situation in that the work has not yet been completed.

Example 15: It would not be at all surprising, therefore, and is perhaps to be expected, even, that some more sensitive bacteria and fungi will yet be **found** [emphasis added] (Ludwig, 1918, p. 29).

Subcategory three is *tools* verbs, which discuss the objects being used to measure or perform the experiment, or which discuss from where the items for experiment were procured. Example 16 shows **obtained** being used to discuss from where the different specimens for the experiments were procured. I considered the procurement of specimens as a *tools* verb instead of as a general *research* verb because I considered the purchase of specimens to be much the same as the purchase of any other supplies that would be needed to complete the experiments.

Example 16: Of these, a number, Bacillus subtilis Cohn, B. Kieliensis (Lehm.

and Neum.) Mig. ("ruber of Kiel"), B. pyocyaneus Gessard, B. rubidus Eisenberg

and Sarcina lutea Schroter, were **obtained** [emphasis added] from the department

of bacteriology of the University of Michigan (Ludwig, 1918, p. 4).

The final main category is *textual* verbs, which refer to the text itself in some

way. In Example 17, **shown** lets the reader know that the information will appear later in

the text.

Example 17: It should be remarked, however, as will be **shown** [emphasis added]

later, that neither of these concentrations of CO is of much significance if the rest

of the mixture be atmospheric air (Ludwig, 1918, p. 11).

Marking the *by*-phrases for full passives

At this point in the study, I was interested in finding out how many full passives

were in my corpus, with full passives indicated by *be + verb + -ed + by agent*, as the *by*-

phrase after a passive voice verb is an indicator of a full passive. I wanted to see how

many of the passive voice sentences I found had an agent, regardless of whether that

agent was human or non-human. According to Biber et al. (1999), academic writing has

the highest frequency of truncated passives (p. 938). Quirk, Greenbaum, Leech, and

Svartvik (1999) point out that, according to their 40 million word corpus of general types

of writing in English, only about one in five, 20%, passive voice sentences in English

have a clear agent (pp 164-5). Even though I was working with a scientific data set and

not a general data set, I wanted to see if this proportion held true for my corpus.

In order to mark the *by*-phrases, I shifted my focus away from the top ten most frequently occurring verbs to all of the *be* + *verb* + *-ed* form that occurred in the *Methods*, *Results*, and *Discussion* sections, as the *by*-phrases rarely occurred with the verbs that were on the Top 10 list. I again used *MonoConc* to search each corpus of sections (*Methods*, *Results*, *Discussion*) to find all of the *by*-phrases in each set of sections. After marking all of the *by*-phrases, I narrowed my search to the *by*-phrases that both occurred after a *be* + *verb* + *-ed* form and that still referred to that verb, indicating that this was a full passive instead of a truncated one. Once I determined which *by*-phrases were actually full passives, I coded those sentences into the spaces listed previously. I wanted to determine in which sections these full passives occurred, and to see if there was a pattern as to where the full passives occurred or if that pattern had changed over time. I was also interested in learning if the *by*-phrases contained a human or non-human agent; about the semantic roles (as will be defined later) that the *by*-phrases occupied; if the agent was human, did it refer to an actual citation, the researcher himself, or to prior work without a citation; if the idea expressed by the *by*-phrase was abstract or concrete; and if the agents within the concrete category were in some way manipulated by humans or if they were a function of nature. Figure 1 shows a diagram of the types of agents, how they relate, and how they were categorized.
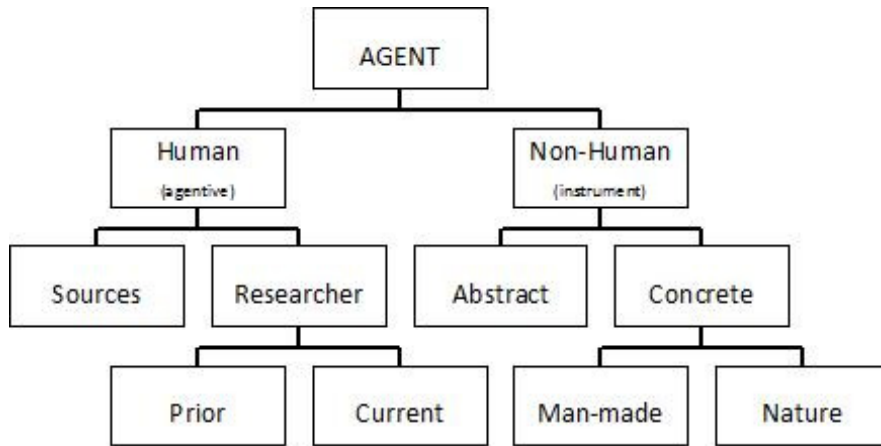
Figure 1: Diagram of Agent types

Human or non-human agent in the by-phrase

I wanted to determine if the agents being used in the *by*-phrases were more likely to be human or non-human agents, as this might help to explain how and why the passive voice was being used in this discipline. Further, once I identified the human agents, those were subdivided into three more categories, 1) source, 2) current researcher, and 3) prior researchers.

The *human-source* category involved agents who were specifically cited as having performed the work, but who were not the researchers themselves. Example 18 demonstrates the human-mention category, where "by Evans (1907)" specifically states who illustrated the previous findings.

> **Example 18:** Mycelium is found throughout the intercellular spaces of the infected areas, where it sends its hyphae into the neighboring cells, forming the branched, finger-like haustoria, which have been well illustrated **by Evans (1907)** [emphasis added] (Mains, 1917, pp 186-7).

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The *human-current researcher* category involved the researcher referring to himself as the agent within the *by*-phrase. In Example 19, "by both of us" refers directly to the researchers.

> **Example 19:** The camera lucida drawings were constructed **by both of us** [emphasis added] (Knobloch & Britton, 1963, p. 52).

The *human-prior researchers* category refers to non-specific researchers who have provided important information by having already completed parts of the research. Example 20 uses the phrase "by several authors" to indicate that other work on this issue has already been completed by a number of other researchers. In this case, <u>who</u> specifically completed the work is not as important as the fact that other work has been completed, and therefore the current author does not need to worry about repeating that work.

> **Example 20:** This indicates that infection takes place through root hairs just as has been shown **by several authors** [emphasis added] for other endotrophic mycorhizas (McDougall, 1914, p. 62).

The *non-human* category refers to any non-human agents within the *by*-phrase. These may be objects used to perform the experiments, plants, ideas, processes, etc. Example 21 gives an example of a research process, "rotating the flask," being used as the agent of the *by*-phrase.

Example 21: The juice was thoroughly mixed with the water **by rotating the**

flask [emphasis added] 25 times (Appleman, 1916, p. 226).

Semantic role of the by-phrases

After determining if the *by*-phrases contained a human or non-human agent, I

marked the semantic roles of the agents in the *by*-phrases. Using Quirk et al.'s (1999)

classification of the types of agents that occur in passive voice sentences, I classified the

semantic roles for the agents into two categories: 1) *agentive* ("the animate being

instigating or causing the happening denoted by the verb") (p. 701) and 2) *instrument*

("the entity (generally inanimate) which an agentive uses to perform or investigate a

process") (p. 701). In my corpus, there were times when the *agentive* role was performed

by non-human objects as well, such as in the case of the plants or Nature performing an

action. As they were still the agents of the sentence, they were classified as *agentive*.

The semantic role of *agentive* agent occurred in *by*-phrases where the agent

included in the *by*-phrase was obviously the one performing the action. Example 22

shows a sentence with a human actor performing the action in the *by*-phrase. It is the

"several authors" who have shown how the infection works.

Example 22: This indicates that infection takes place through root hairs just as

has been shown **by several authors** [emphasis added] for other endotrophic

mycorhizas (McDougall, 1914, p. 62).

In Example 23, we see a non-human agent performing the action. The chemical

"Act. D" is the agent blocking the plant's synthesis.

Example 23: One interpretation of this result is that at the time of treatment, there existed in the cells enough of a compound x to support full growth for about 2 hr, after which x becomes limiting, because its synthesis is blocked **by Act. D** [emphasis added] (Penny & Galston, 1966, p. 3).

The semantic role of *instrument* agent occurred in *by*-phrases where the agent was not explicitly stated the way that it was in the above sentences, and the actions in the phrase were instrumental for the researchers to determine the information that they were looking for. The agents in the *instrument by*-phrases were always non-human. Example 24 shows that the "Beckmann thermometers" are the key item that the researchers use to determine the temperature; therefore, the thermometers are being used as a tool for the researchers to understand their research.

Example 24: The low temperatures were obtained **by means of two Beckmann thermometers** [emphasis added] (Ehlers, 1915, p. 46).

Once I marked both the spaces and the semantic roles that the *by*-phrases occupied, I then examined the verbs with which these *by*-phrases were occurring. I wanted to know if certain verbs were more likely to be part of a full passive than other verbs because I was interested to learn if some verbs were more likely to occur with an agent than others were. If certain verbs often or usually occurred with an agent, that could be a linguistic feature that was unique to those verbs and could be a way of understanding why they usually contained an agent.

Abstract or concrete idea expressed in the by-phrase

Once I had coded the *by*-phrases as human and non-human, I wanted to determine whether the non-human items in the *by*-phrases were <u>concrete</u> (things that you could physically touch) like the "large haustoria" in Example 25, or <u>abstract</u> (like processes or ideas) like the process of "running melted paraffin" in Example 26.

> **Example 25:** In the development of Puccinia Sorghi, it is noticeable that, although most of the cells of the leaf may be invaded **by the large haustoria** [emphasis added], yet no harmful effect is shown by the host until after some period of time (Mains, 1917, p. 208).

> **Example 26:** The chambers were sealed **by running melted paraffin** [emphasis added] between the case of the bell jar and the wall of the dish (Ludwig, 1918, p. 6).

I was also interested to learn if the non-human, concrete agents in the *by*-phrases referred to human manipulated objects (*man-made*), such as the research, or to natural objects (*nature*), such as the plants doing something. Example 27 shows a *made-made* object as the agent in that the plants were cut up by the researcher and added to water to form an extract.

> **Example 27:** An uncooked extract of the plant was made **by cutting up sterile plants** [emphasis added] as finely as possible and adding sterile distilled water to them and then letting the mixture stand for 24 hours (Mains, 1917, p. 207).

Example 28 shows a *nature* object as the agent, because the "fungus tissue" is entirely related to the plant and has nothing to do with the researcher's manipulations.

> **Example 28:** The cells of this row are entirely separated from each other **by fungus tissue** [emphasis added] which surrounds each cell on all sides (McDougall, 1914, p. 55).

By scanning through the articles for these different uses of the passive voice, I hoped to be able to show the ways in which the use of the passive was changing (or staying the same) over time in the *American Journal of Botany*. Determining any changes in the overall use of the passive voice could be a useful tool for writing teachers to understand how to best teach young scientists about the writing norms in their disciplines.

CHAPTER IV

RESULTS

In this chapter, I present my findings beginning with the percentage of passive voice *be* constructions per total words and the proportions of passive voice *be* constructions for the total 15-year period for each section (*Methods*, *Results*, *Discussion*) and by 5-year total of all sections within that 5 years. I then move to a breakdown of the top ten verbs by section for the *Methods*, *Results*, and *Discussion* sections and end by showing the spaces that the top ten verbs occupy and how those shift by 5-year period, as well as how many of the passive constructions contain an explicitly stated agent. Before discussing my findings, I give a quick note about the editors' instructions for contributors to the *American Journal of Botany*.

Notes to Contributors

In 1914, when the *American Journal of Botany* first started, there were no notes to contributors discussing the style of writing or the use of passive voice in the articles. By 1962, there were some notes to contributors with regard to style, but no indication of whether the passive voice was acceptable. However, the editor noted that articles could be no longer than eight pages, including tables and illustrations, leading me to wonder if

that might have slightly affected the use of the passive voice, simply because contributors

were trying to say as much as possible in a limited number of pages, and the passive

voice can sometimes cause sentences to be longer than they would be if they were written

in the active voice. By 2004, the notes to contributors were quite lengthy with a fair bit

of discussion as to the design of the pages. However, there was still no discussion

whatsoever of whether the passive voice was acceptable.

Based on the lack of information about the use of passive voice given to

contributors in each 5-yr period, I feel comfortable dismissing the editors' notes as a

factor in how the use of the passive voice has changed from 1914-2008.

General Results about the Passive Voice

My original hypothesis centered around the question of whether the passive voice

was becoming more prevalent in the *American Journal of Botany*. Anecdotal evidence

suggests that the passive is becoming much more prevalent, but I wanted to determine if

this was actually true, or if this was just an idea that people were focusing on as their

current pet peeve. Table 5 shows the number of passives that occurred in each section,

along with the percentage of the total passives for that 5-year period that each section

contains. As this table illustrates, the use of the passive voice did change over time,

although as it turns out, my research does not support Ding's (2002) discussion of Riley's

work: "Riley stresses that of all the sections of the scientific paper, '[the] Method

consistently displays the highest percentage of passive structures' because in method, 'the

authorial role is that of a presenter of new data' [7, p. 247]" (p. 138).

Table 5: Number and % of passives per section by 5-yr period

Sections	1910s		1960s		2000s	
	# of occurrences	% of Total	# of occurrences	% of Total	# of occurrences	% of Total
Abstract	N/A	N/A	19	5.71%	15	2.25%
Introduction	191	14.89%	32	9.61%	101	15.14
Methods	522	**40.69**	89	26.73	156	23.39
Results	334	20.03	141	**42.34**	136	20.39
Discussion	187	14.58	52	15.62	248	**37.18**
Conclusion	49	3.82	N/A	N/A	11	1.65
Totals	*1283*		*333*		*667*	

In the 1910s, the passive voice was most prevalent in the *Methods* sections. The prevalence of the passive voice then moved to be greatest in the *Results* sections of the 1960s and then the *Discussion* sections of the 2000s. That was an unanticipated change, and I was interested to learn more about how the passive voice was being used to see if I might be able to explain this shift. After discovering this shift, I continued to focus on the *Methods*, *Results*, and *Discussion* sections because the majority of the passive voice constructions occurred in these three sections, making them ideal for a pilot study to determine where and how the passive voice might have changed over time. Table 5, above, shows this shift, with the section having the highest percentage of *be* passives in a 5-year period highlighted in bold.

I continued to examine the data to see if I could determine <u>what</u> might be happening with the passives and <u>why</u> it was happening. Table 6 takes the information from Table 5 and breaks it down further to show the number of passives in each section of the corpus by 5-year period and the total number of passives for the complete 15-year corpus. Then, the percentage of passives for each section per total passives is given in the far right column and for the 5-year periods in the very bottom row. The total number of passives, 2283, is given in the bold box. As Table 6 shows, the percentage of passive voice *be* constructions in each section per total passive voice *be* verbs in the corpus was

greatest in the 1910s, followed by the 2000s, and was the least in the 1960s. In order to

arrive at these percentages, I used Equation 1. In the case of the Methods sections, this

$$\frac{\text{Total for all 15-yrs (by section)}}{\text{TOTAL}} * 100 = \begin{array}{l}\text{Percentage of passive } be \text{ verbs by}\\ \text{section for 15- yr period}\end{array} \qquad \text{Equation (1)}$$

would result in (767/2283) * 100 = 33.60%. Table 6 also shows that the *Methods*,

Results, and *Discussion* sections have the highest percentages overall of passive voice *be*

verbs of all the sections.

Table 6: Proportion of passive *be* verbs by section for 15-yr period and by 5-yr period for all sections

SECTIONS	YEARS			Total for all 15-yrs	Percentage of passive be verbs by sections for 15-yr period
	1910s	1960s	2000s		
Abstract	N/A	19	15	34	1.49%
Introduction	191	32	101	324	14.19 %
Methods	522	89	156	767	**33.60 %**
Results	334	141	136	611	26.76 %
Discussion	187	52	248	487	21.33 %
Conclusion	49	N/A	11	60	2.63 %
TOTAL	1283	333	667	**2283**	
Percentage of passive be verbs by 5-yr period	**56.19 %**	14.78 %	29.25 %		

　　　　Having determined that there had been a shift in which section was most likely to

contain the passive voice, I was left wondering exactly why that might be the case. In

order to determine if there had been a shift in the types of verbs used, I turned my focus

away from the passive *be* constructions to the verbs that directly followed the passive *be*

constructions. These verbs are the focus of the following sections.

Form of the Sentences Containing the Passive Voice

I wanted to determine how often the full passives, as indicated by *be + verb + -ed + by agent*, occurred in each section to see if that had changed over time. Of the 2,283 passive voice *be* verbs, 228 (or 9.99%) of those contained a *by*-phrase and were counted as full passives. This is much lower than Quirk et al.'s (1999) findings that approximately 1 in 5, or 20%, of sentences in academic writing contain a clear agent. This discrepancy could be due to scientists discussing their own work in these articles. When the researchers are the ones also writing up the work, the agent is often understood to be the scientist and need not be clarified or repeated.

Interestingly, if we examine the percentage of full passives per the number of total passives for each section by 5-year period, the full passives were always the most frequent in the 1910s, as indicated by Table 7. It is also interesting to note that the 1960s showed a lack of full passives, but that the percentage of full passives has rebounded by more than 2 times by the 2000s. This could be due to a number of factors, and may be related to the increased use of the verb "initiated" to discuss processes where Nature is the main agent.

Table 7: Percentage of full passives/ total passives by 5-year period and by section

Years	Methods			Results			Discussion		
	full pass	*total pass*	*% full/ total*	*full pass*	*total pass*	*% full/ total*	*full pass*	*total pass*	*% full/ total*
1910s	56	522	**10.73%**	38	89	**42.70%**	39	156	**25.00%**
1960s	12	334	3.59%	14	141	9.93%	10	136	7.35%
2000s	13	187	6.95%	13	52	25.00%	33	248	13.31%

Occurrences of the Passive Voice by Article Sections

Because the majority of the passive *be* constructions appeared in the *Methods*, *Results*, and *Discussion* sections, and because of the shift in where the passive voice was most likely to occur over time from the *Methods*, to the *Results*, and then to the *Discussion*, I continue to focus on these three sections. I also focus on the top ten verbs in each section as a way to narrow my scope, as this is only a pilot study. Future work could examine all of the verbs used in the *be + verb + -ed* form to see if other patterns emerge.

Most frequently occurring verbs

I first wanted to determine which verbs were most likely to occur in a given 5-year period, regardless of section, to see if any patterns emerged over time. Table 8 lists

Table 8: Top 10 occurring verbs by 5-yr period and 15-yr period, regardless of section or *be* passive

Rank	1910s		1960s		2000s		Overall	
	Verb	#[a]	Verb	#	Verb	#	Verb	#
1	***found***[b,c]	79	***used***	16	initiated	38	**found**	101
2	*made*	54	observed	10	observed	18	**used**	74
3	*placed*	48	determined	9	***used***	12	made	68[d]
4	***used***	46	*made*	9	arranged	11	placed	55[e]
5	*obtained*	33	***found***	8	*found*	14	obtained	42[f]
6	*shown*	27	seen	7	deflected	10	initiated	39[g]
7	*kept*	23	removed	6	collected	9	observed	39[h]
8	*produced*	23	detected	5	determined	7	shown	30[i]
9	taken	20	noted	5	estimated	6	produced	29[j]
10	carried	19	pretreated	5	involved	6	kept	25[k]

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] Verbs that occurred in a 5-year period AND in the overall list are italicized.
[c] Verbs that occurred in all three 5-year periods AND in the overall list are noted in bold.
[d] Includes 5 more occurrences from the 2000s that did not make it onto the top 10 list.
[e] Includes 7 more occurrences from the 1960s and 2000s that did not make it onto the top 10 list.
[f] Includes 9 more occurrences from the 1960s and 2000s that did not make it onto the top 10 list.
[g] Includes 1 more occurrence from the 2000s that did not make it onto the top 10 list.
[h] Includes 11 more occurrences from the 1910s that did not make it onto the top 10 list.
[i] Includes 3 more occurrences from the 1960s that did not make it onto the top 10 list.
[j] Includes 6 more occurrences from the 1960s and 2000s that did not make it onto the top 10 list.
[k] Includes 2 more occurrences from the 2000s that did not make it onto the top 10 list.

the most frequently occurring verbs in each 5-year period and in the overall 15-year period, regardless of the section in which the verbs occurred and regardless of which form of *be* occurred with the verb. Not all of the occurrences of each verb appeared in the top 10 list, leading to an appearance that the math is incorrect. The notes below the table explain the differences.

As Table 8 shows, there were two verbs ("found" and "used") that occurred in all three of the 5-year periods AND the overall list. Almost all of the verbs on the 1910s Top 10 list made it onto the overall list. Only "taken" and "carried" had too few occurrences to make the overall list, being displaced by 'initiated" which had a large number of occurrences in the 2000s and "observed" which was used frequently in both the 1960s and the 2000s. While the changing nature of the language may have something to do with which verbs were used most often during a 5-year period, I think that certain verbs are also more likely to be used to discuss certain processes, such as with "initiated." In order to describe what is occurring with the plants outside of human intervention, the verb "initiated" works well.

Top 10 verbs overall

I wanted to determine if there was a pattern for where and when these overall top ten verbs (as shown above in Table 8) appeared so that I might begin to understand how the use of the passive voice had changed. After categorizing the top ten verbs by section and 5-year period, I noticed that there was no clear pattern of occurrence. Almost all of the top ten verbs appeared in all of the sections as indicated in Table B1 in Appendix B. After examining the overall top ten verbs, I then wanted to examine each section more closely to see if this closer examination would indicate any patterns in how or where the

verbs were being used. I hoped that by concentrating on the changes in the top ten verb lists, I might be able to better understand the shift in the use of the passive voice from the *Methods*, to the *Results*, to the *Discussions*.

Passives in the *Methods*

I wanted to determine which verbs were most likely to occur in the *Methods* sections within the *be + verb + -ed* constructions in order to learn if certain verbs were more likely to occur that others. Table 9 lists the top ten most frequently occurring verbs in the *Methods* sections for each 5-year period, and then gives the top ten verbs in the *Methods* section for the overall 15-year period. In cases where there was a tie, all of the verbs with the same frequency score were listed alphabetically, leading to an extensive list for the 1960s. Each verb is listed with its rank in the far left column and the frequency of occurrence in the column directly to the right of the verb.

Table 9: Top 10 occurring verbs in the *Methods* sections by 5-yr period and 15-yr period

Rank	1910s (5-yr)		1960s (5-yr)		2000s (5-yr)		Overall (15-yr)	
	Verb	#[a]	Verb	#	Verb	#	Verb	#
1	*placed*[b]	41	**used**	8	**used**	8	**used**	56
2	**used**	40	determined	4	collected	7	made	41
3	*made*	37	*made*	4	determined	6	placed	41
4	*found*	27	collected	3	estimated	6	found	27
5	*kept*	20	deposited	3	deposited	5	obtained	21
6	*obtained*	19	incubated	3	examined	5	kept	20
7	*inoculated*	14	measured	3	fixed	5	inoculated	14
8	*carried*	11	prepared	3	selected	5	taken	14
9	*removed*	11	added	2	cut	4	carried	11
10	*taken*	10	cleaned	2	stained	4	removed	11
			fixed	2	*taken*	4		
			grown	2				
			identified	2				
			obtained	2				
			purchased	2				
			removed	2				
			replaced	2				

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] Verbs that occurred in a 5-year period AND in the overall list are italicized.

As Table 9 shows, there was only one verb ("used") that occurred in all three of the 5-year periods AND the overall list. It is interesting that all 10 verbs that occurred on the 1910s list made it onto the overall list, most likely due to the sheer number of opportunities given by the longer articles from the 1910s. Most of the verbs on this list from the 1960s and 2000s make it only onto the 5-year period Top 10 list, but then do not have enough occurrences to make it onto the overall Top 10 list, which may again be partially due to changes in the popularity of use for some verbs.

Passives in the *Results*

I was interested to see which verbs were most likely to occur in the *Results* sections within the *be* + *verb* + *-ed* constructions. Table 10 lists the top ten most frequently occurring verbs in the *Results* sections for each 5-year period, and then gives the top ten verbs in the *Results* section for the overall 15-year period. In cases where there was a tie, all of the verbs with the same frequency score were listed alphabetically. Each verb is listed with its rank in the far left column and the frequency of occurrence in the column directly to the right of the verb.

Table 10: Top 10 occurring verbs in the *Results* sections by 5-yr period and 15-yr period

Rank	1910s		1960s		2000s		Overall	
	Verb	#[a]	Verb	#	Verb	#	Verb	#
1	*found*[b]	34	seen	7	initiated	29	found	40
2	*produced*	16	used	7	deflected	10	initiated	29
3	*given*	14	*found*	6	***observed***	11	**observed**	26
4	*made*	14	***observed***	6	arranged	7	made	18
5	*shown*	11	detected	5	characterized	4	produced	16
6	***observed***	9	noted	5	detected	4	given	14
7	*obtained*	9	formed	4	excavated	3	shown	11
8	*taken*	9	*made*	4	formed	3	deflected	10
9	carried	8	pretreated	4	reduced	3	detected	9
10	checked	8	removed	4	united	3	obtained	9
							taken	9

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] Verbs that occurred in a 5-year period AND in the overall list are italicized.

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As Table 10 shows, there was only one verb ("observed") that occurred in all three of the 5-year periods AND the overall list. It is interesting that in this section, only 8 of the 10 verbs that occurred on the 1910s list made it onto the overall list. This was due to the large number of "initiated" and "deflected" verbs that occurred during the 2000s. Without those two verbs being so prevalent in the 2000s, "carried" and "checked" would have made it onto the overall list and the 1910s would once again have mirrored the overall verb list.

Passives in the *Discussion*

I was interested to see which verbs were most likely to occur in the *Discussion* sections within the *be + verb + -ed* constructions. Table 11 lists the top 10 most frequently occurring verbs in the *Discussion* sections for each 5-year period, and then where there was a tie, all of the verbs with the same frequency score were listed alphabetically. Each verb is listed with its rank in the far left column and the frequency

Table 11: Top 10 occurring verbs in the *Discussion* sections by 5-yr period and 15-yr period

Rank	1910s		1960s		2000s		Overall	
	Verb	#[a]	Verb	#	Verb	#	Verb	#
1	*found*[b]	18	noted	3	*found*	9	found	27
2	*shown*	14	*observed*	3	*initiated*	8	shown	14
3	*produced*	6	*produced*	3	*observed*	7	observed	10
4	*obtained*	5	rejected	3	*excluded*	5	produced	9
5	*reported*	5	determined	2	*involved*	5	initiated	8
6	*supplied*	5	*obtained*	2	related	5	obtained	7
7	affected	4	required	2	absorbed	4	excluded	5
8	considered	4			arranged	4	involved	5
9	informed	4			considered	4	related	5
10	infected	4			expected	4	reported	5
	inhibited	4			reduced	4	supplied	5
	known	4						
	said	4						

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] Verbs that occurred in a 5-year period AND in the overall list are italicized.

of occurrence in the column directly to the right of the verb. In the *Discussion* sections

for the 1960s, there were only a few verbs that occurred more than one time, leading to a

list that is smaller than 10 items.

As Table 11 shows, there were no verbs that occurred in all three of the 5-year

periods AND the overall list. It is interesting that in the *Discussion* sections, only 6 of

the 13 verbs that occurred on the 1910s list made it onto the overall list, whereas in both

the 1960s and 2000s almost half of the top ten verbs made it onto the overall Top 10 list.

For some reason, there appears to be a bit more sharing of the verbs by the *Discussion*

sections than by the other two sections.

There was one surprise in the *Discussion* sections in that the verb "initiated"

occurred often enough in the 2000s to enter into the overall Top 10 list. This is a verb

that can be used to indicate a natural process of some kind, leading me to think that it is

prevalent here because the articles I used for my corpus were from the natural sciences.

Example 29 shows "initiated" is being used to discuss the early appearance of the five

sepals, a process that occurs without any human intervention.

> **Example 29:** However, from our data from I. columbaria, a species not particularly
>
> known as having a pentamerous calyx (Grimshaw, 1998), five sepals **appear to be**
>
> **initiated** [emphasis mine] early in the ontogeny (Caris et al., 2006, p. 11).

"Initiated" is a verb that I would not expect to occur as frequently in the hard sciences,

and may be unique to the natural sciences as a way to describe something that Nature

controls and that humans can only observe.

After determining the verb usage within the article sections, I still had questions as to how the passive was being used. I was not yet able to see a clear pattern in where the verbs occurred. I wanted to be able to better understand what was occurring with the different verbs that were being used in the passive constructions. Were some verbs more likely to occur because they worked well in multiple situations, i.e., could the verbs function in multiple spaces? If the verbs could jump across spaces, this could make them more likely to occur simply because of their utilitarian nature. Were there some verbs that were easily able to take an agent when others could not? In determining which verb to use, did it matter if the agent of the full passive was human or not? These were some of the questions for which I wanted to find the answers. In order to learn more about how the verbs were being used, and to determine if there was a pattern or shift in the usage, I next narrowed my focus to the spaces in which the verbs occurred.

Occurrences of the Passive Voice by Space

In this section, I focus on the specific spaces (as explained in the *Methods* chapter and as defined below) being used in each article section (*Methods, Results*, and *Discussions*) and then examine the 5-yr periods where those spaces show up in each section. I also examine the verbs that show up in each space and section, as well as the frequency of appearance for those verbs.

As mentioned in the *Methods* chapter, the spaces I was interested in coding are *citation*, *data*, *fact*, *hypothetical*, *natural process*, *prior work*, *research*, *textual*, and *tools*. I wanted to understand how the verbs were being used and if they were likely to appear in multiple spaces or if they were likely to be confined to just a few spaces. The following

definitions briefly explain the spaces. (For a more detailed description, including

sentence examples, please see Examples 9-17.)

- *Citation* – cite other research, including the author's own previous work
  within the current article.

- *Fact* – commonly found information, other knowledge, or other facts
  outside of the article in question.

- *Natural process* – natural processes for which there was not an identifiable
  agent other than Nature.

- *Prior work* – work that has been done in the past; does not refer to this
  work in a citation manner.

- *Research* – have to do with manipulating the plants in some way or
  running the experiments.
  - *Data* – calculations done within the research.
  - *Hypothetical* – work that could be done in the future, including gap
    statements about ways to further the current research.
  - *Tools* – discuss the objects being used to measure or perform the
    experiment, or which discuss from where the items for experiment
    were procured.

- *Textual* – refer to the text itself in some way.

Spaces for the most frequently occurring verbs

Each of the verbs in the overall Top 10 list occurred at least once in all three

sections, although some verbs were more prevalent in some sections than in others. (To

view the top ten verbs by space, article section, and 5-year period, see Table B2 in

Appendix B.) Not all verbs occurred in each space though. Table 12 shows how many

of the 502 total verb occurrences on the Top 10 list were in each space by section. I was

not at all surprised to find that the majority of verbs fell into the *research* space,

especially in the *Methods* and *Results* sections. In fact, I would have been surprised to

find any other space being used more often, simply because the authors are discussing

what they are doing, as well as the why and how of their experiments.

I was interested to find so many verb occurrences in the *natural process* space

since most of those occurred in the 2000s due to the verb "initiated." However, if

"initiated" is the verb used to discuss Nature, and this is a natural science, the high

instance of *natural process* verbs begins to make more sense as the researchers have to

have a way to discuss what it outside of their control in nature.

Table 12: Spaces used by the most frequently occurring verbs, by section

SPACE	ARTICLE SECTIONS			TOTAL
	Methods	*Results*	*Discussion*	
Research	181	103	36	**320**
Data	3	5	1	**9**
Hypothetical	0	1	1	**2**
Tools	23	1	0	**24**
Natural process	11	38	26	**75**
Citation	9	4	23	**36**
Textual	2	10	6	**18**
Prior work	2	4	5	**11**
Fact	1	3	3	**7**
Total	*232*	*169*	*101*	*502*

After determining how many of the top ten verbs occurred in each space and

section, I was interested to learn which verbs occupied the spaces. This also allowed me

to determine which spaces were not occupied by certain verbs. Table 13 shows how

many occurrences of each verb happened in each space, regardless of year or section. In

order to determine the "% of Overall Total" column, I used Equation 2. For example, the

Table 13: Top 10 verbs by space, regardless of section, ordered from most frequently occurring space to least frequently occurring space

Verbs	Spaces									Total # of occurrences	% of Overall Total
	Research	*Natural process*	*Citation*	*Tools*	*Textual*	*Prior work*	*Data*	*Fact*	*Hypo-thetical*		
made	39	1	3	15	3	2	3	1	1	68	13.55
found	76	4	14	-[a]	1	-	-	5	1	101	**20.12**
observed	31	-	4	-	1	2	-	1	-	39	7.77
obtained	30	1	2	5	-	-	4	-	-	42	8.37
shown	9	4	4	-	12	1	-	-	-	30	5.98
used	58	2	7	-	-	5	2	-	-	74	14.74
placed	51	-	1	2	-	1	-	-	-	55	10.96
kept	22	-	-	2	1	-	-	-	-	25	4.98
produced	4	24	1	-	-	-	-	-	-	29	5.78
initiated	-	39	-	-	-	-	-	-	-	39	7.77
Totals	*320*	*75*	*36*	*24*	*16*	*11*	*9*	*7*	*2*	*502*	

[a] A "-" is used to designate that a verb did not occur in that space. This helps the reader to visualize the actual number of occurrences without having to overlook the 0s.

$$\frac{\text{Total \# of occurrences (by verb)}}{\text{TOTAL}} * 100 = \text{\% of Overall Total} \qquad \text{Equation (2)}$$

verb "made" occurred a total of 68 times out of the 502 total verb occurrences. This lead to (68/502) * 100 = 13.55%.

As Table 13 shows, "found" had the highest percentage of occurrences in passive formations, but did not occur in the greatest number of spaces; instead, it was "made" that occurred in the most spaces. Although "made" was not the most frequently used verb, having the third highest percentage of overall use, it was the only verb to occur at least one time in all nine spaces. The ability of "made" to occur in so many different spaces indicates that "made" is a rather utilitarian verb and can be used in a variety of ways. Examples 30-38 show how "made" is used in each of the nine spaces, beginning with the most frequently used space, *research*, and ending with the least frequently used space, *hypothetical*.

In Example 30, "made" is used in the *research* space, because the author is discussing building a collection to work with.

> **Example 30:** Altogether one hundred and twenty-five collections **were made** [emphasis added] (McDougall, 1914, p. 53).

In Example 31, "made" is used in the *natural process* space, because the phrase "made possible" refers to something that is occurring within the plant.

> **Example 31:** The particular dehiscence mechanism of the fruits is **made possible by the disintegration of the internal tissue of the septa** [emphasis added] (Caris, et at., 2006, p. 13).

In Example 32, "made" is used in the *citation* space because it is immediately followed by a citation about the person who made the original discovery.

> **Example 32:** These have **been made by Carleton** [emphasis added] (1905) who obtained negative results and Ray (1901, 1903) who reports having grown several in culture (Mains, 1917, p. 215).

In Example 33, "made" is used in the *tools* space, because "made" here refers to the company from where the galvanometer was purchased. As explained previously, I considered the purchase of equipment to fall into the *tools* space because this was an object that was necessary to perform the experiment.

Example 33: The galvanometer used was of the d'Arsonval type with a resistance of 30.6 ohms, and was **made by the Eberbach and Son Co.** [emphasis added], of Ann Arbor, Michigan (Ehlers, 1915, p. 42).

In Example 34, "made" is used in the *textual* space, because the researcher is referring to the lack of explanation that will occur in the text.

Example 34: Its alterations are so numerous and complicated, however, that no attempt will be **made to describe them fully** [emphasis added] or to mention the many variations observed (Ludwig, 1918, pp 11-12).

In Example 35, "made" is used in the *prior work* space, because "made" here refers to the prior work including the two attempts that have been made by previous researchers.

Example 35: So far as I know **only two attempts have been made** [emphasis added] to do this (Mains, 1917, p. 215).

In Example 36, "made" is used in the *data* space, because "made" refers to the logarithmic plot that was used to calculate the data.

Example 36: In order to have some basis for the comparison of growth rates obtained in these experiments with those obtained by others with blue-green algae, **a logarithmic plot was made** [emphasis added] of the experimental data obtained under optimum conditions (45 C, 1% CO_2 in air aeration) (Holton, 1962, p. 6) .

In Example 37, "made" is used in the *fact* space, because in order to make an observation, a researcher <u>must</u> remove the glass. This is a statement of fact for other researchers who may also attempt this experiment at a later time.

Example 37: It is usually necessary to remove the glass **when an observation is to be made** [emphasis added] (McDougall, 1914, p. 54).

In Example 38, "made" is used in the *hypothetical* space, because this sentence shows a gap in the work where future research could be performed.

Example 38: No attempt has been made [emphasis added] to correlate the putative supernumerary chromosomes with a present or past sex-determining function (Wiens, 1964, p. 4).

"Found" occupied the next largest number of spaces with six, and was only missing from *data*, *prior work*, and *tools*. "Observed," "obtained," "shown," and "used" were close behind, occupying five spaces; "placed" occupied four spaces; and "kept" and "produced" each occupied three spaces.

"Initiated" was the only verb to occur in just one space—the *natural process* space. (See Example 11 in the Methods chapter.) This makes sense as "initiated" was always used as a way for the researchers to explain what a plant was doing without any human interference.

It is interesting to note that while "placed" occurs within the *citation* space, it does so within the bounds of a quotation. This is the only time that one of the Top 10 verbs occurs within a quote and also the only time that "placed" is used within the

citation space. Although the *hypothetical* space does not have a large number of

occurrences, I felt that it was an important category and could not justify leaving it out

because those verbs did not easily fit into any other category as they were referring to a

non-concrete idea that might or might not be possible.

After determining how many of the top ten verbs occurred in each space, I was

still interested to learn which verbs occurred in each section by space to see if there was a

pattern there. There was no discernable pattern; the results are shown in Table B1 in

Appendix B.

Table 14 takes the spaces discussed above and examines them by 5-year period and

by section, noting the frequency of occurrence for each space in each section and period.

As was shown in Table 6, the majority of occurrences were from the 1910s, which is most

likely due to the larger number of words in articles from the early years of the journal. In

all but one period and two sections, the *research* space was the dominant space; the

exceptions to this are in the 2000s *Results* and *Discussion* where the *natural process* space

is dominant, most likely because of the large number of occurrences of "initiated."

Table 14: Spaces for the top 10 verbs, by 5-yr period and by section

5-yr period	Article Sections			Totals	Percentage of Total
	Methods	*Results*	*Discussion*		
1910s	citation (6)	citation (2)	citation (7)	*15*	4.37%
	data (3)	data (3)		*6*	1.75
	fact (1)	fact (3)		*4*	1.17
			hypothetical (1)	*1*	0.29
	natural process (3)	natural process (12)	natural process (12)	*27*	7.87
	prior work (2)	prior work (3)	prior work (2)	*7*	2.04
	research (156)	research (72)	research (24)	*252*	**73.47**
	textual (1)	textual (7)	textual (5)	*13*	3.79
	tools (17)	tools (1)		*18*	5.25
Total				343	

| 5-yr period | Article Sections | | | Totals | Percentage of Total |
	Methods	*Results*	*Discussion*		
1960s	citation (3)	citation (2)	citation (4)	*9*	15.52
		data (2)	data (1)	*3*	5.17
		hypothetical (1)		*1*	1.72
		natural process (2)	natural process (2)	*4*	6.90
		prior work (1)	prior work (2)	*3*	5.17
	research (11)	research (19)	research (2)	***32***	**55.17**
	textual (1)	textual (3)		*4*	6.90
	tools (2)			*2*	3.45
Total				58	
2000s			citation (12)	*12*	12.24
			fact (3)	*3*	3.06
	natural process (8)	natural process (24)	natural process (12)	***44***	**44.90**
			prior work (1)	*1*	1.02
	research (14)	research (12)	research (10)	36	36.73
			textual (1)	*1*	1.02
	tools (1)			*1*	1.02
Total				98	

It is interesting that while the *research* space is the largest space by number of occurrences in the 1910s and 1960s, it drops over time in overall percentage, losing about 20% from one 5-year period to the next in all three cases. While the *natural process* space saw a minor decline from the 1910s to the 1960s, it saw a drastic increase from the 1920s to the 2000s, again most likely due to the increased use of the verb "initiated." The *citation* space saw a large jump from the 1910s to the 1960s, and then a slight loss in the 2000s. The other spaces did not show any major gains or losses over time.

Table B1 in Appendix B further illustrates the spaces and article sections by 5-yr period, examining which verbs appeared in each block. The spaces are in bold, followed by the verbs and frequencies for each section and 5-year period. It is interesting to note that *found*, *made*, *observed*, *obtained*, *placed*, and *used* are all used in the *research* space in all three 5-year periods. This could be because these verbs provide a core grouping of

verbs for scientific research and because these are usually prevalent verbs in the English language, as indicated by the Francis and Kučera (1982) Brown Corpus study[30].

Occurrences of the Passive Voice with Truncated or Full Passives (as indicated with the by-*phrase)*

As indicated earlier, I was interested to learn how many of the *be* passive sentences in my corpus were also full passives, as indicated by *be + verb + -ed + by agent*.

Frequency of *by*-phrases

After determining how many full passives were in the 15-year corpus, I was then interested to see if the full and truncated passives occupied the same spaces, or if there were any major differences in how these two types of passives were used. I wanted to learn more about how the inclusion of an agent affected the verbs that were used and the spaces where those verbs occurred. I examined the most frequently occurring verbs in the *by*-phrases by 5-year period; there was a three-way tie for 10th place, causing me to have 12 verbs instead of 10 in this list.

Table 15 shows the overall breakdown of the top 12 verbs in the *by*-phrases into their spaces by the three 5-year periods and the overall 15-year timeframe. As with the overall Top 10 verbs list, the *research* space is the most prevalent here, followed rather

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[30] Francis and Kučera (1982) examined a 1,000,000-word corpus from 1963-64 (known as the Brown Corpus) containing selections from 500 samples and belonging to 15 writing genres (p. 1). This corpus contained both technical/professional and lay publications. They ranked each word contained in the corpus based on how often the word appeared in the total corpus, how many samples the word occurred in, and how many genres the word occurred in. They looked at all forms of the word; for example, "get" had 1 main entry and 16 sub entries.

distantly by the *natural process* space. I was not terribly surprised to see that the

research and *natural process* spaces were so prevalent here, as the *research* space would

need to be clarified if it was not the current researcher performing the tasks and the

natural process space would need to be clarified if it was some other part of nature aside

from the plant that was performing the action.

Table 15: Number of full passive occurrences in the spaces by 5-year period

Space	1910s	1960s	2000s	Total for 15-yrs	% of Total
Citation	5	1	0	*6*	7.89%
Fact	4	0	0	*4*	5.26
Natural process	9	1	8	*18*	23.68
Prior Work	1	3	0	*4*	5.26
Research	23	3	6	*32*	42.11
Data	2	0	1	*3*	3.95
Hypothetical	0	0	1	*1*	1.32
Tools	5	0	0	*5*	6.58
Textual	2	0	1	*3*	3.95
Total for 5-yrs	*51*	*8*	*17*	*76*	

Table 16 compares the number of full passives versus the total number of passives

by space. Note that although *fact* and *hypothetical* spaces have the largest percentage of

total passives that are also full passives, there were few enough occurrences of each of

these that those numbers do not mean a lot. It is interesting to note that the *research*

space, which has the greatest number of occurrences of both the full and the total

Table 16: Comparison of full and truncated passives in the overall Top 10 list of verbs by space

Space	Full passives	Total passives	% of total passives that are full
Citation	6	36	16.67
Fact	4	7	57.14
Natural process	18	75	24.00
Prior Work	4	11	36.36
Research	**32**	**320**	10.00
Data	*3*	9	33.33
Hypothetical	*1*	2	50.00
Tools	*5*	24	20.83
Textual	3	18	16.67
Total for 5-yrs	*76*	*502*	**15.14**

passives, has the lowest percentage of total passives that are also full passives. This could be because the researchers did not need to clarify that they were the ones performing the tasks; therefore, the use of the full passive would not be necessary.

These results also show a difference in the percentage of total passives that are full passives, as compared to what Quirk et al.'s (1999) finding that only about one in five, 20%, passive voice sentences in English have a clear agent (pp 164-5). This could have to do with the corpus that was used. Quirk et al.'s corpus was a much more general corpus, consisting of 40 million words from four major genres including conversation, fiction, news, and academic writing (p. 24). As they were not focused on scientific writing, I would expect to see some differences between their percentages and mine.

Verbs and *by*-phrases

At this point in the study, I once again focused on the verbs regardless of the spaces they occupied, this time to determine if certain verbs were more or less likely to occur with the *by*-phrase. In this case, I was concerned with determining how (or if) the inclusion of an agent affected the verb choice in the *by*-phrase. I will comment only on the verbs that occurred more than two times so as to avoid overstating the frequency of verbs that do not end up appearing very often. (The verbs in the 1960s all occurred wither one or two times, meaning that the list for that 5-year period would include all of the verbs that occurred if I did not include this cut-off.) First, let's examine the verbs that occur most often by 5-year period and overall. As Table 17 shows, the majority of the verbs in the <u>overall</u> verbs list also occurred in the 1910s. The verbs "obtained," "evidenced," "followed," and "inoculated" only occurred in the 1910s Top 10 list and in the overall list, but did not occur in the other 5-year periods Top 10 lists. This is not

surprising, as the articles from the 1910s contained the most words and, therefore, contained the greatest opportunity for the verbs to occur multiple times.

Table 17: Top ten occurring verbs in the *by*-phrases by 5-yr period and overall, regardless of section

Rank	1910s		1960s [a]		2000s		Overall	
	Verb	**#**[b]	**Verb**	**#**	**Verb**	**#**	**Verb**	**#**
1	*shown*[c]	14	*made*	3	*characterized*	5	shown	15
2	*made*	10	*produced*	2	*determined*	4	made	14
3	obtained	6	tested	2	*caused*	3	determined	7
4	evidenced	4			indicated	3	caused	6
5	*followed*	4			emitted	2	characterized	6
6	*inoculated*	4			estimated	2	obtained	6
7	*prepared*	4			examined	2	produced	6
8	*produced*	4			formed	2	indicated	5
9	*caused*	3			influenced	2	prepared	5
10	favored	3			released	2	evidenced	4
	inhibited	3			separated	2	followed	4
	invaded	3			supported	2	inoculated	4
	reported	3						

[a] In the 1960s, there were only 3 verbs that appeared more than 1 time.
[b] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[c] Verbs that occurred in a 5-year period AND in the overall list are italicized.

In order to be able to draw conclusions between the use of certain verbs with the passive voice in the overall corpus and the use of certain verbs specifically within the *by*-phrases, I also examined the data by section (*Methods*, *Results*, and *Discussions*), to see which verbs are most likely to occur with the *by*-phrases of the full passives. In the *Methods* sections, there were 81 verb occurrences in the full passives, with 56 occurrences in the 1910s, 12 occurrences in the 1960s, and 13 occurrences in the 2000s. There were no surprises among those verbs. It is also not surprising that the majority of the verbs occurred in the 1910s, as this was the 5-year period where the articles were the longest. Table 18 lists the most frequently occurring verbs in the *Methods* sections by 5-year period and overall.

Table 18: Most frequently occurring verbs in the *Methods* sections by 5-yr period and 15-yr period

Rank	1910s (5-yr) Verb	#[a]	1960s (5-yr) Verb	#[b]	2000s (5-yr) Verb	#	Overall (15-yr) Verb	#
1	*made*[c]	7	N/A	N/A	*determined*	3	made	9
2	*inoculated*	4					determined	5
3	*obtained*	4					inoculated	4
4	*prepared*	3					obtained	4
5							prepared	4
6							estimated	3
7							used	3

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] In the 1960s, *made* was the only verb to occur more than once, and it only occurred two times.
[c] Verbs that occurred in a 5-year period AND in the overall list are italicized.

In the *Results* sections, there were 65 verb occurrences, with 38 occurrences in the 1910s, 14 occurrences in the 1960s, and 13 occurrences in the 2000s. The most frequent verbs are shown in Table 19. As with the *Methods* sections, there were no surprises in the *Results* sections as to which verbs appeared most frequently.

Table 19: Most frequently occurring verbs in the *Results* sections by 5-yr period and 15-yr period

Rank	1910s (5-yr) Verb	#[a]	1960s (5-yr) Verb	#[b]	2000s (5-yr) Verb	#	Overall (15-yr) Verb	#
1	*evidenced*[c]	4	N/A	N/A	*characterized*	4	characterized	4
2	*shown*	4					evidenced	4
3	*caused*	3					shown	4
4	*followed*	3					caused	3
5							followed	3
6							made	3

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] In the 1960s, *tested* was the only verb to occur more than once, and it occurred only two times.
[c] Verbs that occurred in a 5-year period AND in the overall list are italicized.

In the *Discussion* sections, there were 82 verb occurrences, with 39 in the 1910s, 10 in the 1960s, and 33 in the 2000s. The most frequent verbs are shown in Table 20. Again, there were no surprises here with the types of verbs that occurred.

As there were no surprises in the verbs that were used most frequently in the *by*-phrases in each section, I continued to search for patterns in the ways that the *by*-phrases were being used. First, I wanted to determine if the verbs that occurred with the *by*-phrases were the same as the verbs that occurred in my top ten verbs overall regardless of

Table 20: Most frequently occurring verbs in the Discussion sections by 5-yr period and 15-yr period

Rank	1910s (5-yr)		1960s (5-yr)		2000s (5-yr)		Overall (15-yr)	
	Verb	#[a]	Verb	#[b]	Verb	#	Verb	#
1	*shown*[c]	8	N/A	N/A	*caused*	3	shown	9
2	*inhibited*	3					produced	4
3	*reported*	3					caused	3
4							indicated	3
5							influenced	3
6							inhibited	3
7							reported	3

[a] The symbol "#" here refers to the frequency with which that verb occurred within the given section.
[b] In the 1960s, *produced* was the only verb to occur more than once, and it only occurred two times.
[c] Verbs that occurred in a 5-year period AND in the overall list are italicized.

full or truncated passive designation. Then, I narrowed my focus further by 1)

determining the semantic roles (agentive or instrument) and the spaces (*citation*, *fact*,

natural process, *prior work*, *research*, *data*, *hypothetical*, *tools*, *textual*) where the *by*-

phrases occurred; 2) determining if the agent of the *by*-phrase was human (*source*,

current researcher, *prior researchers*) or non-human; 3) determining if the non-human

agent of the *by*-phrase was a concrete, touchable thing or an abstract process or idea; and

4) determining if the concrete agent was a human manipulated thing or a natural process.

Verbs in the by-phrases versus verbs in the Top 10 lists

Part of my comparison involved examining the verbs that were used in both the

Top 10 list of overall verbs and the most frequent verbs used with the *by*-phrases. As

Table 21 shows, in the 1910s there were 133 instances of full passives; "made," "shown,"

and "obtained" were the only verbs that occurred both in the full passives and in the

overall Top 10 list for the sections. These are verbs that I would expect to show up in

both lists as all three verbs could easily take a *by*-phrase after them. Surprisingly though,

only "shown" occurs in more than one section during this 5-year period.

Table 21: Verbs in full passive and Top 10 lists, by section in the 1910s

Years	Full passive verbs			Top 10 verbs overall		
	Methods	*Results*	*Discussions*	*Methods*	*Results*	*Discussions*
1910s	**made** (7)	evidenced (4)	**shown** (8)	placed (41)	found (34)	found (18)
	inoculated (4)	**shown** (4)	inhibited (3)	used (40)	produced (16)	**shown** (14)
	obtained (4)	caused (3)	reported (3)	**made** (37)	made (14)	produced (6)
	prepared (3)	followed (3)		found (27)	**shown** (11)	obtained (5)
				kept (20)	obtained (9)	made (3)
				obtained (19)	observed (8)	kept (2)
				observed (2)	placed (5)	placed (2)
				shown (2)	used (5)	used (1)
				produced (1)	kept (1)	initiated (0)
				initiated (0)	initiated (0)	observed (0)

In the 1960s, there were 36 instances of full passives. Unfortunately, no verbs occurred more than twice, although "made" occurred 2 times in the *Methods*, "tested" occurred 2 times in the *Results*, and "produced" occurred 2 times in the *Discussions*. Both "made" and "produced" occur in the Top 10 lists for the 1960s in the same sections where they occur for the full passives. "Tested" does not occur on the overall Top 10 list of verbs. "Made" occurred in both the 1910s and the 1960s, but not in the 2000s. "Produced" only occurred in the 1960s. Table 22 lists the Top 10 verbs in order of frequency.

Table 22: Verbs in full passive and Top 10 lists, by section in the 1960s

Years	Full passive verbs			Top 10 verbs		
	Methods	*Results*	*Discussions*	*Methods*	*Results*	*Discussions*
1960s	N/A	N/A	N/A	used (8)	used (7)	observed (3)
				made (4)	found (6)	produced (3)
				obtained (2)	observed (6)	obtained (2)
				found (1)	made (4)	found (1)
				observed (1)	obtained (2)	made (1)
				placed (1)	produced (2)	used (1)
				kept (0)	shown (2)	kept (0)
				initiated (0)	placed (1)	initiated (0)
				produced (0)	kept (0)	placed (0)
				shown (0)	initiated (0)	shown (0)

In the 2000s, there were 59 occurrences of full passives, but there were no overlaps between the full passives and the Top 10 lists, perhaps because so few verbs occurred with *by*-phrases. Table 23 lists the verbs in both the full passive and Top 10 lists. No verbs occurred on both lists.

Table 23: Verbs in full passive and Top 10 lists, by section in the 2000s

Years	Full passive verbs			Top 10 verbs		
	Methods	*Results*	*Discussions*	*Methods*	*Results*	*Discussions*
2000s	determined (3)	characterized (4)	caused (3)	used (8)	initiated (30)	found (12)
				made (3)	observed (10)	observed (9)
				placed (3)	found (2)	initiated (8)
				kept (2)	used (2)	made (2)
				obtained (2)	kept (0)	placed (2)
				initiated (1)	made (0)	used (2)
				found (0)	obtained (0)	obtained (1)
				observed (0)	placed (0)	produced (1)
				produced (0)	produced (0)	shown (1)
				shown (0)	shown (0)	kept (0)

As there was no overlap in the verbs that occurred in the *by*-phrases and the Top 10 verbs for the 2000s, I would like to examine more closely how the three verbs that

occurred more than twice in the *by*-phrases were used. The first verb, "determined," was used three times with *by*-phrases, once in the *data* space and twice in the *research* space. Example 39 shows the *data* space and how the *by*-phrase "measuring the distance on a digital image of the leaf" is a way for the researcher to gain data from the experiment.

Example 39: At the conclusion of the experiment (58 d), the linear distance from the original leaf to the furthest extent of protonemal growth was determined **by measuring the distance on a digital image of the leaf** [emphasis added], using image analysis software, to the nearest 0.01 mm (Stark et al., 2004, p. 3).

Example 40 shows the *research* space and how the *by*-phrase "a time course" is used to explain how the experiment was being run.

Example 40: The optimal staining time was determined **by a time course** [emphasis added] of 5, 10, 15, and 20 min of staining (Effmert et al., 2005, p. 4).

The next verb, "characterized," was used four times with *by*-phrases, all of which occurred in the *natural process* space. Example 41 shows how the *by*-phrase "a bullate surface" is used to describe the plant. The researcher has no control over how the plant shapes itself; he can only describe what he sees here.

Example 41: The adaxial epidermis (Fig. 4A–D) of the upper petaloid lobe between the arms of the star-shaped center was characterized **by a bullate surface** [emphasis added] (Fig. 4A) (Effmert et al., 2005, p. 5).

The next verb, "caused," was used three times with *by*-phrases, once in the *hypothetical* space and twice in the *natural process* space. Example 42 gives an example of the hypothetical space and shows how the *by*-phrase "different periods of sampling" is a guess as to why the differences in the fragrance analysis might be occurring.

Example 42: Differences in fragrance analysis in various studies could also be caused **by different periods of sampling** [emphasis added] (Effmert et al., 2005, p. 9).

Example 43 gives an example of the *natural process* space and shows how the *by*-phrase "the fusion of the dermal integument initials together with a shift and a growth restriction of the outer integument primordium" is an action that the plant is performing on its own.

Example 43: The changeover from bitegmic (plesiomorphic) to unitegmic (apomorphic) is caused **by the fusion of the dermal integument initials together with a shift and a growth restriction of the outer integument primordium** [emphasis added] (Boesewinkel and Bouman, 1991) (Caris et al., 2006, p. 12).

Human or non-human agent in the by-phrase

After determining which verbs were most likely to occur in the *by*-phrases, I then shifted back to examining the complete set of *by*-phrases, regardless of verb. I wanted to determine if those agents in the *by*-phrases were human (*citation* and *prior work* spaces) or non-human (*fact*, *natural process*, *research*, *data*, *hypothetical*, *tools*, and *textual* spaces).

(See Examples 18-21 in the Methods chapter for the differences between human and non-human.) When I think of the agent of a *by*-phrase, I usually think of a sentence like "The ball <u>was kicked</u> **by John**," where the agent "John" is a person who is doing something. Interestingly, in my corpus, of the 228 full passives, only 30 of them, or 13.16%, had a human agent. The other 198, 86.84%, had non-human agents. I did not expect to find that because when I think of an "agent," I usually first think of a human or other animate object performing the action. I thought that in science articles, the scientists would be the ones to perform the actions and would use the passive voice so as to avoid repeating "the researcher" throughout the paper, or that the scientists would use the agent to refer to other researchers or to work that had previously been completed. I also found it interesting that there were so few human agents within the *Results* section. Table 24 shows how the numbers break down when examining all sections in each 5-year period. The non-human agents greatly outnumbered the human agents in all three sections.

Table 24: Human versus non-human agents as part of the *by*-phrases by section and 5-yr period

Years	Methods		Results		Discussions		Totals	
	Human	*Non-human*	*Human*	*Non-human*	*Human*	*Non-human*	*Human*	*Non-human*
1910s	5	51	3	35	11	28	19	114
1960s	5	7	2	12	1	9	8	28
2000s	1	12	0	13	2	31	3	56
Column Total	*11*	*70*	*5*	*60*	*14*	*68*	***30***	***198***

Table 25 shows the percentage of human and non-human agents in each section and 5-year period as a portion of the total human and non-human agents for that 5-year period. The largest percentage of human agents occurred in the *Methods* sections of the 1960s and the largest percentage of non-human agents occurred in the *Discussion* sections of the 2000s.

Table 25: Percentage of human and non-human agents in each section and 5-year period

Years	Methods		Results		Discussions	
	Human	*Non-human*	*Human*	*Non-human*	*Human*	*Non-human*
1910s	26.32%	44.74%	15.79%	30.70%	57.89%	24.56%
1960s	**62.50**	25.00	25.00	42.86	12.50	31.14
2000s	33.33	21.43	0	23.21	66.67	**55.36**

I wanted to determine what sorts of human agents were most likely to occur in the full passives, as it seemed like the researchers would be less likely to refer to themselves than to people outside of the experiment. Of the agents that were human, I was then interested to determine if the agent referred directly to the author (current researcher), to a citation (source), or to general prior work (prior researchers) that had been completed. (See Examples 18-20 in the Methods chapter.) Most of the human agents fell into the *citation* space, with a few that referred to the *prior work* space. Of the 228 full passives, 30 (13.16%) contained an explicit human agent. Of those 30, 26 (86.67%) occurred in the *citation* space and four used the human agent to refer to *prior work*. The *Discussion* sections contained the most human agents, with 14, followed by the *Methods* with 11, and the *Results* with five. This was not entirely unexpected, as the agent in the *Methods* section can most likely be inferred to be the researcher himself. Table 26 shows the breakdown of human agents into their types.

The 1910s and 1960s had similar numbers of human agents in the *Methods* and *Results*, while the *Discussions* for the 1910s clearly had the largest number of explicit agents. The 2000s had few explicit human agents in any section, leading me to wonder if the use of the full passive with regard to the human agent has lessened because readers anticipate that any truncated passives will refer to the researchers doing the work, unless otherwise indicated.

Table 26: Type of human agent by section and 5-yr period

Years	Methods	Results	Discussions	Totals
1910s	source (1)	source (2)	source (9)	12
	prior researchers (2)	prior researchers (1)	current researcher (2)	5
	current researcher (2)			2
Sub-total				**19**
1960s	source (4)	source (1)	source (1)	6
	current researcher (1)	prior researchers (1)		2
Sub-total				**8**
2000s	current researcher (1)		source (2)	3
Sub-total				**3**
Totals	source (5)	source (3)	source (12)	20
	prior researchers (2)	prior researchers (2)	current researcher (2)	6
	current researcher (4)			4
Grand-total				**30**

Semantic roles and spaces where the by-phrases occurred

After determining the frequencies of the human and non-human agents, I examined the semantic roles (agentive and instrument) that the verbs in the full passives occupied to determine whether the agent of the sentence was more likely to be a human or non-human agentive (where the agent was performing the action in the *by*-phrase) or a non-human instrument (where the agent was being used by the researchers to learn something about the experiment). (See Examples 22-24 in the Methods chapter.) I was interested in determining why the agent of the sentence was sometimes included and if there appeared to be a pattern for when the agent was mentioned and when it was not.

I was not surprised to find that the *research* space contained more instruments than agentives. This makes sense, as much of the time the agent in the research space was the tool being used to measure something. There were a few points of interest with the semantic roles and spaces that occurred with the *by*-phrases (see Table C1 in

Appendix C). The *hypothetical* space only occurred once—in the *Discussion* sections of

the 2000s as an instrument. This is may not be so surprising though, because the agent of

a *by*-phrase is usually not a hypothetical suggestion, and because this occurs in the

Discussion section where some hypothesizing it to be expected. In this case, the sentence

is referring to some reasons why there might be differences in sample outcomes between

different experiments (see Example 44).

> **Example 44:** Differences in fragrance analysis in various studies could also be
>
> caused **by different periods of sampling** [emphasis added] (Effmert et al., 2005,
>
> p. 9).

The *citation* space was almost always used as an agentive, except for one instance

in the *Discussion* sections of the 1910s, where it was instead used as an instrument.

Example 45 shows this anomaly, where "by my glass plate experiments" refers to both

the author (citation) and his experiments (instrument).

> **Example 45:** This was brought out **by my glass plate experiments**, and is easily
>
> verified by digging up the roots of any mycorhiza forming tree [emphasis added]
>
> (McDougall, 1914, p. 64).

I also found it somewhat interesting that the *natural process* space was used in all

three sections. I expected it to occur in the *Results* and *Discussion* sections, but was rather

surprised that it appeared in the *Methods* sections. It was used almost equally as an

agentive and an instrument overall, while being used slightly more often as an agentive in

the *Methods* sections, slightly more often as an instrument in the *Results* sections, and

almost 49% more often as an instrument in the *Discussion* sections. Example 46 shows the

natural process space being used as an agentive, where the "haustoria from neighboring

hyphae" are the ones who are invading the epidermal cells. The researcher has no control

over this action, and is only able to observe the haustoria performing a task.

> **Example 46:** By the fifth day, the epidermal cells were invaded **by haustoria**
>
> **from neighboring hyphae** [emphasis added], and the amount of starch was
>
> noticeably less in the parenchyma sheaths of the infected areas (Mains, 1917, p.
>
> 186).

Example 47 shows the *natural process* space being used as an instrument, where

"the amount of CO_2 expired from the tubers" is something that the plant is performing on

its own, but is measurable by the researcher.

> **Example 47:** The rate of respiration was determined **by the amount of CO_2**
>
> **expired from the tubers** [emphasis added] (Appleman, 1916, p. 225).

Abstract or concrete idea expressed in the by-phrase

Once I determined whether an agent was human or non-human, I then coded the

non-human agents in the *by*-phrases into *abstract* or *concrete* ideas. Since there were so

many non-human agents, I was interested to learn if these non-human agents were more

likely to be abstract ideas or concrete processes. Out of the 228 explicit agents, 198, or

86.84%, were non-human agents. Overall, there were approximately 25% more concrete

non-human agents (110) than abstract non-human agents (88) as shown by Table 27.

There did not seem to be a pattern as to what section or 5-year period the concrete non-

human agents occurred in, although the usage of the abstract and concrete agents is an almost mirror image between the *Methods* and the *Discussion* sections. The *Methods* were always more abstract than concrete, and the *Discussions* were always more concrete than abstract, but the *Results* varied by 5-year period.

Table 27: Abstract or Concrete non-human agents by section and 5-yr period

Years	Methods		Results		Discussion		Totals	
	Abstract	*Concrete*	*Abstract*	*Concrete*	*Abstract*	*Concrete*	*Abstract*	*Concrete*
1910s	30	21	12	23	10	18	52	62
1960s	7	0	7	5	2	7	16	12
2000s	9	3	0	13	11	20	20	36
Totals	**46**	**24**	**19**	**41**	**23**	**45**	**88**	**110**

Once I coded the agents as *abstract* or *concrete*, I wanted to examine the abstract agents a bit more closely. I was interested to determine how many of them were processes that used *-ing* verbs to discuss the action taking place. As Table 28 shows, about half of the total *abstract* agents described processes using *-ing* verbs. The use of *-ing* verbs was most prevalent in the 1910s, and has been dropping by about 10% every 50 years. In order to further explore what was occurring here, I also examine the sections to see where the *-ing* verbs were most often used.

Table 28: Total Abstract agents occurring with *-ing* verbs

Years	Total		% of *-ing* verbs/ Abstract agents
	Abstract agents	*-ing verbs*	
1910s	52	32	**61.54**
1960s	16	8	50.00
2000s	20	8	40.00
Totals	**88**	**48**	**54.55**

Table 29 examines the data from Table 28 more closely, showing that the use of *-ing* verbs to describe a process was quite high in the *Methods* and *Results* sections, but

dropped by over 70% in the *Discussion* sections. This may be due to the researchers

discussing the processes of completing the experiments in the *Methods* and *Results*

sections, and discussing more of the abstract ideas about the experiment in the *Discussion*

sections.

Table 29: Number and % of abstract agents that use *-ing* verbs to describe the process

Years	Methods			Results			Discussion		
	# Abs[a]	*-ing* verbs	*-ing* % of Abs	# Abs	*-ing* verbs	*-ing* % of Abs	# Abs	*-ing* verbs	*-ing* % of Abs
1910s	30	23	76.67	12	8	66.67	10	1	10
1960s	7	4	57.14	7	4	57.14	2	0	0
2000s	9	5	55.56	0	0	0	11	3	27.27
Totals	**46**	**32**	**69.57**	**19**	**12**	**63.16**	**23**	**4**	**17.39**

[a] "# Abs" refers to the total number of abstract agents in each section and 5-year period.

Of these *concrete non-human* agents, I then wanted to determine which of those

were human manipulated (*man-made*), including places where the researchers were

experimenting on the plants and causing changes to occur, and which of those were the

result of something occurring in nature (*nature*) that would have occurred with or without

human intervention. (See Examples 27 & 28 in the Methods chapter.) The human-

manipulated agents were items that either required human interaction or were buildings

or other objects that caused a change in the experiments. The agents that occurred in

nature were the plants themselves or some other natural process that was not being

manipulated by the researchers.

As Table 30 shows, of the 110 *concrete non-human* agents, 36 (31%) of them were

man-made and 74 (69%) were *nature*. The *Methods* sections had a higher percentage of

man-made agents than *nature* agents, and the *Results* and *Discussion* sections both had a

higher percentage on *nature* agents. This is most likely due to the *Methods* sections

carrying the weight of the discussion about how the experiment was performed, whereas

the *Results* and *Discussion* sections carry the weight of description about the plants and why things might have happened as they did. It is interesting to note that while both the *Results* and *Discussion* sections did have more *nature* agents, the *Discussion* sections had approximately 8 times as many *nature* agents as they had *man-made* agents. This difference could again be due to the purpose of the *Discussion* section as a place to fully describe and try to understand what is occurring with the results from the experiments. This could also be somewhat due to the large use of "initiated" in the 2000s.

Table 30: Non-human concrete agents as human manipulated or natural by 5-yr period

Years	Methods		Results		Discussion		Total	
	Man-made	*Nature*	*Man-made*	*Nature*	*Man-made*	*Nature*	*Man-made*	*Nature*
1910s	11	10	13	10	2	16	26	36
1960s	0	0	2	3	3	4	5	7
2000s	3	0	0	13	2	18	5	31
Totals	14	10	15	26	7	38	**36**	**74**
% of Totals	12.96	9.26	13.89	24.07	4.63	35.19		

CHAPTER V

DISCUSSION

I began my study thinking that understanding how the use of the passive voice had changed in the *American Journal of Botany* since the journal began would be easy to determine, that a simple look at the number of passives per words in each 5-year period would tell me what I wanted to know. As with any study, once I began to examine the numbers, I realized that understanding how the passive voice was being used would require a much more in-depth search than I had originally planned.

Whereas Tarone et al. (1981, 1998) were concerned with both the rhetorical situations in which the authors chose to use the passive voice AND the use of first person plural pronouns with the active voice, I focused only on the rhetorical functions of the passive voice. Keeping in mind that Tarone et al. were concerned because they were not able to find any other studies that looked at the rhetorical functions of the passive voice within a whole text, I examined the following questions:

- Was the passive voice becoming more prevalent as so many writers argued?

- Had it been a feature of science writing for the last 300 years that people had overlooked until recently?

- Was it truly a bad stylistic and rhetorical choice, or could it serve useful functions in science writing?

- How exactly was it being used in science writing anyway?

I thought that the results would be relatively straightforward and that the answers would be easy to determine. Instead, I learned that while the ways that writers use the passive voice has indeed changed, it was not such a simple answer. My data showed that writers were not relying more or less on the passive voice as a percentage of overall words. Instead, the ways in which the passive voice was used, and the sections and spaces where it occurred, changed over time in much more subtle ways. It seems that when Gross, Harmon, and Reidy (2002) note that

> [t]he scientific article has evolved, not in the sense of becoming better (or worse), but in the sense of changing to cope with the communicative and argumentative needs of an evolving set of disciplines whose messages have become ever more complex and have, consequently, strained to the utmost the resources inherent in natural language (p. 219),

they could be just discussing the passive voice and how it has changed. My data suggests that the use of the passive voice has <u>not</u> become better or worse, but has evolved as a tool for helping scientists to discuss what they are doing in their experiments. By examining the data from a few different angles, I was able to build a greater understanding of those subtleties and to postulate some of the reasons for why those changes may have occurred.

Overall passive voice findings

I started this study by examining the passive voice as a simple concept; I was concerned with the number of passive voice constructions per total words in each article, which I then grouped by 5-year period. My findings show that the section in which the passive voice occurred most frequently changed over time, with the *Methods* in the 1910s

having the highest percentage (40.69%) of passives from the total number of passives in

that 5-year period, the *Results* in the 1960s having the highest percentage (42.34%) of

passives from the total number of passives in that 5-year period, and the *Discussions* in

the 2000s having the highest percentage (37.18%) of passives from the total number of

passives in that 5-year period. This shift may have been related in part to the change in

the length of the sections over time. In the 1910s, the *Methods* sections were often as

long, if not longer than the other two sections, providing a greater possibility for the

passive voice to occur. However, the *Results* and *Discussion* sections remained about the

same length regardless of 5-year period. If we consider the percentage of passives per

total words for each 5-year period (disregarding the anomaly in the 1960s *Abstracts*

section), the *Methods* always had the highest percentage of passives, 0.5-2 times as high,

depending on the 5-year period. (See Table 31.) The lack of a conclusive answer about

the change in the passive voice over time by section led me to continue searching the data

for answers as to how the passive voice was changing over time.

Table 31: Percentage of passives per total words by section for 5-yr periods

SECTIONS	YEARS		
	1910s	*1960s*	*2000s*
Abstract	N/A	**7.63%**	1.55%
Introduction	2.19%	2.85%	1.91%
Methods	**3.65%**	4.54%	**3.61%**
Results	2.51%	2.46%	1.53%
Discussion	2.24%	1.89%	1.93%
Conclusion	2.16%	N/A	1.81%

While the verbs that occurred most often in each section and each 5-year period

shifted some over time, I was able to identify ten verbs that occurred most frequently in

the overall Methods, Results, and Discussion section within the passive constructions

("made," "found," "initiated," "kept," "observed," "obtained," "placed," "produced,"

"shown," "used"). This led me to wonder if the ways in which those verbs were being used was similar over time or if their usage changed. Most of the verbs on that list, with the exception of "initiated," occurred in multiple research spaces; "initiated" was specific to the *natural process* space. "Made," while not having the largest number of occurrences, did occur in the greatest number of spaces—it was the only verb on the Top 10 list to occur in all nine spaces, indicating that it was utilitarian in function and would most likely show up in scientific writing, regardless of the discipline.

Many of the other verbs in the Top 10 list also appeared to be relatively utilitarian. "Found" occupied six spaces and was only missing from *data*, *prior work*, and *tools*. "Observed," "obtained," "shown," and "used" each occupied five spaces, although they varied as to which spaces they occurred in. These are the verbs that I would also expect to find in many disciplines of scientific writing, as they are utilitarian and make sense for use when writing about science. "Placed" (occurring in four spaces) and "kept" and "produced" (occurring in three spaces each) were less utilitarian in where they could occur, but I would still expect to find them in a number of different scientific disciplines as they could all be used to describe what is occurring.

"Initiated" was an interesting verb to find. I was amazed to find that it only occurred in the *natural process* space and only in the 2000s, but that it occurred often enough to make it onto the overall Top 10 list. I think that this is a niche verb, one that will occur only in certain disciplines of scientific writing. These niche verbs are something that future researchers may choose to search for in different disciplines to determine what sorts of verbs are specific to different hard and natural sciences. It makes sense that a verb such as "initiated" would occur frequently in Botany and other natural

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sciences, because the researchers have to have a way to discuss what is occurring outside of their control and what Nature is accomplishing without their intervention.

Aside from determining the top ten most frequently occurring verbs, I was also able to determine how the use of spaces changed over time. In the 1910s and 1960s, the *research space* was the most frequently used space in all but the *Discussion* sections of the 1960s. In the 2000s, the *natural process* space was the most frequent, most likely due to the use of "initiated," but the *research* space was close behind. In fact, in the *Methods* sections of the 2000s, the *research* space was still the dominant space. The dominance of the passive voice in the *research* space makes sense. Most readers do not want to read, "We did _____," "John and I prepared _____," or "The researchers mixed _____" over and over. By using the passive voice to explain the actions that are occurring during the experiment, the researchers avoid continuously repeating that they were the ones to perform the action. In the cases where the agent mattered, the researchers could choose between the active voice and the full passive as indicated by "*be + verb + -ed + by agent.*"

Had I not chosen to examine the use of spaces, I most likely would not have noticed the *natural process* space, and might have missed finding the niche verb "initiated." As this was one of the most interesting findings, I think that examining the spaces was a valuable choice. Future studies may choose to study the spaces more closely to see what niche verbs occur in different science disciplines, to determine if each discipline has its own niche verbs and to determine what those verbs are.

Full passive (by-phrases) findings

The full passives were another part of the data that I examined. Of the 2,283 passive *be* constructions in my corpus, 228 (or 9.99%) contained a *by*-phrase and were counted as full passives. This is significantly lower than Quirk et al.'s (1999) findings that approximately 20% of sentences in academic writing contain a clear agent. This difference most likely has to do with the types of corpuses that we were using; mine is specific to Botany, whereas Quirk et al. were using a general corpus of English spoken and written texts.

I found it interesting that the full passives showed many of the same results as the Top 10 overall passives did. The *research* space was again the dominant space, with 42.11% of the full passives occurring there. Four of the frequently occurring verbs showed up in both the truncated and full passive sentences ("made," "obtained," "produced," "shown"), again showing the utility of these verbs. They can occur with or without an agent and in multiple spaces making them good choices for researchers to employ.

I was also interested in determining if the use of human and non-human agents in the *by*-phrases changed over time, space, and section. The largest percentage of human agents occurred in the *Methods* sections of the 1960s, with 62.50%, and the largest percentage of non-human agents occurred in the *Discussion* sections of the 2000s, with 55.36%. While I am not sure why the most human agents occurred in the *Methods* of the 1960s, I think that the most non-human agents occurred in the *Discussion* sections of the 2000s because of "initiated." The 2000s *Discussion* sections featured plants and Nature performing many of the actions, so it would make sense that the highest percentage of non-human agents would occur here.

Of the 198 non-human agents in the *by*-phrases, 110 were *concrete* (something that could be physically touched) and 88 were *abstract* (an idea or a process). It makes sense that these two would only have about a 25% difference, since both types of agents work equally well in the sciences. Interestingly, the *Methods* and *Discussion* sections were almost mirror images of each other, with the *Methods* having almost twice as many *abstract* as *concrete* agents, and the *Discussions* having almost twice as many *concrete* agents as *abstract* ones. The *Results*, on the other hand, were more *abstract* in the 1960s and more *concrete* in the 1910s and 2000s, with no discernable reason for the change.

Of the non-human, *abstract* agents in the *by*-phrases, almost half of the overall number were processes, as indicated by an *-ing* verb. The percentage of *abstract* agents that were also processes dropped by about 10% each 5-year period, starting at 61.54% in the 1910s and ending up at 40.00% in the 2000s. The use of *-ing* verbs was highest in the *Methods* sections, which is not surprising as the researchers would need to have a way to describe what they were doing. Using *-ing* verbs makes sense here. The *Results* sections had a large number of *-ing* verbs in the 1910s and 1960s (66.67% and 57.14% respectively), but dropped to 0 in the 2000s. It would be interesting for future studies to examine why this might have occurred, and to see if this is an anomaly in Botany, or if this is a widespread change. The *Discussion* sections had the lowest number of *-ing* verbs overall, having four overall and none in the 1960s. This may be due to what the *Discussion* sections usually contain – information about the results and future work. There would be less need for *-ing* verbs in these sections.

Finally, I found that of the *concrete non-human* agents in the *by*-phrases, 31% of them were *man-made* and 69% of them were *nature*. The *Methods* sections contained

slightly more *man-made* agents than *nature* agents, whereas the *Results* and *Discussion*

sections contained almost two times more and almost eight times more *nature* agents than

man-made agents, respectively. The *Methods* sections most likely have more *man-made*

than *nature* agents due to the subject matter being discussed. It is in the *Methods* sections

that the researchers discuss what they are doing to perform the experiments and what

sorts of tools are needed. In these instances, it makes sense that the *man-made* would

outweigh the *nature* agents. It also makes sense that the *nature* would outweigh the *man-*

made agents in the *Results* and *Discussion* sections (although without the use of

"initiated" I would not expect there to be such a large difference in the percentages in the

Discussions), as these are the sections where the experimental results are presented and

where general discussion about the plants occurs.

Response to the two camps

As mentioned at the beginning of this study, there are two major camps in the

debate about passive voice, those who think that passive voice serves a purposeful

function in scientific writing, and those who think that passive voice should be banished

forever. I think that these results begin to show some of the ways in which the passive

voice does serve a purposeful function in scientific writing. The percentage of passive

voice shifted from being the greatest in the *Methods* of the 1910s, to being the greatest in

the *Results* of the 1960s, to being the greatest in the *Discussions* of the 2000s, which may

indicate a greater preference for the use of the passive voice when discussing how things

are occurring in nature. I believe that this is supported by the use of "initiated" to discuss

what is occurring outside of human influence. It makes more sense to write "the sepals were initiated" than it does to say "the plants initiated the growth of the sepals."

The use of spaces to define when and how the past participles are being used within the passive voice constructions also appears to be a good indicator of the passive being used purposefully. I think that finding some verbs such as "kept" and "produced" that only occurred in three spaces each suggests that writers are at least somewhat aware of how to use certain verbs in specific situations in order to best present information to their audience. If all of the verbs were like "made" and appeared in all or most of the spaces, this would indicate to me that writers were not aware of the purposeful nature of language use. The fact that the *research* space was usually the most prevalent space for the passive voice to occur also suggests that writers have an understanding of when their audience might expect to find the active voice and when their audience might not mind finding the passive voice.

The findings about the *by*-phrases occurring in only 10% of the passives also seems to show a purposeful use of the passive. When the audience needs to know who performed an action, writers have the option if using the active or using a full passive. The use of a full passive instead of the active voice may indicate an understanding of the audience's need for an agent while still foregrounding the "what" that the audience might be most interested in.

It seems that the camp seeking to vilify the passive voice without taking into account the ways that it can be used purposefully may be missing the point. Poor writing can occur with or without the passive voice, and assuming that writers are writing poorly just because they are using the passive voice seems unfair. Instead, it would seem to

make more sense to have further studies into how and why the passive is being used so that critics could get to the heart of the problem (bad writing) and stop condemning passive voice outright.

Limitations of this study and future research

Examining both the full and truncated passives led me to better understand the use of the passive voice in the *American Journal of Botany* and allowed me to learn about the use of niche verbs such as "initiated" and how/why agents are used at all with the passive voice. One of the limitations of this study is that I only examined a small sample of articles within one discipline and one journal. This works well for a pilot study, but further work will need to be done to see if these results can apply to the overall sciences. A larger study examining journal articles from multiple professional journals in multiple science disciplines would allow for more generalized conclusions to be drawn about the use of the passive voice and how it has changed over time. A larger study could also help to balance out much of the anecdotal knowledge that writers pass on about the prevalence of the passive voice.

Another study that would be interesting to run would be one that examined both pre-edited and post-printed versions of the articles to determine if writers start out using more or less passive voice before the journal editors become involved. This would allow for a further understanding of how Gross' (1996) selection theory plays into how researchers write with regard to the passive voice. Do outside pressures from editors and reviewers cause a change in the use of voice? Examining writing from researchers at

multiple stages in their careers would further help to determine if selection pressures change how researchers write at different stages in their careers.

Recommendations to English teachers

If the use of passive voice is considered to be a dominant norm in published scientific writing, but scientists are counseled by some authorities and teachers to avoid the passive voice whenever possible, scientists might begin to wonder why the passive voice is thought to be bad even though it is often used to write about experiments. It would seem that what is being taught in writing classes does not always agree with common practice. If this is the case, as writing teachers, maybe we need to reassess how and why we are teaching our science students to write their research papers. I think that this study begins to show where, when, why, and how the passive voice can be used effectively to convey experimental ideas in the least convoluted way. This study also begins to explain why the passive voice might work in some instances but not in others, and why the passive voice is not necessarily a way for the researcher to hide, but is instead a way for the researcher to avoid being repetitive when reporting how the experiment was accomplished.

I have heard anecdotal stories that would indicate that the use of the passive voice in science writing is getting worse and read many articles that indicate the use of passive voice is a bad thing and that writers should exert every effort to remove from their writing. Yet, there are few studies that show anything about how the use of passive voice has changed over time in any discipline. Given that this seems to be one of the myths that circulates and is passed down from mentor to student, it seems that this study might

be a good way of trying to explain <u>why</u> the use of passive voice is not necessarily a bad thing and that the use of passive voice, while changing over time, has not become so dominant as to ruin science writing.

As teachers of writing, we need to pay attention to how the passive voice can be used well. In order for us to be able to teach our students about using language to their benefit, we need to understand that each discourse community has its own ways of using language to produce a desired result. Instead of telling our students that the passive voice always has been and always will be the choice of poor writers, we need to be able to explain to our students why the passive voice might be better for some situations than for others. Our students need to know that we practice what we teach. How can we expect our students to be willing to learn how to write for different audiences if we ourselves are not willing to understand how to teach to students in different disciplines. While it may not be an easy transition for us to make, and while it may require us to step outside of teaching what we have become comfortable with, it seems that by failing to change our understanding of the usefulness of the passive voice, we are doing a disservice to both our students and to ourselves. We are closing ourselves off to a critical understanding of the power of language choice in helping a reader to understand information in a particular way. Students who begin to understand the power that language has over their message can work to become stronger writers and can have a better chance of having their work read by others in their fields.

Classroom Practices

Talking about working with students to help them become better writers is wonderful; putting this into practice can be a bit harder. To that end, I think that we can

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give some of the work back to the students by requiring them to talk with professors in their major so that they can find a couple of articles that are well-written as a way to begin looking at how the passive voice is used in real-world writing. If students have sample articles that are well-written, we can then have them focus in on specific sections, such as the *Methods* section, to see how the author is using the passive voice. Using the spaces that I defined (*citation, fact, natural process, prior work, research, data, hypothetical, tools,* and *textual*), teachers could have students look for specific examples of how each space is used in each section of the sample articles. Are certain spaces more likely to occur in the *Methods* or the *Discussion*? If so, how can students take what they have found and use that in their own writing? Students could also look for agents in the passive voice sentences. How often are agents used and for what purposes? Are they human or non-human? Are they referring to processes, ideas, physical objects, etc? If the sentences have agents, could they be written more clearly in the active voice, or would using the active voice make the sentences more confusing? By having students focus on small sections of larger articles and having them identify these sorts of features in articles that discourse community insiders consider to be well written, teachers can help students to gain a working knowledge of good writing practices in their fields. Trying to teach grammar to students who do not always see the value in such knowledge can be a difficult task. But, if the grammar lessons are more practical than theoretical, students might be better able to internalize the information and might not feel as though they were learning English rules simply for the sake of passing an English course.

Another idea for teaching students about good writing practices with the passive voice involves an exercise in writing for multiple audiences. This would most likely

come after students had already begun to identify the spaces where the passive was most likely to occur, as it would seem to make more sense for students to have an understanding of what to look for before they moved on to their own writing. For this assignment, teachers could have students use a lab write-up from a science course as the basis for learning how to write for multiple audiences. For the first audience, students could write about the experiment and the findings for another scientist. What sorts of language choices would they make? If the students were the only ones involved in the experiments, how often would agents need to be involved? Would the agent be obvious in some cases, and therefore not need to be mentioned? If an agent was involved, would the active or passive voice make the writing clearer? Questions such as these give students an outline of things to focus on while writing, helping to keep the assignment from becoming overwhelming.

After writing the experiment for an audience of scientists, next have the students write the same information while focusing on a different audience – this time a popular culture magazine or paper such as *Time* or the *New York Times*. How would the language choices differ in a popular article? What sorts of language features would average readers expect to find in an article about an experiment? In order to prepare for this portion of the assignment, teachers could see if they could find an example of an article written for a niche science journal and a popular culture write-up of the same information. Students could then have an idea of what to look for in their own writing, based on how the example articles changed for their different audiences.

By giving students good models to look at, going through those models and explaining the features so that students know what to look for, and then requiring the

students to perform their own writing, teachers have a better opportunity to explain how and when to use the passive voice than if they just give worksheets on changing passive voice sentences to the active voice. Teaching rules without requiring any sort of practical writing merely helps to ensure that students will not take away much from discussions of grammar. It seems that part of the problem with existing style guides is that they do just that, they give rules for when to use the active or passive voice without taking into account much about the realities of writing. Style guides seem to focus on the concept that language use is black and white, that rules cannot be broken. Instead of continuing down that path, teachers should be willing to break out of the concept of hard and fast rules so that they can work on teaching students the nuances of language use.

While this is only a pilot study, further research into this topic could form a stronger basis for understand the purpose and use of the passive voice, without condemning it outright. My hope is that future work will help to build a database of the uses of passive voice that students, teachers, and real-world researchers can turn to as a way to understand how to use the passive voice most effectively, without letting it become a crutch for obscuring information or for bad writing practices.

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APPENDICES

Appendix A

Tables A1-A10 show each of the top ten overall verbs from the corpus broken down into their different phrasal units (i.e., **found** to, **found** in, **found**, etc.), spaces (*citation*, *fact*, *natural process*, *research*, *data*, *hypothetical*, *tools*, *textual*), and the section where they occurred. The far right column, "Total # of occurrences," is for that particular phrasal unit and takes into account the "Frequency by space-type" counts.

Table A1: "Found" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
1	**found**					**101**
		all **found** on	research	Results	1	*1*
		also **found** in	research	Discussion	1	*1*
		also **found** with	natural process	Results	1	*1*
		already **found** to be	natural process	Methods	1	*1*
		always **found**	research	Discussion	1	*1*
		commonly **found**	fact	Discussion	1	*1*
		easily **found** in	research	Discussion	1	*1*
		ever **found** in	fact	Results	1	*1*
		found	citation	Methods	2	*40*
				Discussion	2	
			hypothetical	Discussion	1	
			natural process	Methods	1	
			research	Methods	8	
				Results	19	
				Discussion	7	
		found also	research	Results	1	*1*
		found at	citation	Discussion	1	*2*
			research	Results	1	
		found by	citation	Results	1	*2*
			textual	Results	1	
		found from	research	Results	1	*1*
		found in	citation	Discussion	4	*15*
			fact	Discussion	1	
				Results	1	
			research	Methods	3	
				Results	2	
				Discussion	4	
		found on	fact	Results	1	*5*
			research	Methods	1	
				Results	3	

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
		found that	citation	Results	1	*6*
			research	Methods	4	
				Results	1	
		found throughout	research	Methods	1	*1*
		found to	research	Methods	1	2
				Discussion	1	
		found to be	citation	Discussion	3	9
			research	Methods	2	
				Results	3	
				Discussion	1	
		found to have	research	Methods	1	2
				Results	1	
		however **found**	research	Methods	1	1
		not **found**	research	Methods	1	1
		not **found** to	research	Results	1	1
		often **found**	natural process	Discussion	1	1
		only **found** in	research	Results	1	1
		sometimes **found**	research	Discussion	1	1
		soon **found** that	research	Methods	1	1

Table A2: "Used" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
2	**used**					74
		not **used**	research	Methods	1	*1*
		so **used** in	prior work	Results	1	*1*
		therefore **used** in	research	Results	1	*1*
		occasionally **used**	research	Methods	1	*1*
		successfully **used**	citation	Methods	1	*1*
		used:	research	Methods	2	*2*
		used	citation	Results	1	*25*
				Discussion	1	
			data	Results	1	
			natural process	Results	1	
			prior work	Methods	1	
				Results	1	
			research	Methods	17	
				Results	1	
				Discussion	1	
		used as	data	Results	1	*6*
			research	Results	2	
				Methods	3	
		used at	research	Results	1	*1*
		used by	citation	Methods	2	*3*
			prior work	Methods	1	
		used for	natural process	Discussion	1	*10*
			research	Methods	7	

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Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
				Results	2	
		used in	citation	Methods	1	*11*
			prior work	Discussion	1	
			research	Methods	8	
				Results	1	
		used throughout	research	Methods	2	*2*
		used to	research	Methods	8	*8*
		used up	citation	Methods	1	*1*

Table A3: "Made" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
3	made					68
		all **made** in	data	Methods	1	*1*
		either **made** in	research	Methods	1	*1*
		made	fact	Methods	1	*12*
			natural process	Discussion	1	
			research	Methods	5	
				Results	1	
			textual	Methods	1	
			tools	Methods	3	
		made are	research	Methods	1	*1*
		made at	research	Methods	1	*2*
				Results	1	
		made by	citation	Discussion	1	*10*
			research	Methods	3	
				Results	2	
			textual	Methods	1	
			tools	Methods	3	
		made for	citation	Discussion	1	*1*
		made from	research	Methods	2	*4*
				Results	2	
		made in	data	Results	1	*10*
			research	Methods	4	
				Results	1	
			tools	Methods	4	
		made of	data	Discussion	1	*2*
			tools	Methods	1	
		made on	research	Results	2	*2*
		made out	research	Results	1	*1*
		made to	citation	Methods	1	*14*
			hypothetical	Results	1	
			prior work	Discussion	2	
			research	Methods	3	
				Results	5	
			textual	Results	1	
			tools	Methods	1	

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Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
		made up	research	Methods	1	*1*
		made upon	research	Methods	1	*1*
		made using	tools	Methods	2	*2*
		then **made** in	research	Methods	1	*1*
		then **made**	research	Methods	1	*1*
		therefore **made** at	research	Methods	1	*1*

Table A4: "Placed" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
4	placed					55
		all **placed** during	research	Results	1	*1*
		all **placed** in	research	Methods	1	*1*
		being **placed** in	research	Methods	1	*1*
		first **placed**	research	Discussion	1	*1*
		immediately **placed** on	research	Methods	1	*1*
		often **placed** in	prior work	Discussion	1	*1*
		placed	research	Methods	3	*3*
		placed at	research	Results	1	*1*
		placed between	research	Methods	1	*2*
			tools	Methods	1	
		placed in	citation (in a quote)	Methods	1	*20*
			research	Methods	17	
				Discussion	1	
			tools	Methods	1	
		placed into	research	Methods	1	*1*
		placed on	research	Methods	4	*8*
				Results	3	
				Discussion	1	
		placed under	research	Methods	2	*2*
		placed upon	research	Methods	1	*1*
		subsequently **placed** in	research	Results	1	*1*
		then **placed** in	research	Methods	7	*7*
		then **placed** over	research	Methods	1	*1*
		then **placed** under	research	Methods	2	*2*

Table A5: "Obtained" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
5	**obtained**					**42**
		finally **obtained** in	research	Methods	1	*1*
		obtained	citation	Discussion	1	*13*
			data	Methods	1	
			natural process	Discussion	1	
			research	Methods	4	
				Results	4	
				Discussion	1	
			tools	Results	1	
		obtained as	tools	Methods	1	*1*
		obtained at	citation	Discussion	1	*1*
		obtained by	research	Methods	3	*5*
			data	Results	2	
		obtained for	data	Methods	1	*1*
		obtained from	research	Methods	4	*7*
			tools	Methods	3	
		obtained in	research	Methods	3	*5*
				Results	1	
				Discussion	1	
		obtained of	research	Results	1	*1*
		obtained on	research	Results	2	*2*
		obtained upon	research	Discussion	2	*2*
		obtained using	research	Methods	1	*2*
				Discussion	1	
		of course, easily **obtained**	research	Methods	1	*1*

Interestingly, "initiated," shown below in Table A6, is the only verb that occupies only one space—*natural process*. This is also the only verb to appear in only one of the three 5-year periods—2000s. Due to its dominance in the *natural process* category, I wondered if this verb might be specific to the natural sciences because it gives a way for the authors to discuss what the plants are doing without invoking an actor other than Nature. As the researchers themselves can have no control over how the plant might normally act, form, or grow, the only actor can be the plant itself (or Nature) itself.

Table A6: "Initiated" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
6	**initiated**					**39[a]**
		also **initiated** in	natural process	Discussion	1	*1*
		always **initiated** in		Results	1	*1*
		first **initiated**		Results	1	*1*
		initiated		Meth	1	*8*
				Results	4	
				Discussion	3	

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
		initiated after		Results	5	*6*
				Discussion	1	
		initiated as		Results	1	*1*
		initiated before		Results	4	*5*
				Discussion	1	
		initiated by		Methods	1	*1*
		initiated first		Results	1	*1*
		initiated in		Methods	2	*4*
				Results	1	
				Discussion	1	
		initiated later		Results	1	*1*
		initiated on		Methods	4	*4*
		initiated when		Results	3	*3*
		not **initiated**		Discussion	1	*1*
		not **initiated** in		Discussion	1	*1*

[a] All occurrences of *initiated* are in the 2000s, with 1 instance in the Methods, 29 in the Results, and 8 in the Discussions.

Table A7: "Observed" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
7	**observed**					**39**
		also **observed**	research	Discussion	1	*1*
		frequently **observed** in	research	Results	1	*1*
		not **observed** in	research	Results	1	*2*
			textual	Results	1	
		observed	prior work	Discussion	1	*14*
			research	Methods	2	
				Results	9	
				Discussion	2	
		observed after	prior work	Results	1	*2*
			research	Results	1	
		observed at	research	Results	2	*2*
		observed for	research	Results	1	*1*
		observed in	citation	Discussion	2	*11*
			fact	Discussion	1	
			research	Results	6	
				Discussion	2	
		observed on	research	Results	1	*1*
		observed to	citation	Discussion	1	*2*
			research	Methods	1	
		often **observed** on	citation	Discussion	1	*1*
		readily **observed**	research	Discussion	1	*1*

Table A8: "Shown" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
8	**shown**					**30**
		always **shown** at	research	Results	1	*1*
		also **shown**	research	Discussion	1	*1*
		also **shown** in	textual	Results	1	*2*
				Discussion	1	
		clearly **shown** by	textual	Discussion	1	*1*
		shown	textual	Results	2	*2*
		shown by	citation	Results	1	*13*
				Discussion	3	
			natural process	Discussion	3	
			prior work	Results	1	
			research	Methods	2	
				Discussion	2	
			textual	Results	1	
		shown however	natural process	Discussion	1	*1*
		shown in	textual	Results	2	*4*
				Discussion	2	
		shown it	research	Results	1	*1*
		shown on	textual	Results	1	*1*
		shown that	research	Discussion	1	*2*
			textual	Discussion	1	
		shown to be	research	Results	1	*1*

Table A9: "Produced" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
9	**produced**					**29**
		also **produced** by	natural process	Discussion	1	*1*
		not **produced**	natural process	Results	1	*1*
		not **produced** by	citation	Discussion	1	*1*
		produced	natural process	Methods	1	*15*
				Results	9	
				Discussion	3	
			research	Results	2	
		produced at	natural process	Results	1	*1*
		produced between	natural process	Results	1	*1*
		produced by	natural process	Discussion	2	*4*
			research	Results	2	
		produced in	natural process	Results	1	*3*
				Discussion	2	
		produced upon	natural process	Discussion	1	*1*
		usually **produced**	natural process	Results	1	*1*

Table A10: "Kept" verb broken down into units and "space"

Rank	Verb	Phrasal Units	Space	Section	Frequency by space-type	Total # of occurrences
10	**kept**					**25**
		all **kept** in	research	Methods	1	*1*
		kept	research	Methods	4	*6*
				Discussion	1	
			tools	Methods	1	
		kept at	research	Methods	3	*4*
			tools	Methods	1	
		kept in	research	Methods	11	*13*
				Results	1	
			textual	Discussion	1	
		kept under	research	Methods	1	*1*

Appendix B

Table B1 shows the spaces that the top ten verbs occupy along with the number of occurrences of each. A few points of interest in this table:

1) The verb "placed" is used as a *citation* space, but only within the confines of a quote from an outside source. This is the only time that one of the top 10 verbs occurs within a quote.
2) "Initiated" only occupies the *natural process* space. This is the only top 10 verb to occupy only one space.
3) "Made" is the only verb to occur in all nine spaces. "Found," "Observed," "Obtained," "Shown," and "Used" come in next, appearing in five of the nine spaces, followed by "Placed" appearing in four of the nine spaces. "Produced" appears in three of the nine spaces and "Kept" appears in three of the nine spaces.
4) All of the verbs, show up in all three sections, even if only briefly.

Table B1: Spaces for the top ten verbs, by section and by verb

Space	Article Sections		
	Methods	*Results*	*Discussion*
Citation	found (2)	found (2)	found (10)
	made (1)		made (2)
			observed (4)
			obtained (2)
	placed (1)		
			produced (1)
		shown (1)	shown (3)
	used (5)	used (1)	used (1)
Fact		found (3)	found (2)
	made (1)		
			observed (1)
Natural process	found (2)	found (1)	found (1)
	initiated (8)	initiated (22)	initiated (9)
			made (1)
			obtained (1)
	produced (1)	produced (14)	produced (9)
			shown (4)
		used (1)	used (1)

Space	Article Sections		
	Methods	*Results*	*Discussion*
Prior work			made (2)
		observed (1)	observed (1)
			placed (1)
		shown (1)	
	used (2)	used (2)	used (1)
Research	found (24)	found (35)	found (17)
	kept (20)	kept (1)	kept (1)
	made (24)	made (15)	
	observed (3)	observed (22)	observed (6)
	obtained (17)	obtained (8)	obtained (5)
	placed (42)	placed (6)	placed (3)
		produced (4)	
	shown (2)	shown (4)	shown (3)
	used (49)	used (8)	used (1)
Data	made (1)	made (1)	made (1)
	obtained (2)	obtained (2)	
		used (2)	
Hypothetical		made (1)	found (1)
Tools	kept (2)		
	made (15)		
	obtained (4)	obtained (1)	
	placed (2)		
Textual		found (1)	
			kept (1)
	made (2)	made (1)	
		observed (1)	
		shown (7)	shown (5)

Table B2 shows the spaces and article sections by 5-yr period, examining which verbs appeared in each block. The spaces are in bold at the top of each box, followed by the verbs and frequencies for each section and 5-year period. It is interesting to note that "found," "made," "observed," "obtained," "placed," and "used" are all used in the *research* space in all three 5-year periods.

Table B2: Most frequently occurring spaces, by section and by verb, for each 5-year period

5-yr period	Article Sections		
	Methods	*Results*	*Discussion*
1910s	**citation** found (2) made (1) placed (1) used (2)	**citation** found (1) shown (1)	**citation** found (3) made (1) shown (3)
	data made (1) obtained (2)	**data** made (1) obtained (2)	

5-yr period	Article Sections		
	Methods	*Results*	*Discussion*
	fact made (1)	**fact** found (3)	
			hypothetical future found (1)
	natural process found (2) produced (1)	**natural process** produced (12)	**natural process** found (1) obtained (1) produced (6) shown (4)
	prior work used (2)	**prior work** shown (1) used (2)	**prior work** made (2)
	research found (23) kept (19) made (21) observed (2) obtained (15) placed (38) shown (2) used (36)	**research** found (29) kept (1) made (12) observed (8) obtained (6) placed (5) produced (4) shown (4) used (3)	**research** found (13) kept (1) placed (2) obtained (4) shown (3) used (1)
	textual made (1)	**textual** found (1) made (1) shown (5)	**textual** kept (1) shown (4)
	tools kept (1) made (12) obtained (2) placed (2)	**tools** obtained (1)	
1960s	**citation** used (3)	**citation** found (1) used (1)	**citation** observed (1) obtained (2) produced (1)
		data used (2)	**data** made (1)
		hypothetical future made (1)	
		natural process produced (2)	**natural process** produced (2)
		prior work observed (1)	**prior work** observed (1) used (1)

5-yr period	Article Sections		
	Methods	*Results*	*Discussion*
	research found (1) made (2) observed (1) obtained (1) placed (1) used (5) **textual** made (1) **tools** made (1) obtained (1)	**research** found (5) made (3) observed (4) obtained (2) placed (1) used (4) **textual** observed (1) shown (2)	**research** found (1) observed (1)
2000s	**natural process** initiated (8) **research** kept (1) made (1) obtained (1) placed (3) used (8) **tools** kept (1) made (2) obtained (1)	**natural process** found (1) initiated (22) used (1) **research** found (1) observed (10) used (1)	**citation** found (7) made (1) observed (3) used (1) **fact** found (2) observed (1) **natural process** initiated (9) made (1) produced (1) used (1) **prior work** placed (1) **research** found (3) observed (5) obtained (1) placed (1) **textual** shown (1)

Appendix C

Table C1 gives the article sections, along with the semantic roles and the spaces, by 5-year period. The *space frequency* column shows the number of occurrences of that particular space in the section, and the *semantic role* column shows how many of the agents were *agentive* and how many were *instruments*.

Table C1: Spaces and semantic roles for the *by*-phrases, by 5-yr period and by section

5-yr period	Article Sections						
		Methods		*Results*		*Discussion*	
	Space	*Space frequency*	*Semantic role*	*Space frequency*	*Semantic role*	*Space frequency*	*Semantic role*
1910s	citation	3	agentive (3)	2	agentive (2)	11	agentive (10) instrument (1)
	data			2	instrument (2)		
	fact	3	agentive (2) instrument (1)	4	instrument (4)	1	agentive (1)
	natural process	11	agentive (6) instrument (5)	9	agentive (8) instrument (1)	6	agentive (6) instrument (10)
	prior work	2	agentive (2)	1	agentive (1)		
	research	28	agentive (3) instrument (25)	15	agentive (2) instrument (13)	10	agentive (5) instrument (5)
	textual			5	agentive (1) instrument (4)	1	agentive (1)
	tools	9	agentive (2) instrument (7)				

5-yr period	Article Sections						
		Methods		Results		Discussion	
	Space	*Space frequency*	*Semantic role*	*Space frequency*	*Semantic role*	*Space frequency*	*Semantic role*
1960s	*citation*	5	agentive (5)	1	agentive (1)	1	agentive (1)
	data			1	instrument (1)		
	fact			1	instrument (1)		
	natural process			2	agentive (1)	4	agentive (2)
					instrument (1)		instrument (2)
	prior work			1	agentive (1)	4	
							instrument (4)
	research	6		7	agentive (1)	1	
			instrument (6)		instrument (6)		instrument (1)
	tools	1	instrument (1)	1	instrument (1)		
2000s	*citation*	1	agentive (1)			2	agentive (2)
	data	2	instrument (2)				
	fact	1	agentive (1)			1	
							instrument (1)
	hypothetical					1	instrument (1)
	natural process	1	agentive (1)	13	agentive (3)	32	agentive (9)
					instrument (13)		instrument (23)
	research	6		10	agentive (1)	16	agentive (1)
			instrument (6)		instrument (9)		instrument (15)
	textual					1	instrument (1)
	tools	2	instrument (2)				

VITA

Laura Marie Dumin

Candidate for the Degree of

Doctor of Philosophy

Dissertation: CHANGES IN THE USE OF THE PASSIVE VOICE OVER TIME: A

HISTORICAL LOOK AT THE *AMERICAN JOURNAL OF BOTANY* AND THE

CHANGES IN THE USE OF THE PASSIVE VOICE FROM 1914-2008

Major Field: English

Biographical:

Education:
Completed the requirements for the Doctor of Philosophy in English at Oklahoma State University, Stillwater, Oklahoma in July, 2010.

Completed the requirements for the Master of Science in English at Radford University, Radford, Virginia in May, 2001.

Completed the requirements for the Bachelor of Arts in Interdisciplinary Studies at Virginia Tech, Blacksburg, Virginia in May, 1999.

Experience:
TA – OSU English Department   Aug 2004 – May 2010

AD – Technical Writing, English, OSU   June 2005 – May 2009

Name: Laura Marie Dumin   Date of Degree: July, 2010

Institution: Oklahoma State University   Location: Stillwater, Oklahoma

Title of Study: CHANGES IN THE USE OF THE PASSIVE VOICE OVER TIME: A

HISTORICAL LOOK AT THE *AMERICAN JOURNAL OF BOTANY* AND THE

CHANGES IN THE USE OF THE PASSIVE VOICE FROM 1914-2008

Pages in Study: 148   Candidate for the Degree of Doctor of Philosophy

Major Field: English

Scope and Method of Study: This study looks at 15 articles from the *American Journal of Botany* – 5 articles from 1914-1918, 5 articles from 1962-1966, and 5 articles from 2004-2008 – to determine if and how the use of the passive voice has changed over time.

Findings and Conclusions: The ways in which the passive voice was used, and the sections (*Methods, Results, Discussion*) and spaces where it occurred (categories into which the verbs fit, *Citation, Fact, Natural processes, Prior work, Research, Data, Hypothetical, Tools, Textual*), changed in subtle ways over time. The findings show that the section in which the passive voice occurred most frequently changed over time, with the *Methods* in the 1910s having the highest percentage (40.69%) of passives in that 5-year period, the *Results* in the 1960s having the highest percentage (42.34%) of passives in that 5-year period, and the *Discussions* in the 2000s having the highest percentage (37.18%) of passives in that 5-year period.

Certain verbs were more likely to occur than others in this corpus, leading to some interesting findings. "Initiated" was an interesting verb to find, as it occurred only in the *natural process* space and only in the 2000s. I think that this is a niche verb, one that will occur only in certain disciplines of scientific writing.

The full passives were another part of the data that I examined. Of the 2,283 passive *be* constructions in the corpus, 228 (or 9.99%) contained a *by*-phrase and were counted as full passives.

The data suggests that the use of the passive voice has <u>not</u> become better or worse, but has evolved as a tool for helping scientists to discuss what they are doing in their experiments.

ADVISER'S APPROVAL: Dr. Richard Batteiger