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Solving for Nonsense: Mathematics and Lewis Carroll's Linguistic Play in the Alice Books

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Solving for Nonsense:

Mathematics and Lewis Carroll's Linguistic Play in the *Alice* Books

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Thank you

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And to my friends for tolerating my madness and over use of the word "nonsense" during this process.

How doth the little mathematician

Improve his silly rhymes,

And prove himself a true logician

A half a dozen times.

How carefully he seems to write,

How neatly crafts his poems,

And weaves his tales with such delight

With deftly hidden sums!

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Introduction

Alice climbs through the looking-glass.

Lewis Carroll wrote the following letter to his fourteen-year-old child friend Wilton Rix:

Honoured Sir,

Understanding you to be a distinguished algebraist (i.e. distinguished from other algebraists by different face, different height, etc.), I beg to submit to you a difficulty which distresses me much.

If x and y are each equal to "1," it is plain that $2 \times (x^2 - y^2) = 0$,

and also that $5 \times (x - y) = 0$.

Hence $2 \times (x^2 - y^2) = 5 \times (x - y)$.

Now divide each side of this equation by $(x - y)$.

Then $2 \times (x + y) = 5$.

But $(x + y) = (1+1)$, i.e. $= 2$.

So that $2 \times 2 = 5$.

> Ever since this painful fact has been forced upon me, I have not slept more than 8 hours a night, and have not been able to eat more than 3 meals a day.
>
> I trust you will pity me and will kindly explain the difficulty to
>
> Your obliged, Lewis Carroll. (Wilson 108)

Why would a famed writer of children's literature send a letter primarily concerning a mathematical proof to one of his child friends? It seems odd that an author would not send a poem or short story instead, but Carroll was not just an author. His trade of choice was mathematics, which he taught at Christ's Church, Oxford. In addition to his playful works of fiction he also published many works on mathematics and logic, though most of these were produced under his real name, Charles Lutwidge Dodgson.

Let me take a moment to assure you that two times two does not equal five. At first glance (and, in my case at least, second, and third), this logic looks sound. Carroll appears to be following the rules of mathematics, but in reality he cheats. By dividing by $(x - y)$ he is dividing by (1-1), meaning he is dividing by zero. This is an illegal move in mathematics. Dividing by zero causes a function to become undefined. Carroll, who was unquestionably very familiar with this rule, plays with the way in which he arranges his proof in order to perplex and amuse his young friend. This trick slips by undetected because Carroll first assigns values to x and y, and then allows them to return to being arbitrary values, thus side stepping the division issue.

Unsurprisingly, I am hardly the first to consider Carroll's most famous works, *Alice's Adventures in Wonderland* and *Through the Looking-glass and What Alice Found There*, with respect to mathematics. Though my research has only reinforced my presumption that it has hardly been a popular topic of study[1], two critics stand out for their mathematical interpretations: Helena Pycior and Melanie Bayley. Both women propose similar theories. Pycior claims that the *Alice* books embody Carroll's "misgivings about symbolic algebra, the major British contribution to mathematics of the first half of the nineteenth century" (Pycior 149). She theorizes that "the roots of his nonsense verse may also be in symbolic algebra, which stressed in mathematics structure over meaning" (149). While this may be an apt description of Carroll's nonsense, Pycior fails to sufficiently explain how symbolic algebra differed from the math commonly practiced before its creation. Much of her description of symbolic algebra can also serve as a description for much older areas of mathematics. Pycior's focus is not on how Carroll's mathematical background helps shape his nonsense, but rather how his nonsense serves as mathematical critique by showing how emphasizing structure over meaning leads to confusion. She introduces her paper with a quote from Augustus De Morgan's précis of symbolic algebra. It is unclear exactly how much of his work and the new mathematics Carroll was really at odds with. For De Morgan "the symbols represented numbers, but *unspecified* numbers, so that reasoning about them applied to any particular numbers" (Cooke 543). This was not an approach Carroll was uncomfortable with, as seen by his notes on Euler[2]. I will not wholly dispute Pycior's claim that Carroll was a rather conservative mathematician, but I will point out that this may be caused not entirely by discomfort with the contemporary advances in mathematics, but because he was primarily a teacher, not a researcher, and preferred to pursue his "mathematical interests in a solitary

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[1] As Bayley says, "the critical literature focused mainly on Freudian interpretations of the book as a wild descent into the dark world of the subconscious."
[2] For example, see page 70, Proposition A of *The Pamphlets of Lewis Carroll: Volume 2*.

fashion" (Dodgson 3). Most of his mathematical publications concerned "the teaching of students" or reflected "his personal interests" (3).

Bayley also makes claims about Carroll's nonsense and new theories of mathematics. However, she does not lean heavily on the presumption that symbolic algebra is being critiqued throughout *Wonderland* and *Looking-glass*. She quotes more specific mathematical theories she believes are being critiqued. She ventures that *Alice in Wonderland* contains "satire of [Carroll's] contemporary mathematicians" (Bayley), and believes that this criticism is part of what inspired the addition of some of the scenes added to *Alice's Adventures Underground*[3] for mass publication. Whether Carroll inserted any intentional criticism of contemporary mathematical advances in the *Alice* books cannot be determined with certainty, but Carroll himself admitted he might have put much in these books without realizing it. As he said, "Words mean more than we mean to express when we use them: so a whole book ought to mean a great deal more than the writer meant" (*Nonsense, Sense, and Meaning* 18).

Important to this thesis is not just a discussion of criticisms of mathematics and the *Alice* books, but also examinations of Nonsense literature in general. In my research the three critical sources that have stood out as authorities on the subject are Susan Stewart's *Nonsense*, Jean-Jacques Lecercle's *Philosophy of Nonsense*, and Elizabeth Sewell's *The Field of Nonsense*. Stewart defines nonsense against "common sense" and claims the operations that transform common sense into nonsense "stand in a paradoxical relationship to common sense" (Stewart viii). She stresses that nonsense deals with inversion. Lecercle claims that nonsense is a "conservative-revolutionary genre" (Lecercle 2). It is "respectful of

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[3] *Alice's Adventures Underground* was the version that Carroll wrote and presented to Alice Liddell. Some of the scenes missing from *Underground* that appear in *Wonderland* include the Cheshire Cat, Mad Tea Party, and the Duchess.

authority in all forms: rules of grammar, maxims of conversation...," but it is "inextricably mixed with the opposite aspect…where rules and maxims appear to be joyously subverted" (2-3). He says, "the genre is structured by the contradiction… between over-structuring and destructuring, subversion and support" (3). Sewell says that nonsense can be described as "a collection of words or events which in their arrangement do not fit into some recognized system in a particular mind" (Sewell 3). She proposes a reading of nonsense as a type of play and compares nonsense to a game that "is an enclosed whole, with its own rigid laws which cannot be questioned within the game itself; if you put yourself inside the system which is the game, you bind yourself by that system's laws...." (25-26).

So nonsense depends on recognized structure, but then contradicts the expected outcome of following that structure. Carroll often chooses structures that can be linked to his relationship with mathematics and logic. The ways in which he contradicts the expected outcomes of those structures can also be linked to mathematics. Even though Carroll's letter to Wilton Rix does not contain quite the same level of playful nonsense that the author is known for, it still serves as a good example of how Carroll approaches the formation of his nonsense. The letter has two forms of nonsensical play. The first is in the proof. The proof is nonsense because while it follows acceptable mathematical rules, the result contradicts one of our most basic mathematical assumptions (that two times two *always* equals four) and therefore seems to result in paradox, or it does unless you catch Carroll's trick. He breaks the rules of the game and does not tell anybody. It is also paradoxical because this method of mathematical deduction would hold true for other numbers that didn't require one to divide by zero, but this is the exception.

Linguistically this is nonsense too. The concluding sentence is set up to prompt the reader to expect that Carroll got little sleep and ate little after he learned that two times two equaled five. This is easier to see if one removes the words that contradict this expectation. If one removes these the sentence will look like this: “Ever since this painful fact has been forced upon me, I have not slept more than *x* hours a night, and have not been able to eat more than *y* meals a day.” The meaning of the words surrounding the numbers imply that Carroll has slept and ate little, but the numbers he supplies imply that he has been sleeping and eating a healthy amount. The structure of the sentence makes the reader anticipate one thing, but the numbers Carroll plugs in implies the opposite, thus creating a paradox or a result that contradicts our expectations.

The point of this thesis is not to define how Carrollian nonsense is formed or functions, or to argue that Carroll’s nonsense serves as mathematical critique. It is merely a humble exploration of how his mathematical background affected the formation of his nonsense. “Chapter I: How doth the little mathematician” will dive into a study of some of the more general structures Carroll leans on in the formation of his nonsense, namely multiplication tables, poems, syllogisms, and proofs. “Chapter II: The Mad Adder” explores some of the more specific mathematical structures Carroll employs in the construction of his nonsense; specifically, several examples of his use of the commutative property and an example Bayley proposes called quaternions. In “Chapter III: Mirror Math” I will discuss *Through the Looking-glass and What Alice Found There* in consideration to my explorations in Chapters I and II, and as its own entity where Carroll’s mathematic side shows not only in borrowed structure, but also in his treatment of words and his play with the referential value of words and numbers.

Before we delve into nonsense, mathematics, and logic, I must share one final thought. In writing about mathematics and the *Alice* books, one has to choose between referring to the author as Lewis Carroll or as Charles Dodgson. After great amounts of silent debate within my head I chose Carroll for the simple reason that I was writing primarily about his literature, not his mathematics. When I came across Carroll's letter to Wilton Rix I also discovered a more justifiable reason. Carroll signs this mathematically playful letter with his pen name: the name of the author, not the name of the mathematician. By putting his authorial name on a piece of mathematics he is aligning Lewis Carroll the author with Charles Dodgson the mathematics professor. They are one and the same. No silly pseudonym could ever strip him of his love of mathematics and logic. By signing this letter with his nom de plume, Carroll merges Carroll and Dodgson[4], declaring them to be one, and exposes himself as a lover of nonsense, logic, word play, and mathematics.

[4] Carroll first used his pseudonym when publishing the poem "Solitude". He manufactured it "based on a Latinized reversal of his first two names, Charles Lutwidge" (Cohen 72). Lutwidge=Ludovic=Lewis and Charles=Carolus=Carroll.

Chapter I: How doth the little mathematician

The Cheshire Cat, surveying Alice from its perch in a tree, proves that it is mad.[5]

The King of Hearts says to "Begin at the beginning…and go on till you come to the end" (*Annotated Alice*[6] 121). This seems to be decent advice (and is in fact advice someone once offered me), and so it seems a somewhat logical decision to start by discussing the first truly obvious example of mathematics in *Alice's Adventure's in Wonderland* - Alice's famous attempt at reciting multiplication facts - and proceed somewhat chronologically from there. After exploring Alice's multiplication, we will move on to a dissection of two of Carroll's parody poems, "Twinkle, twinkle, little bat" and "How doth the little crocodile." Following this will be a focus on the author's use of syllogisms and proofs in the Pigeon and Cheshire Cat scenes. All of these examples follow a relatively familiar structure (basic arithmetic, well known poetry, common logical techniques), but provide confusing and

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[5] All images in this project are the illustrations by John Tenniel for the original *Alice's Adventures in Wonderland* and *Through the Looking-glass and What Alice Found There*. For reasons of practicality I have taken them from this website: <http://www.alice-in-wonderland.net>.
[6] From here on out *The Annotated Alice: The Definitive Edition* will be denoted by the abbreviation *AA*.

unexpected results. Additionally, all these instances of nonsense contribute to the unsettling conclusion that Carroll is manipulating Alice in a similar manner by maintaining her basic form yet simultaneously fiddling with the contents of her mind.

i. Mabel Math

Shortly after she tumbles down the rabbit hole, Alice is subjected to many unexpected changes in size. The transformations cause her to wonder if she has been "been changed in the night" (*AA* 22) for one of the little girls her age she knows. Her biggest concern is that she has been turned into Mabel, so she attempts to test herself. She reasons that Mabel knows so very little and if she, Alice, knows everything she used to know she must still retain her original identity. She turns first to mathematics[7] and tries to recite her multiplication table. As she attempts to do this Alice says, "Let me see: four times five is twelve, and four times six is thirteen, and four times seven is—oh dear! I shall never get to twenty at this rate!"(23)[8]. There are two explanations as to why she will never reach twenty. The first, as Martin Gardener tells us, is the simpler one. Most multiplication tables stop with twelve. If this is the case with Alice's, then, in the pattern she is following, her recitation will end with four times twelve, which will equal nineteen (23 note 4)**.**

The other explanation for why Alice will never reach twenty involves the mathematical principle of bases. A. L. Taylor points out that four times five does equal twelve in a number system of base eighteen, and four times six equals thirteen in a number system of base twenty-one. If one follows the patter of increasing the base by three, the

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[7] It is interesting to note that Alice turns to mathematics first. She chooses academic knowledge as a determiner of identity rather than knowledge such as her own name, the names of her family members, her address, or her favorite foods.
[8] Food for thought: why is Alice's goal to reach twenty? Is it because her initial multiplication sum, four times five, was supposed to equal twenty?

products produced increase by one. Thus four times five equals twelve base eighteen, four times six equals thirteen base twenty-one, four times seven equals fourteen base twenty-four, etc. However the pattern ends when it reaches four times thirteen. Four times thirteen does not equal twenty base forty-two as it would if the scheme held. Therefore, Alice really never will get to twenty (Abeles 183)[9].

While we cannot tell for sure if Carroll thought of any of this while writing *Alice's Adventures in Wonderland*, it seems impossible that an experienced mathematician would accidently create such a coincidence. In considering this, one must also consider that Carroll chose to start specifically with "four times five." If he was not having Alice multiply numbers in a base other than ten, why not start with one times one, or two times two? Both of these seem to be more practical or natural places to start when reciting a multiplication table. It seems indescribably more likely that Carroll wrote Alice reciting multiplication facts using different bases, than accidently writing in such a coincidence.

This is perhaps the best example of what Peter Hunt calls "remorseless logic masquerading as nonsense"(Hunt 37). The multiplication recitation appears to be complete unmathematical absurdity, but proves to be fact. Alice's arithmetic "still makes sense, but only to a relatively sophisticated mind" ("Alice's Journey" 315). To the average reader working in base ten, Alice has simply made a silly mistake, but to the clever mathematician (like Carroll), this is a mathematical mind game. While this looks like nonsense, it follows its own structure and rules to the letter. Just as Wonderland must seem to one of its residents, to those well versed in mathematics and in the know, the multiplication table makes perfect

[9] Francine Abeles points out that by using this theory, one can create a multiplication table for multiplication in changing bases, that is commutative (e.g. a+b=b+a and a×b=b×a), but not associative (e.g. a+(b+c)=(a+b)+c and a×(b×c)=(a×b)×c) (Abeles 183).

sense. However, to the normal reader, and to poor confused Alice who has no idea why her words are being "ventriloquially altered" (Knoepflmacher 198), this is still nonsense. The multiplication table follows a structure familiar to anyone who has ever been taught arithmetic. The problem occurs when the expected answer is removed and replaced with an answer that seems to be entirely wrong. Carroll changes the rules of the game without telling the reader. The audience sees a pile of mathematical gibberish because the reader and the author are now playing the same game, but each with a different set of rules.

In addition to this, the oddity of this multiplication table is increased by its presentation. Firstly, a little girl of seven years old is reciting math that is far too advanced to be within her realm of comprehension. Secondly, she has no idea of what this information is or how she came to recite it. It is as if someone scooped the expected answers or mathematical structure (the structure that working in base ten provides) out of her brain and replaced them with something entirely different.

ii. Parodic Poems

It is not only mathematics that Carroll turns to in order to find suitable structures for his nonsense. Several of Carroll's most notable poems turn to popular poems from the eighteen hundreds for their framework. Just as a mathematician follows a formula and plugs in numbers or variables to get a result, Carroll follows the basic form (or formula) of the original poem, and then swaps out key words that help determine meaning in order to create nonsense. I will discuss two of these parodic poems: "Twinkle, Twinkle, little bat" and "How doth the little crocodile." Though "How doth the little crocodile" occurs first in *Wonderland* I will address "Twinkle, Twinkle, little bat" first as it is simpler and will serve as a clearer introduction to the method I will use to analyze both poems.

The Mad Hatter introduces Alice and the reader to “Twinkle, Twinkle, little bat” by recounting his recital of it for the Queen of Hearts, which ended in the Queen demanding that his head be removed. It is a parody of Jane Taylor’s “The Star,” a poem that to this day remains a popular children’s song. Both “Twinkle, twinkle, little bat” (on the left) and “The Star” (on the right) are side by side below for comparison.

Twinkle, Twinkle, little bat!	Twinkle, Twinkle, little star,
How I wonder what you’re at!	How I wonder what you are!
Up above the world you fly	Up above the world so high
Like a tea-tray in the sky.	Like a diamond in the sky
AA 73-74	*AA* 74, note 8

Carroll prioritizes the form of the poem, preserving the structure in respect to rhyme, number of syllables, and, for the most part, which part of speech each word is (noun, adjective, etc), and punctuation. He treats words as arbitrary variables and plugs them into the poem, the meaning of which he considers (or allows his readers to ponder) later.

If one were to break down these two poems linguistically in terms of differences, they would look like this:

Twinkle, Twinkle, little **Noun**!	Twinkle, Twinkle, little **Noun(1)**,
How I wonder what **Pronoun/verb(1)**	How I wonder what **Pronoun(1)**
Preposition(1)!	**Verb(1)**!
Up above the world **Pronoun(1)**	Up above the world **Adverb(1)**
Verb(1)	**Adjective(1)**,
Like a **Noun(2)** in the sky.	Like a **Noun(2)** in the sky
(“Twinkle, Twinkle, little bat”)	(“The Star”)

The words that have been taken out have been replaced by their part of speech in bold and their syllable count in parenthesis. While there are some minor differences between the parts of speech used, these poems are clearly very similar. However, they become identical if one applies the definitions of word types Carroll laid out in his book *Symbolic Logic*[10]. I will not bore you with a summary of all the terms Carroll defines, but will instead constrain myself to the ones that are necessary.

Firstly, "the Universe contains 'Things' (For Example, 'I', 'London…)"(*Symbolic Logic* 1). 'Things' are essentially nouns. 'Things' have 'Attributes', that describe them. An 'Adjunct' is "any Attribute, or any Set of Attributes" (1). For example, 'red' is an attribute, but can also be called an adjunct. Additionally, any set of attributes such as "red, scented and full-blown" (1) may be called an adjunct. A 'Class' is a group of things. Carroll says, "the formation of Classes, is a Mental Process, in which we imagine that we have put together, in a group, certain Things." (2). A class can be divided into smaller classes by considering attributes (for example, "books" is a class, as is 'old books' and 'new books'). Finally, a 'Name' is a "word (or phrase) which conveys the idea of a Thing, *with* the idea of an Adjunct" (5). Carroll provides many examples of this: "the words 'Thing', 'Treasure,' 'Town', and the phrases 'valuable thing', 'material artificial thing consisting of houses and streets'…'Town paved with gold,' 'old English Book'" (5).

In the original linguistic breakdown, the phrases "you're at" and "you are," as well as "you fly" and "so high," forced the analysis to look a little different. However, in a Carrollian logic breakdown, all four phrases can be considered adjuncts allowing the analysis to be

---

[10] Braithwaite points out the following: "Whereas the works on Trigonometry, Geometry, and Determinants were published over the name of Charles L. Dodgson…the two small works on Logic—*The Game of Logic* and *Symbolic Logic, Part I*—and the two interesting logical notes in *Mind* appeared over the signature of the creator of Alice" (174).

identical. As “you’re at” and “you are” are being used in a more descriptive sense, they can be seen as adjuncts. Similarly, “you fly” is describing the action of the bat, and so high is describing the position of the star. Thus, “you fly” and “so high” are also adjuncts. Therefore, the “Twinkle” poems can now be broken down as identical linguistic formulas:

Twinkle, Twinkle, little **Thing(1)**!	Twinkle, Twinkle, little **Thing(1)**!
How I wonder what **Adjunct(2)**!	How I wonder what **Adjunct(2)**!
Up above the world **Adjunct(2)**	Up above the world **Adjunct(2)**
Like a **Name(2)** in the sky.	Like a **Name(2)** in the sky
(“Twinkle, Twinkle, little bat”)	(“The Star”)

Carroll’s definitions also allow for a clearer understanding of why this poem feels so nonsensical. In “Twinkle, Twinkle, little bat,” the ‘things’ have been allocated ‘attributes’ that do not belong. The “bat” is given the attribute “twinkle” and the “tea-tray” is assigned the attribute “in the sky.” While it would be natural and understandable for a “bat” to be “in the sky” and for a “tea-tray” to “twinkle,” the assignment of attributes in Carroll’s poem makes no sense (unless tea-trays grow wings and some cruel force feels it fit to bedazzle a bunch of bats), which, of course, results in nonsense.

There is one more minor mathematically related thought that may have crossed Carroll’s mind when writing “Twinkle, Twinkle, little bat.” Gardner explains it on page seventy-two in note eight of *The Annotated Alice: The Definitive Edition*. He writes, “Carroll’s burlesque may contain what professional comics call an ‘inside joke’. Bartholomew Price, a distinguished professor of mathematics at Oxford and a good friend of Carroll’s, was known among his students by the nickname ‘The Bat’.” Certainly a tea tray, even a flying one, can be more easily linked to a math professor than a bat.

While “The Star” is arguably more popular today than “Twinkle, Twinkle, little bat,” the same cannot be said for the parent poem of “How doth the little crocodile.” When Alice’s recitation of the multiplication table ultimately fails to help her prove to herself that she is not Mabel, she turns to other types of recitation. She attempts to recall the poem “Against Idleness and Mischief,” a poem intended for children by Isaac Watts. Somehow Alice’s “memorized poems” are coming out “ventriloquially altered” (Knoepflmacher 198). She repeats a poem that is structurally similar, but that is strikingly different in content and meaning. Out of Alice’s mouth mysteriously and unwittingly spills Carroll’s famous parody of “Against Idleness and Mischief”: “How doth the little crocodile.” This poem is frequently described as a nonsense poem, but why? It is certainly silly, potentially metaphoric, and definitely more fun that its didactic predecessor, but it doesn’t employ gibberish words like “Jabberwocky” (which will be addressed in Chapter III) or pair attributes with things they do not belong with as in “Twinkle, Twinkle, little bat.” So why is it nonsense? The reason is perhaps not immediately clear. Elizabeth Sewell describes “nonsense as a collection of words or events which in their arrangement do not fit into some recognized system in a particular mind” (Sewell 3). This definition implies that different people identify nonsense as different things. Everyone’s view on what nonsense involves is unique and depends on their particular system of how they view the world. Therefore, what is usually defined as nonsense may not be considered nonsense by all.

When “How doth the little crocodile” is placed next to the other children’s poetry of Victorian England, the reason it is a nonsense poem becomes apparent. Other children’s poems of the 1800’s, especially “Against Idleness and Mischief,” were strictly moral and didactic. Carroll’s crocodile poem is not. It “uses a series of inversions to change didactic poetry into nonsense poetry" (Stewart 76) and therefore does its best to subvert the moralist messages. At least according to the imagined Victorian mindset, Carroll's poem does not fit into the recognized system of moralist didacticism as the reader might expect it would.

However, this poem does fit into a recognizable structure. The structure of "How doth the little crocodile" is the same as "Against Idleness and Mischief." The syllable count and rhyme scheme are the same in both poems, as are the general placement types of words (verbs, nouns, adjectives, etc.). Similarly to "Twinkle, Twinkle, little bat" and "The Star," "How doth the little crocodile" and "Against Idleness and Mischief" can be broken down using the definitions of Things, Attributes, Adjuncts, and Names that Carroll created for his *Symbolic Logic*. Using these definitions we can break down "How doth the little Crocodile" and "Against Idleness and Mischief" structurally and thus provide a kind of formula for these poems. This formula using Carroll's logical terms is helpful to have because it shows how these two poems are identical in a way that a regular linguistic breakdown cannot.

Below I have include the full version of "How doth the little crocodile" (on the left) and the first two verses of its "parent poem" (on the right) because it will be useful to have read both verses for the remainder of this section. For the sake of simplicity, I will only break down the first verse of each. The numbers in parentheses after a word type will be how many syllables it needs to be. The exponents at the end of each line represent the rhyme scheme.

How doth the little crocodile	How doth the little busy bee
Improve his shining tail,	Improve each shining hour,
And pour the waters of the Nile	And gather honey all the day
On every golden scale!	From every opening flower!

How cheerfully he seems to grin,
How neatly spreads his claws,
And welcomes little fishes in,
With gently smiling jaws!

AA 23

How skillfully she builds her cell!
How neat she spreads the wax!
And labors hard to store it well
With the sweet food she makes.

AA 23, note 5

How doth the **Attribute (2) Name(3)**[A]
Improve **Adjunct(2) Thing(1)**[B],
And **Verb(1) Thing(3) Adjunct(3)**[A]
Preposition(1) every **Attribute(2)**
Thing(1)[B]!

("How doth little crocodile")

How doth the **Attribute (2) Name(3)**[A]
Improve **Adjunct(2) Thing(1)**[B],
And **Verb(2) Thing(2) Adjunct(3)**[A]
Preposition(1) every **Attribute(2)**
Thing(1)[B]!

("Against Idleness and Mischief")

In both poems, the first line is not challenging to break down: "little" is an Attribute, and "crocodile" and "busy bee" are both Names. In the next line, both "his shining" and "each shining" can be seen as Adjuncts because both words are being used to describe the thing in each sentence ("tail" and "hour"). The third line is more difficult to dissect using Carroll's terms. The words "pour" and "gather" not only have different numbers of syllables, but are also verbs and are thus trickier to sort into Carroll's categories. However, the verbs, in this case at least, can be seen as Attributes because they are being used to describe what is being done with "the waters" and "honey" and can therefore, by definition, be incorporated into the Name. The process becomes slightly problematic when working with the last line when one is forced to ask how to characterize a preposition using Carroll's language. However, if we approach the prepositions in conjunction with the word "every" that follows them, "On every" and "From every" become attributes or adjuncts because they are used in the process of describing a thing.

By using Carroll's language, we can combine Adjuncts, Attributes, Things, and Names to further simplify the poems. While the first breakdown showed that these poems are structurally similar, simplifying if further with Carroll's definitions shows how these poems can be seen as identical and formulaic.

How doth the **Name(5)**[A]	How doth the **Name(5)**[A]
Improve **Name(3)**[B]**,**	Improve **Name(3)**[B],
And **Name(4) Adjunct(3)**[A]	And **Name(4) Adjunct(3)**[A]
Adjunct(2) Name(3)![B]	**Adjunct(2) Name(3)**![B]
("How doth little crocodile")	("Against Idleness and Mischief")

By keeping certain words and phrasing, as well as preserving syllabic content, type of rhyme scheme, and general placement of word types, "How doth the little crocodile" allows itself to be easily recognizable as a parody of "Against Idleness and Mischief."

The words Carroll chooses to create his new poem contrast with the old one in many ways. The most obviously contrasting terms are in the subjects of the poems: the bee and the crocodile. The bee is not an uncommon animal in England. It is plain and familiar. The crocodile, on the other hand, is exotic, from a far away land, and, in the cold damp country that is England, essentially mythical. The bee's actions are recorded as seen and then personified slightly. The crocodile's actions must be imagined by Carroll, unless he visited Egypt (because this a Nile crocodile he is writing about) before writing this poem. It is also worth noting that a crocodile is not covered in "golden scales." The creature being written about is not just unfamiliar to England, but also unfamiliar to all of Alice's world (though perhaps Wonderland has a Nile River full of shiny golden crocodiles).

While the bee labors to improve things in a more general sense (if one allows that time is far less specific than tail), the crocodile's exertions are focused on himself and his individual and physical improvement. In her close reading of these poems, my friend Amanda Benowitz points out that in the first stanza of "Against Idleness and Mischief" the busy bee focuses on work to improve society, whereas in the second she focuses on the more individual task of "build[ing] her cell" (*AA* 23 note 5). The crocodile focuses on self-improvement first, and then takes care of its other physical needs, namely hunger. Its physical attributes, such as its smile and neatly spread claws, allow for it to be successful in getting food. The messages of these two poems are thus very different. The busy bee works primarily for the community and fulfills her responsibilities before taking up a more personal task, whereas the crocodile labors only for himself. The moralist and didactic message of "Against Idleness and Mischief" is the type of knowledge that adults frequently try to impose upon children. The crocodile provides a much more recognizable model of behavior.

Carroll preserves the structure of "Against Idleness and Mischief," but drains it of its original didactic message. He then proceeds to fill in the holes with golden crocodiles, stuffing new, very different meaning into the old structure. A poem set entirely in the known world, about familiar creatures, is transformed into one with mythical creatures who do not exist in Alice's world. A mathematician can plug new numerals into a formula and get a result that is different in value, but still categorically the same. For example, if a mathematician changes the value of the variables in an equation to find the area of a triangle, he will end up with the area of a triangle, but it will be different from whatever the original area was. Comparably, when Carroll plugs new words into the poem's linguistic formula, the result is still a poem, but it is a poem with a very different meaning.

Similarly to the multiplication table that precedes it, the manner in which this poem is presented adds to the strangeness of it. Alice is reciting a poem about a creature she has probably never seen, who lives in a place she has likely never visited. Someone has removed the original poem from her brain, but left its structure in place to be refilled with new words and meaning by the mysterious force that removed it or by Alice's clever mind.

Admittedly, it cannot be proven if Carroll consciously took a mathematical or logical approach to his parody poetry. At the very least, it is clear that numbers and verse are compatible in Carroll's mind. In his book *The Universe in a Handkerchief*, Martin Gardner states, "Carroll's system of mnemonics…allows one to translate numbers into easily remembered words. To help recall the words, Carroll composed two-line rhymes in which the word was prominent, and the couplet described in some way the number it symbolized" (*The Universe in a Handkerchief* 31). An example of this can be found in Carroll's *Memoria Technica,* where he wrote a short four-line poem, to help him remember the dates 1495 and 1455:

> "Shout again! We are free!"
> Says the loud voice of glee.
> "Nestle home like a dove,"
> Says the low voice of love.
>
> 32

By the code that Carroll sets up, the phrase "voice of glee" can be translated to the number 1495. Each consonant corresponds to one of the ten numbers that are used to represent all numbers (e.g. 0, 1, 2, …, 8, 9). Carroll assigned two letters to each number. His method of assignment varies from letter to letter. For example, "b" and "c" both correspond to 1 because they are the first consonants. For 2, he takes "*d* from '*deux*'" and "*w* from '*two*'" (32). He assigns "g" to nine for its shape, "z" and "r" to 0 because they are the two consonants in the word zero, and he allows "j" to be 3 simply because it was the last consonant unappropriated and 3 only had one other letter assigned to it. In this case, "v" is dropped, "c" is 1, "f" is 4, "g" is 9, and "l" is 5. Similarly, "voice of love" represents the number 1455. I do not think that Carroll encoded his poetry in the *Alices* with hidden numbers, but it is nonetheless interesting to note the fluidity that exists between numbers and letters in Carroll's mind. He allows letters to function as symbols that stand for some other thing or value, and then, by extension, for words to mean more than their previously assigned definitions and exactly what he wants them to.

iii. Serpentine Syllogisms

In addition to arithmetic and poetry, logic[11] and proofs also serve as structures for Carroll to graft his nonsense onto. When she attempts to adjust her size, Alice nibbles on the Caterpillar's mushroom. She grows a ridiculously long neck and terrifys a poor bird while attempting to get her head back down to her arms. The Pigeon is convinced that Alice is a serpent who desires nothing more than to eat the bird's eggs. The bird and Alice have the following exchange:

> "I've seen a good many little girls in my time, but never *one* with such a neck as that! No, no! You're a serpent; and there's no use denying it. I suppose you'll be telling me next that you never tasted an egg!"

[11] Logic and mathematics share a very close relationship. In mathematics logic is a frequently used tool, especially in the construction of proofs.

> "I *have* tasted eggs, certainly," said Alice, who was a very truthful child; "but little girls eat eggs quite as much as serpents do, you know."
>
> "I don't believe it," said the Pigeon; but if they do, why, then they're a kind of serpent: that's all I can say." (*AA* 55)

The Pigeon is using logic to prove Alice is a serpent. The Pigeon knows from experience that serpents have long necks, but little girls do not. Since little girls do not have long necks, but Alice does, she cannot be a little girl. The set of attributes associated with "little girls" does not include "long neck." Alice possesses this attribute, which places her outside the class "little girls." Serpents however have long necks. They also, like Alice, like eggs. Alice possesses the two attributes that the bird uses to define the class "serpents," which allows her to be placed in this class. Therefore, by the bird's logic, Alice must be a serpent.

The bird's proof follows the form of a type of logical argument called a syllogism. In a syllogism, the first two statements imply the third. Carroll discusses this concept in his *Symbolic Logic*. However, similarly to Humpty Dumpty, he explains it in words that mean exactly what he wants them to mean and which one would have to spend time carefully reading his book to understand. However, he does provide several very helpful examples. One is "All cats understand French, Some chickens are cats. Some chickens understand French" (*Symbolic Logic* 57). It is clear from Carroll's example that syllogisms have to the potential to be incredibly faulty. In much of mathematics they hold true, but the same cannot always be said for real life situations. His example can be simplified to "All *c* is *f*. Some *k* are *c*. Therefore, some *k* are *f*." Another example using variables would be "All *a* are *c*. All *b* are *c*. Therefore, all *a* are *b*," or, even more concisely, "A equals C, B equals C, therefore A equals B."

To rewrite the Pigeon's syllogism in simpler terms, let Alice be "A," serpents be "S," and eggs be "E." Therefore, Alice liking eggs can be written as A equals E. Similarly, S equals E. Since A equals E and S equals E, A equals S. The Pigeon's other assumptions can be written this way as well. Little girls do not have long necks, Alice has a long neck, and therefore Alice is not a little girl. In slightly more simplified and mathematical variables, G does not equal N, but A equals N. Therefore, G does not equal A. Similarly, serpents have long necks, Alice has a long neck, and therefore Alice is a serpent. Thus, S equals N, and A equals N. Therefore, A equals S.

Despite the fact that the Pigeon is using a logical method of deduction, her proof that Alice is a serpent seems like obvious nonsense. "This argument is formally valid" (Buchalter 332), but the result seems entirely implausible. Alice, despite her many changes is still a little girl. Or is she? Alice herself expresses some doubt over this fact when she "remembered the number of changes she had gone through, that day" (*AA* 55). From the view of the reader, who comes from Alice's world where little girls cannot change into serpents, the logic must be nonsense because this type of transformation exists outside their mental scheme and this seems impossible. It exists outside of Alice's too; or rather it did before she tumbled down the rabbit hole. Alice is starting to doubt her old set of rules and starting to adjust to and adopt the laws of Wonderland. The idea that she may have been changed into a serpent is not as improbable as it was before.

The Pigeon's is not the only syllogism in *Wonderland*: the Cheshire Cat utters one as well. Before its preposterous proof that it is not sane, the Cat tells Alice, "we're all mad here. I'm mad. You're mad…you must be…or you wouldn't have come here" (*AA* 66). All beings in Wonderland are mad, Alice is a being and she is in Wonderland, therefore Alice must be mad. Once again, logical structure is maintained, but as we will soon discuss, the disappearing cat is a little confused by what madness is. So despite the seemingly sturdy syllogism, the Cat's claim loses all weight.

iv. Preposterous Puss's Proofs

Equally nonsensical to the syllogisms is the Cheshire Cat's "proof" that it is mad. When Alice tells the Cat that she does not wish to "go among mad people," the Cat famously tells her "Oh, you can't help that…we're all mad here. I'm mad. You're mad" (*AA* 66). Alice inquires as to how the Cat knows it's mad, leading to the following exchange:

> 'To begin with,' said the Cat, 'a dog's not mad. You grant that?'
>
> 'I suppose so,' said Alice.
>
> 'Well, then,' the Cat went on, 'you see, a dog growls when it's angry, and wags its tail when it's pleased. Now I growl when I'm pleased, and wag my tail when I'm angry. Therefore I'm mad.'
>
> 'I call it purring, not growling,' said Alice.
>
> 'Call it what you like,' said the Cat. (*AA* 66)

I include the entire quotation because there is much to be said about it. Firstly, it contains an example of Carroll's play with language that is quite similar to the commutative property. The Cat presents Alice with the statements "a dog growls when it's angry, and wags its tail when it's pleased" and "I growl when I'm pleased, and wag my tail when I'm angry." These can be rewritten using variables as "x when y, and s when t" and "x when t, and s when y." In this form, "y" and "t" are switched. The rearrangement of these variables has a similar purpose of the previous example.

The Cheshire Cat is using the rearrangement to highlight the differences between it and a dog in order to "prove" his insanity.

This passage is also interesting because it is reminiscent of a proof[12]. In mathematics, a proof is an argument used to show an initial statement or proposition is true. Proofs are usually written in paragraph form and depend heavily on logic. In his book *The Universe in a Handkerchief,* Martin Gardner says, "In logic and mathematics you cannot prove a theorem except within a formal system based on a set of posits or assumptions" (72). This formal system is that of proofs. He also summarizes a problem with proofs that Carroll discussed in "What the Tortoise Said to Achilles." Gardner begins by questioning the verity of the assumptions proofs are based on. He says that:

> To prove them you have to make additional assumptions, and to prove *those* assumption requires still further posits. You thus seem to be trapped in an infinite regress. Deductions can never reach absolute certainty. You are forces to stop at some point and accept a set of posits as true by an act of faith. (*The Universe in a Handkerchief* 72)

In the study of literature, the closest equivalent of a proof in purpose may be an analytical essay, though proofs are perhaps more rigorous. However, in his essay "Mathematics and Narrative: Why Are Stories and Proofs Interesting?," Bernard Teisser compares proofs to narration. He states that narration "provides vicariously the experience of a path in a set (or a graph) of interactions among characters" (Teisser 232). He continues "proofs are also…paths in a graph of logical interactions between statements," but that the

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[12] The Cheshire Cat's argument is also similar to a technique often employed in the bible called *chiasmus* (Quinn 95). Though the two techniques are still quite different, it is interesting to note this especially considering Carroll's religious studies.

mathematician “has more difficulty identifying with the ‘characters’ of the proof…while the understanding of a narration is usually direct, the understanding of a proof is more often in the nature of a sudden illumination” (Teisser 233).

There are many different types of proofs, or rather different tactics that mathematicians use to prove something. The Cat’s argument is most similar to a proof by contradiction. Using this approach, a statement is validated by showing that if it were false, a logical contradiction would occur. According to the Cheshire Puss’s proof, if the Cat was sane, it would growl when angry and wag its tail when pleased. However, it does not. This contradiction must mean that it is mad. The problem here is of course the Cat’s definition of sanity[13]. By its definition, most animals with tails are mad. Additionally, this may imply that all humans and animals who do not possess a tail would be considered mad, simply because they cannot wag their nonexistent tail when pleased. The Cat groups itself in the same class as a dog. The entire argument is based on the initial assumption that cats and dogs belong in the same class and thus can be diagnosed by the same definition of madness. However, while cats and dogs do share some attributes, they do not have enough in common to belong to the same class when it comes to defining sanity. The Cat’s faulty initial assumption causes the entire proof to loose its validity. Once again, structure is maintained while meaning is missing.

Both the Cheshire Cat and the Pigeon base their proofs on a single assumption: that their definition, of sanity and serpents respectively, is the correct one. They take their assumptions on faith just as, as Gardener points out in *The Universe in a Handkerchief*, any mathematician must at some point do. To these two creatures their posits are fact and so their

[13] George Hubbell points out that, “we are not mad. We have saved ourselves from any such calamity by a definition; by defining madness relatively” (Hubbell 387).

proofs hold true. However, to Alice and the reader, both of who function with an entirely different set of basic assumptions and posits, the conclusions of the Cat and Pigeon are utter nonsense.

v. Alice

Before allowing this chapter to conclude, I must discuss one more structure Carroll employs to create confusion: Alice herself. It has occurred to many a reader of *Alice's Adventures in Wonderland* that something about Alice seems a little off. She unknowingly recites multiplication facts in a base that is not ten, cannot recite the poems she used to know, and frequently tries to treat words as variables. In addition to being able to recite multiplication facts in bases other than ten, Alice seems to be aware of contemporary mathematical treatises. During the trial of the Knave of Hearts, Alice says, "*I* don't believe there's an atom of meaning in it" (*AA* 122). It seems rather odd that a seven year old child would know such a word such as "atom" well enough to be comfortable using it, not to mention using it correctly. In addition to this, Helena Pycior points out that mathematician Augustus De Morgan introduced a chapter of his 1849 work *Trigonometry and Double Algebra* with the sentence, "With one exception, no word nor sign of arithmetic or algebra has one atom of meaning throughout this chapter…" (Pycior 149). Whether this was a conscious or unconscious reference on Carroll's part cannot be said. The significance is that now Alice has made the reference. Carroll has created a paradox: a little girl who knows advanced mathematics.

As a seven-year old girl, Alice begins as a familiar concept in the reader's mind. However, this is entirely undermined throughout her adventures in Wonderland. Alice is constantly forced to question her own identity. She wonders if she has "been changed in the night" (*AA* 23) and when the Caterpillar asks her who she is Alice replies, "I hardly know" (47). Then there are the unsettling implications of the Pigeon's syllogism. Alice has been changed so dramatically that the structure we cling to define her is threatened and we must ask which has failed: logic or our conception of Alice? The failure of logical reasoning is in itself unsettling, but the idea that Alice may not just be the little girl of seven we perceived her to be is perhaps an even less approachable idea. The Cheshire Cat's syllogism and proof raises similar concerns as well. Though they are easily debunked, these issues cause us to question Alice's sanity, and this leads to queries about her identity.

The way in which Carroll manipulates Alice is reminiscent of the way in which he alters "Against Idleness and Mischief. " He maintains the form of each, but empties them of their original meaning while gives them new ones. He maintains the structure of Alice, but changes some key elements. She remains a little girl of seven who has had to memorize boring, generic lessons all her life and turns to them as her primary form of knowledge and identity, but Carroll removes key components of these lessons. He fiddles with the structure of the multiplication she has learned and strips words and didactic meaning from the poems she has memorized. He replaces what he has removed with new words, meaning, and his own mathematical inclinations. Alice maintains her general understanding of the universe, even when the way in which she interacts with it is changed and sits outside her own realm of comprehension. Her structure is still secure, but her contents are changed. Alice, therefore, becomes a parody of herself.

Alice's altered multiplication facts and poems, and the problematic proofs of the Pigeon and Cheshire Cat are all classic examples of how Lewis Carroll borrows well known or familiar structures to graft his nonsense onto. However, they also serve another function.

The alterations to the knowledge stored in Alice's mind and the unsettling implications of the Pigeon and Cheshire Cat using logic to question the fundamentals of her identity lead to the conclusion that Alice herself is a paradox and a parody, and therefore is an element of Carrollian nonsense.

A grin without a cat.

Chapter II: The Mad Adder

Alice joins the Hatter, Hare, and Dormouse for tea.

Gardner informs us that Ellis Hillman suggested that if one drops the *H* from "Mad Hatter" it sounds like "Mad Adder." Such a description could be used to describe a mathematician, "perhaps Charles Babbage, a Cambridge mathematician widely regarded as slightly mad in his efforts to build a complicated mechanical calculating machine" (*AA* 70 note 1). Even if the Mad Hatter did not prove to be the Mad Adder, the nickname could be a very appropriate description for Lewis Carroll himself. While we have already seen from his proof that two times two equals five that his actual arithmetic can be a little mad, what really makes Carroll a mad adder is his addition of mathematical structure to his linguist play. The result of this addition is that the author treats words, and characters, as variables in a formula. The most common mathematical form he applies to his language is the commutative property. This application can be seen many times throughout the *Alice's Adventures in Wonderland* with several different results. However, it is not the only mathematical theory Carroll leans upon. As Bayley proposes, Carroll modeled the entire Mad Tea Party scene on a concept called quaternions. By allowing mathematics to serve as structure for his linguistic play and narration Carroll points out paradox, creates perplexing situations and character behaviors, and strips sentences of meaning.

i. I x what I y, I y what I x

There are several instances throughout *Alice's Adventures in Wonderland* in which Carroll applies the commutative property to language. However, the most memorable occurs in an exchange between Alice, the Hatter, Hare, and Dormouse (the other instances will be discussed in the next chapter). The Commutative property states that when adding or multiplying a numeral or variable you can change the order in which the values occur within the operation and still have the same result. For example[14], *a* plus *b* is equal to *b* plus *a*. Similarly[15], *a* times *b* equals *b* times *a*. In other words, an equation is commutative if *a* plus *b* is equal to *b* plus *a*. This property always holds true for everyday addition and multiplication. However, in more complex and more abstract areas of mathematics (such as quaternions which will be discussed later in this chapter) the commutative property does not always hold true.

Carroll frequently uses the commutative property in his linguist play. In their discussion of the Hatter's riddle ("Why is a raven like a writing-desk"), the March Hare tells Alice, "you should say what you mean." Alice responds, "I do…At least—at least I mean what I say—that's the same thing you know" (*AA* 70-71)[16]. The Hatter, beginning a series of linguistic examples of the commutative property, tells her, "you might as well say that 'I see

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[14] $a+b=b+a$
[15] $a \times b=b \times a$
[16] David Nelson alerted me to the refrain that runs through *Horton Hatches the Egg* by Dr. Seuss, which is "I meant what I said/And I said what I meant…/An elephant's faithful/One hundred per cent!" Whether Dr. Seuss was making specific references to Carroll I cannot say, but it seems likely that the Mad Tea Party was floating around somewhere in Dr. Seuss's subconscious while writing.

what I eat' is the same thing as 'I eat what I see'!" (*AA* 71). In her statement, Alice allows "what" to be the operation and "I mean" and "I say" to be the variables that she rearranges the order of. The other members of the tea party use the same method of rearrangement on their sentences to prove by contradiction that language is not universally commutative. The Hatter, Hare, and Dormouse's sentences become formulaic. All three follow the same pattern in their responses: 'I *a* what I *b'* equals 'I *b* what I *a'*. In each of their examples, as well as Alice's initial statement, *a* and *b* are verbs. Unlike many mathematical formulas, in the English language order plays a key role in determining meaning; "language is not reversible like mathematical equations" ("Alice's Journey" 317). Mathematics and language function with different rules. When the order of words is altered in a sentence, the meaning of the original sentence is stripped from it and entirely altered, whereas in mathematics the meaning (usually) remains constant.

Interestingly enough, Alice's two statements are not all that different. 'I mean what I say' and 'I say what I mean' are perhaps more different in tone than actual meaning. As Lecercle says, "the speaker is always torn apart between the two poles of the contradiction of language, 'language speaks'…and 'I speak language'" (Lecercle 3). "I say what I mean" implies "full control" of an utterance, where as "I mean what I say" gives more agency to the language itself. While technically these two statements may be slightly different, colloquially they are the same, as Alice knows, but the Hatter, Hare, and Dormouse refuse to accept. As George Hubbell says, "*in a particular case*…her statement of identity of meaning might very well be true. It is only when one generalizes the statement into a rule that it obviously becomes false" (Hubbell 395). Sometimes the commutative property actually does work when applied to language, but it frequently does not. This is very similar to advanced mathematics. At some point in every modern mathematician's career comes the mildly upsetting lesson that the commutative property doesn't hold for all systems of math (such as matrices and quaternions). In math this is simply fact, sad but true. In language, it is an odd, paradoxical quirk, which when pointed out by example makes nonsensical linguistic play.

According to Lecercle, nonsense often deals in paradox. It follows the structure of language, or in this case math, but at the same time subverts meaning. Alice's two statements, 'I mean what I say' and 'I say what I mean', are essentially the same, but the statements of the Hare, Hatter, and Dormouse are not. The same structure, or linguistic formula, is followed, but it results in paradox. Carroll applies the structure of the commutative property to language, gives one case where it holds true, where the original meaning remains intact, and then three more where it does not. In the cases where it does not, the significance of the original statement is violently stripped and replaced with meaning that is far less applicable to Alice's understanding of the world (the phrase 'I see what I eat' is far more applicable in general, and has a very different meaning, than 'I eat what I see,' which is a phrase that would imply the speaker eats many inedible things). This paradox creates nonsense.

In applying the commutative property to language, Carroll treats words as arbitrary variables that can be plugged into a linguistic formula. The 'I say what I mean' and 'I mean what I say' incident is not the only time Carroll treats words as variables in the "Mad Tea Party" chapter. In her article "At the Intersection of Mathematics and Humor: Lewis Carroll's "Alices" and Symbolical Algebra," Helena Pycior points out another example. During the Dormouse's attempt to tell a story about three little girls who lived at the bottom of a well and live on treacle, Alice, who finds the entire story very confusing, inquires as to what the little girls drew from the well. Upon receiving the answer “treacle,” she says, “But I don’t understand. Where did they draw the treacle from?” The Mad Hatter replies, “You can draw water out of a water-well…so I should think you could draw treacle out of a treacle well—eh, stupid?” (*AA* 76). As Pycior explains, “The structure of the two sentences is the same (you can draw *b* out of a *b*-well), but the content is different.” She explains that there are nouns that when plugged in for *b* “leave the sentence with no empirical significance”[17]. She argues that, “emphasis on structure over meaning…can lead to nonsense” (Pycior, 167). Poor Alice would most certainly agree.

ii. Commutative Cats (and Bats)

The “Mad Tea Party” is not the only occasion where Carroll plays with language by applying the commutative property to a sentence or where he treats words as arbitrary variables to be played with. While falling down the rabbit hole, Alice wonders to herself, “'Do cats eat bats? Do cats eat bats?' and sometimes, 'Do bats eat cats?'” Since she could not answer either question, Alice felt that “it didn’t much matter which way she put it” (*AA* 14). The reversal here is clear. By applying the commutative property to this sentence Carroll changes “do x eat y?” to “do y eat x?” Similarly to equations, these questions both have answers. With the commutative property *x+y* equals *y+x* and vise versa, but both must also equal some other single number. Since “do cats eat bats?” and its counterpart are questions, like x+y and y+x, they also have answers. “Do cats eat bats” may actually equal “do bats eat cats?” if the answers to each question are the same. However, even if the answers are

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[17] As Peter Hunt says on page 43 of *The Oxford Handbook of Children’s Literature* “the treacle well is not a nonsense invention: an early meaning of treacle was “balm” or “medicine/medicinal,” and there are several medicinal or treacle wells in Oxfordshire. Alice would probably have known of such a well.” While this is perhaps true of Alice Liddell, the book’s Alice vehemently declares that “There’s no such thing!” (*AA* 75).

identical, the meaning of each query will still differ. The answer to one will lend insight into the dietary preferences of cats and the other of bats. Following the same structure in forming a question may allow for a consistency of answers, but it does not allow for consistency of meaning.

Alice's repetition of her initial query adds another level of nonsense to this scene. She repeats "do cats eat bats" so many times that the answer and meaning becomes entirely irrelevant. Structure is maintained, but multiplied so many times it looses significance. Lecercle says that "this compulsive repetition contributes to the meaninglessness of the stanza" and that "Carroll himself noted the 'curious phenomenon…that if you repeat a word a great many times in succession…you will end by divesting it of every shred of meaning, and almost wondering you could ever have meant anything by it" (Lecercle 23). Alice's repetition makes the answer of her query entirely irrelevant, thus undermining the entire purpose of a question. By the time she asks, "Do bats eat cats?" the meaning of a question is general is no longer a factor in the equation. Both questions are thus stripped of meaning.

Cats and commutativity come up again when Alice encounters the Cheshire Cat. After having a conversation with Alice, the Cheshire Cat takes its time disappearing, and eventually is entirely gone except for its grin. Alice remarks, "'Well! I've often seen a cat without a grin…but a grin without a cat! It's the most curious thing I ever saw in my life!'"(*AA* 67)[18]. In this case, "cat" and "grin" can be treated as arbitrary variables. If we allow "cat" to be represented by x and "grin" by y, we can rewrite the sentence "a x without a y...a y without a x." This example is different from Alice's word play when tumbling down the rabbit hole and the Hatter, Hare, and Dormouse's linguistic lesson in "The Mad Tea Party."

[18] Interestingly enough, Gardner remarks in a footnote in *The Annotated Alice* that "the phrase 'a grin without a cat' is not a bad description of pure mathematics"(68 note 11).

Alice is not playing with language for play's sake, and she is not making the assumption that these two phrases equate to the same thing. Rather, she is using the commutative property to emphasize the difference between her understanding of how her world is supposed to work and the rules that govern Wonderland. In Wonderland a grin doesn't need a cat; it can exist independently. By the rules of the world above ground, this is an entirely nonsensical concept. In Alice's world a grin is an attribute that is always attached to a thing, but in Wonderland "an attribute without a subject" ("Alice's Journey" 320) is an acceptable occurrence.

Alice's Adventures in Wonderland is not the only place in which Carroll has a character treat words as arbitrary variables to create nonsense, or to prove a point. In his play *Euclid's Modern Rivals,* two mathematicians are discussing a new mathematical proposition they disagree with. The play's main character, Minas, says, "So far as I can make it out, Mr. Cooley quietly assumes that a Pair of Lines, which make equal angles with *one* Line, do so with *all* Lines. He might just as well say that a young lady, who was inclined to *one* young man, was 'equally and similarly inclined' to *all* young men!" (*Euclid and His Modern Rivals* 3)**.** This is remarkably similar to the technique that the Hatter, March Hare, and Dormouse employ in *Alice's Adventure's in Wonderland* to show Alice that the English language is not commutative. In both cases, structure is maintained and meaning is twisted or changed.

iii. Variables without Time

The commutative property is not the only mathematical structure that helps form Carroll's nonsense. As Melanie Bayley proposes in her article "Alice's Adventures in Algebra: Wonderland Solved," it is possible that the entire Mad Tea Party is an analogy of a mathematical concept called quaternions. In her article, Bayley explains that the Mad Tea

Party (as well as the trial, Cheshire Cat, and the Duchess's baby) were all absent from Carroll's original manuscript of *Alice's Adventures in Wonderland* (originally called *Alice's Adventures Under Ground*). During the nineteenth century, "many new and controversial concepts, like imaginary numbers, [were] becoming widely accepted in the mathematical community" (Bayley). Bayley argues that in the scenes added post-*Alice's Adventures Under Ground*, Carroll, who was a rather conservative mathematician, aimed "fierce satire" (Bayley) at his colleagues and the new mathematics they had begun to embrace.

During her article, Bayley proposes that the Mad Tea Party is based on a concept discovered by Irish mathematician William Rowan Hamilton in 1843 called quaternions. This concept "was being hailed as an important milestone in abstract algebra, since they allowed rotations to be calculated algebraically" (Bayley). Quaternions, Bayley explains, are members of a number system based on four terms. Hamilton apparently spent several years working with only three terms, "but could only make them rotate in a plane[19]. When he added the fourth, he got the three-dimensional rotation he was looking for" (Bayley). He connected this "extra-spatial unit with the conception of time" (Bayley).

As Bayley states, "the parallels between Hamilton's maths and the Hatter's tea party are uncanny" (Bayley) (she also suggests that perhaps tea party should be read as "t-party" since "t" is the variable usually assigned to time in math. This seems a bit of a stretch, though Carroll would have probably enjoyed the pun). When one reads this scene with quaternions in mind, the Hatter, Hare, and Dormouse become the three terms in a quaternion. The fourth term is of course Time, who is absent because he has had a falling out with (or has perhaps been murdered by) the Hatter. Just as the three variables of an incomplete quaternion can

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[19] A plane is a flat, two-dimensional surface that is often used in geometry. They are most frequently represented as rectangles.

only rotate around a plane without time, the three members of the tea party are stuck at their table, perpetually rotating around it in order to find clean cups. If Time was to return they would be able to move in three-dimensions, rather than just two, and therefore would no longer be condemned to circle their table.

The prospect of the Mad Tea Party being based on quaternions provides an additional twist to the Hare, Hatter, and Dormouse's insistence that language is not commutative. Quaternions are non-commutative[20]. Bayley theorizes that the idea of this, "must have grated on a conservative mathematician like Dodgson, since non-commutative algebras contradicted the basic laws of arithmetic" (Bayley). Alice's statement that "I say what I mean" is the same as "I mean what I say" is not as non-commutative as the members of the tea party claim it is. The meanings, while slightly different, are really rather similar. Possibly, because the Hatter, Hare, and Dormouse are the personification of quaternions, commutativity simply does not exist in their world in any form. While they are correct that language is not usually commutative, they are not necessarily correct that Alice's statement is entirely false. However, to them, order *always* determines meaning and switching that order will *always* change the meaning.

Quaternions serve as a macrostructure for the general nonsense of the Mad Tea Party. Carroll bases his characters and their actions on this concept, personifying arbitrary variables and imagining what would happen to their sanity if they were really trapped rotating around a flat plane. Carroll makes math, or what may have been nonsense math in his opinion, come

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[20] Howard Eves says, "Hamilton was forced…to invent an algebra in which the commutative law of multiplication does not hold. The radical step of abandoning the commutative law did not come easily to Hamilton; it dawned on him only after years of cogitation on a particular problem" (Eves 505).

to life. He even seems to give Time a personality. The situation is mad, the characters are mad, and the entire chapter is simply soaked in silliness.

This scene is nonsensical for several reasons. Firstly, the antics of the Hatter, Hare, and Dormouse is disarming and confusing. It is unlikely the reader has ever encountered people who act as these characters do, and therefore the mad behavior sits outside of the reader's mental scheme. Furthermore, the parody of a well-known social custom adds to this confusion. Instead of getting up and leaving the table after finishing their tea, the Hatter, Hare, and Dormouse rotate around to the next set of dishes and have teatime all over again. Just as the repetition of "do cats eat bats" causes the answer to Alice's queries to become irrelevant, the endless of tea time and (as a result) the nonstop repetition of tea parties causes all purpose and meaning to be stripped from the practice in general, as well as it being ascribed a daily time.

Bayley notes that when Alice leaves the party, the Hatter and the Hare are attempting to stuff the Dormouse into the teapot. "This could be their route to freedom," Bayley says. "If they could loose the Dormouse, they could exist independently, as a complex number with two terms. Still mad, according to Dodgson, but free from an endless rotation around the table" (Bayley). Perhaps they do manage to eventually lose the Dormouse: both the Hatter and the Hare appear in *Through the Looking-glass*, but the Dormouse does not.

By modeling the "Mad Tea Party" on quaternions Carroll inevitably ends up treating his characters as variables. As we have seen, he approaches sentences this way as well. He uses the commutative property as the structural force, and then, disregarding semantic meaning, treats words as variables that can be reordered with in the sentence. However, these are not the only instances or ways in which he treats words as variables. As we will see in

"Chapter III: Mirror Math," Carroll continues to approach words as a mathematician approaches in *Through the Looking-glass and What Alice Found There*.

Two variables attempt to gain freedom from their endless rotation by removing the third from the picture.

Chapter III: Mirror Math

The Queens quiz Alice.

It is important when studying the *Alice* books to distinguish *Alice's Adventures in Wonderland* and *Through the Looking-glass and What Alice Found There* as separate texts. They often are grouped together in the popular consciousness (as in Disney's *Alice in Wonderland* which borrows characters and narratives from both books), but the sequel to *Alice's Adventures* is different from its predecessor in many ways. *Looking-glass* borrows its underlying structure from a chess problem, which provides the narration with a more "systematic progression" (Knoepflmacher 224) than *Wonderland*. They also differ in the method of and intent behind their creation. While *Wonderland* was fabricated partly on the spot for one particular little girl and then added to and edited for publishing, its sequel was conceived with the intent to publish. Additionally, Alice herself is a very different character. She does not change size or shape in *Looking-glass*: rather, the creatures around her (such as the chess pieces and the Gnat) change and her "memorized poems" no longer come out "ventriloquially altered" (198). These differences allow Alice to feel secure in her identity. She is "less of a pawn" (196) than she was in *Wonderland* and thus no longer a structure

Carroll can use to graft his nonsense onto. The mathematical influence on the author's linguistic play also proves to be quite different in the sequel. In *Wonderland*, Carroll leans heavily on previously defined structures, such as arithmetic, popular poetry, logic, and proofs. In *Looking-glass* the mathematics are often more subtle, such as in the case of the poem "Jabberwocky" and Alice's interaction with Humpty Dumpty. In these instances the author's mathematical influence can be seen in the way in which words are treated as variables with no or flexible referential values. Even in the more obvious occurrences of mathematical linguistic play, such as when Carroll parodies simple arithmetic problems and slips an equation into a poem in the chapter "Queen Alice," the author fiddles with the referentality of numbers and words. The result of this play is the denial of clear meaning and the creation of perplexing situations.

i. Beware the what?

Any discussion of Lewis Carroll's linguistic play would not be complete without touching upon "Jabberwocky." This poem certainly is not expressed in "terms of our world experience" (Teisser 233) and requires a reader to pick it apart to come even vaguely close to a "scheme that is" in terms of "our world experience" (233). The first stanza[21] of what is perhaps Carroll's most famous nonsense poem appeared in 1855 in *Mischmasch*, which was a part of a series of "periodicals" that Carroll wrote when he was young (*AA* 148 note 16). "Jabberwocky" is strikingly different from "How doth the little crocodile" and "Twinkle, Twinkle, little bat" in two key ways. Firstly, it is not a parody poem; it is an original poem by Carroll. Secondly, it employs a different form of linguistic play. In "How doth the little crocodile" Carroll changes important words of "Against Idleness and Mischief" in order to

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[21] The stanza was originally presented as a "Stanza of Anglo-Saxon Poetry."

distort the original meaning and create nonsense. In his parody of "The Star" he replaces key words with new names that do not fit with the attributes they are paired with. "Jabberwocky" does not aim to alter meaning or employ mismatched attributes. Instead, the author creates original verbs, nouns, and adjectives and then, with the use of traditional sentence construction and these new words, fashions a poem.

As Susan Stewart says, "the conjunctions and prepositions are 'spared' being turned into nonsense" and "the result is an exposure of metonymic relationships as purely systematic, as having no context outside of their own conventions" (Stewart 33). In his *Philosophy of Nonsense* Jean-Jacques Lecercle notes "the text is eminently readable…All the words can be pronounced, even the coined ones, because they all conform to the phonotactics of English" (Lecercle 21). He says that the syntax is also coherent, and that "we can ascribe a part of speech to every word" (21). It is semantics where "we draw a blank" (22). The poem is nonsense because Carroll's linguistic play makes it impossible to determine meaning even though he follows entirely correct linguistic structure.

It is possible to analyze this poem the same way we broke down the parody poems in "Chapter I"; however, it is unnecessary. In our analysis of "Jabberwocky" our goal is not to show that it is logically or formulaically identical to another poem. Rather the goal is to study the linguistic structure itself as a type of formula into which the author can plug his nonsense words. It is just as useful in this case, if not more so, to break it down linguistically. To illustrate this, we shall turn to the first two lines of "Jabberwocky." These lines state, "Twas brillig, and the slithy toves/Did gyre and gimble in the wabe" (*AA* 148). The nonsense words Carroll created for these lines are *brillig*, *slithy*, *toves*, *gyre*, *gimble*, and *wabe*. Let us first look at "It was brillig" (I use "It was" as it is the expanded version of "Twas"). Clearly "brillig" is being used to describe "It," therefore brillig is most likely an adjective or a noun like summer or Tuesday which describes a time. "The slithy" is describing "toves," so slithy must be an adjective and toves a noun. As "gyre" and "gimble" are describing what the "toves" *did*, they must be verbs. Finally, "wabe" is a noun as implied by the fact that it is preceded by the preposition "in." In addition to allowing the supporting words to help us determine the parts of speech, Carroll provides various hints in the formation of some of the nonsense terms themselves. For instance, it is easy to guess that the word "slithy" is an adjective even out of context because of its ending. Adjectives frequently end in "y" (for example, *nicely*, *tidy*, *mighty*, etc), whereas verbs and nouns do not. In some ways this makes the poem even more confusing. As fluent users of the English language, we can identify the parts of speech of these fabricated words, but we cannot determine their meaning. This is an odd sort of paradox. They fit into our perception of the English language structurally, but carry no referential meaning.

By employing the methods used in the previous paragraph, one can make a little more sense of "Jabberwocky" by analyzing it using traditional linguistic terms, which I have done for the first two stanzas of "Jabberwocky" below. The original stanzas are on the left and the linguistic breakdown on the right.

'Twas brillig, and the slithy toves
Did gyre and gimble in the wabe;
All mimsy were the borogoves,
And the mome raths outgrabe.
"Beware the Jabberwock, my son!
The jaws that bite, the claws that catch!
Beware the Jubjub bird, and shun
The frumious Bandersnatch!"

'Twas **adjective(2)**, and the **adjective(2)**
noun(1)
Did **verb(1)** and **verb(2)** in the **noun(1)**;
All **adjective(2)** were the **noun(3),**
And the **adjective(1) noun(1) verb(2)**.
"Beware the **Proper Noun(3),** my son!
The jaws that bite, the claws that catch!
Beware the **Proper Noun(2)** bird, and shun
The **adjective(3) Proper Noun(3)**!"

AA 148

Carroll treats the English language as a type of formula. Structure is maintained, but key variables are treated as arbitrary. Mathematicians can use any variable they prefer, whether it's x, y, z, k, etc[22], and determine its meaning. It is not against any rule for them to borrow symbols from other alphabets or create a symbol to use as a variable. They can apply any meaning they wish to their variables, as long as it fits within the structure of their formula. For example, let us take the Pythagorean theorem. This states that *a* squared plus *b* squared is equal to *c* squared[23] where *a* and *b* are the short sides of a right triangle and *c* is its

[22] I even once had a teacher who used symbols such as stars and spirals as variables.
[23] $a^2+b^2=c^2$

hypotenuse[24]. One can assign any numerical value to *a* and *b* with the result that *c* represents the hypothetical hypotenuse of an imagined right triangle with *a* and *b* as sides. However, it must be kept in mind that any values applied to *a* and *b* must represent the leg of a right triangle. While the value for *a* may be swapped with the value of *b*, the value of *c* cannot be substituted for either *a* or *b* because it is the wrong type of variable. Carroll treats language in a similar way. He puts adjectives where he should put adjectives, and nouns where he should put nouns. The result is a poem that follows an entirely valid linguistic formula. However, while mathematical formulas like the Pythagorean theorem gain value from their result, linguistic formulas gain meaning from the implications of their variables. As our poet uses words only he knows the meanings of[25] it is difficult for us to glean the significance of "Jabberwocky." While the nouns and adjectives he provides are identifiable as their respective parts of speech, their referential significance is nearly indeterminable.

Like a mathematician using arbitrary variables (or Humpty Dumpty who we will discuss soon) Carroll can make his nonsense words refer to whatever he wants them to and does. He does supply meanings to some of these words (though not all of them), but since he

[24] A right triangle is a triangle that has a ninety-degree angle made up by the two legs of the triangle (*a* and *b*). The hypotenuse (c) is the third and longest side.

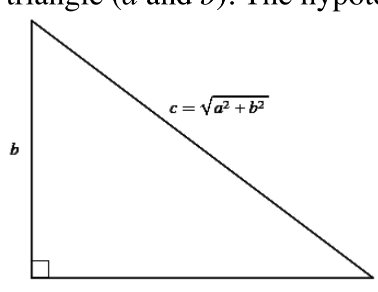

Image From "Pythagorean Theorem" <http://mathworld.wolfram.com/PythagoreanTheorem.html>.

[25] It is entirely possible that these nonsense words were created with no intended meaning at all. The Hatter's famous riddle, "Why is a raven like a writing-desk?," was originally created with no particular answer in mind. It would not be out of Carroll's character to also create words with no meaning.

is free to assign whatever value he wishes, he is also free to change that value if it suits him. When he printed the first stanza in *Mischmasch* he informed his readers that "gyre" means "to scratch like a dog," "gymble" to "screw out holes in anything," and "wabe" the "side of a hill" (*AA* 149 note 16). In *Through the Looking-glass* Carroll defines these terms again, this time through his character Humpty Dumpty, who Alice asks to help her understand "Jabberwocky." Humpty, who claims that he "can explain all the poems that were invented—and a good many that haven't been invented just yet" (214), tells Alice that "gyre" means "to go round and round like a gyroscope," "gymble" to "make holes like a gimblet," and "wabe" refers to the "grass-plot around a sun-dial" (215).

ii. The Egghead

Critics have much to say on Humpty Dumpty. Braithwaite calls him the "masterpiece of Lewis Carroll as unconscious logician" and says that the character "is spiritually in agreement with those mathematical logicians who insist that the meaning of a mathematical proposition is its proof. But it is his uncompromising attitude to words that makes him such a logical prophet" (Braithwaite 178). The egghead who helps Alice to understand "Jabberwocky" has a unique approach to language. Humpty Dumpty states, "When *I* use a word…it means just what I choose it to mean—neither more nor less." On this Buchalter says, "If he meant by this that he had the right to attach a word to whatever object he pleased, he was correct" (Buchalter 332). He continues that "This is the very essence of symbolic mathematics where calculations are carried out in symbols, and it does not matter what we call them so long as we are consistent" (332). Pycior, who seems to be of a similar mind, points out, "Humpty Dumpty makes two points: words (like algebraic symbols) can have multiple meanings and he (like the symbolic algebraist) gets to determine those meanings."

Humpty Dumpty treats words like arbitrary variables and applies whatever meaning he wants to them. Arguably, this is not just something done by symbolic algebraists. Humpty's approach to words mimics a mathematician's approach to variables in general. In the world of mathematics, a mathematician gets to choose what a variable stands for. For instance, the variable "*c*" is frequently used to represent the hypotenuse of a right triangle, but it is also often used to denote a constant. However, if a mathematician chooses it could also refer to a vector, the number forty-two, or anything else that suits the mathematician's fancy, as long as he or she initially inform their reader of what the symbol stands for. Carroll believed that logicians had this power too. As Gardner points out, Carroll writes in his *Symbolic Logic* "I maintain that any writer of a book is fully authorized in attaching any meaning he likes to any word of phrase he intends to use…every writer may adopt his own rules, provided of course that it is consistent with itself and with the accepted facts of Logic" (*Symbolic Logic* 166).

In his assignment of meaning to words Humpty does not inform his reader of their new connotations before using them, and therefore, like a mathematician who forgets to define his variables before embarking on a proof, he fails to ensure his readers can follow his argument logically. Additionally, as Carroll shows time and time again, words are not variables. While a mathematician or logician may assign new significance to words or variables, there is no such accepted practice in language. The effect of this is that Humpty Dumpty cannot possibly make sense to anyone (at least not anyone from Alice's side of the mirror), but himself. Gardner says, "if we wish to communicate accurately we are under a kind of moral obligation to avoid Humpty's practice of giving private meanings to commonly used words" (*AA* 215 note 11). As Peter Hunt says, "It takes a genuine adult egghead to have the confidence that his interpretations are the *correct* ones" (Hunt 41).

While "Jabberwocky" denies the reader any form of semantic reference by using nonsense words, Humpty undermines the referential meaning of words by changing their meanings to something entirely unexpected with no warning. When Alice asks Humpty Dumpty to explain what he meant by "impenetrability," which is one of the words he applies his own personal meaning to, he says, "I meant by 'impenetrability' that we've had enough of that subject, and it would be just as well if you'd mention what you mean to do next, as I suppose you don't mean to stop here all the rest of your life." Alice replies, "That's a great deal to make one word mean" (*AA* 213). She is, of course, quite right. Humpty Dumpty is taking several words and phrases and grouping them under one word. This is arguably similar to grouping constants, or allowing a variable to equal an equation of other variables (for example, $x = ab+c$) which is a method sometimes used to simplify complex formulas. However, while mathematicians define and group variables howsoever they choose, they do so in the pursuit of clarity. Their goal is to solve a problem. Carroll's goal here is entirely the opposite: to confuse, baffle, bewilder, entertain, and complicate. Humpty's needless grouping of definitions does not simplify his sentence and allow his audience to see the bigger picture as a mathematician's grouping of variables often does. Rather, it creates confusion by stripping meaning from his words and thus rendering his formally constructed sentences meaningless. While his language may make perfect sense to the egghead (and perhaps to all the other occupants of the looking-glass world), from the view of Alice and the reader, he is speaking total nonsense.

Though Humpty follows the rules of mathematics in his approach to language, he finds simple arithmetic quite difficult. We see this when the egghead is trying to explain the concept of unbirthdays to Alice. Their conversation starts off rather like a lesson might. Humpty assumes the role of the teacher and attempts to lead Alice to comprehend the subject by asking her a series of questions. He asks her first, “How many days are there in a year?” and then how many birthdays she has, and then, as Alice has answered first “three hundred and sixty-five” and then “one,” he asks, “if you take one from three hundred and sixty-five, what remains?” (*AA* 212). Alice tells him “three hundred and sixty-four, of course” (212). It is at this point that the traditional child-adult, or student-teacher, roles switch. Humpty (clearly struggling) “requires the figuring of the sum as well as its expression in words, so that he may the better verify the arithmetic” (Sewell 62). Alice humors him and “worked the sum for him” (*AA* 212). This is the only mathematical problem written using numbers instead of words in either book. Humpty remains perplexed, finding it to seem “to be done right” (212) when he initially holds it upside down and when he finally turns it the right way up. He is rather childishly willing to unquestionably accept her as an authority on this basic arithmetic. Humpty starts the conversation in the role of the teacher and adult, but ends the lesson as the child student with Alice, the child, filling the role of the adult teacher. The general structure of a lesson is maintained, but the “inversion of hierarchical relationships” (Stewart 68) creates a rather nonsensical situation. Sewell says that nonsense is a collection of “events which in their arrangement do not fit into some recognized system in a particular mind” (Sewell 3). This role reversal undermines the general scheme of adult teachers and child students.

It is also interesting that these numbers all have defined referential values, something Carroll frequently denies numbers in the *Alice* books. The number “365” refers to the days of the year and “1” refers to the number of birthdays a year. However, “364” is more problematic. It refers to “unbirthdays.” While Carroll does not deny the number a reference, he provides one of his own creation. Normally, in this subtraction problem “364” would refer to the number of days a year when it is not one’s birthday, but Humpty has redefined this. Those 364 days are now not the ordinary, boring, not birthdays, but “unbirthdays” which are special and celebratory occasions. By changing the expected referential value of 364, the egghead inverts the popular view of birthdays and regular days and created a parody of a popular social convention (not dissimilarly to the Mad Tea Party).

iii. Queenly Math Test

While Humpty Dumpty’s subtraction sum is perhaps the easiest bit of mathematics to spot in both the *Alice* books, several of the most obvious examples of mathematics in *Through the Looking-glass* occur in the chapter “Queen Alice.” Alice has finally made it to the Eighth Square and has been crowned Queen. However, she cannot be Queen until she has “passed the proper examination” (*AA* 251). The Red and White Queen begin her test by presenting Alice with several “math” questions. It is perhaps good to pause here and note that in both *Wonderland* and *Looking-glass* the first subject that is turned to in order to test knowledge is mathematics. In *Wonderland* Alice used the multiplication table to test her identity. Here, the Queens primarily ask the girl questions of Addition, Subtraction, and Division, or rather the Queens’ versions of each. The White Queen begins the test by providing Alice with the addition problem, “What’s one and one and one and one and one and one and one and one and one and one” (253). Alice’s response to this query is “I don’t know…I lost count" (253). Like Alice's seemingly misspoken multiplication facts in *Wonderland*, this problem is an example of what Hunt would identify as "remorseless logic masquerading as nonsense" (Hunt 37). Even though the equation is created by using the linguistic equivalent of an addition sign ("and"), as well as the written form of the number "one" (rather than the numeral "1"), this is an entirely valid arithmetic problem. However, its presentation is confusing. Elizabeth Sewell has this to say on the matter:

> Alice cannot answer, and this is not just an accident…the sum-total is unimportant; it is the composition of it that matters for this is to be the composition of the universe of Nonsense, a collection of ones which can be summed together into a whole but which can always fall back into separate ones again. (Sewell 54)

Here, Sewell takes this one relatively simple arithmetic problem, and connects it the concept of literary Nonsense as a whole. However, her phrase "a collection of ones which can be summed together into a whole" also describes mathematics, or at least arithmetic, very well. At its core, this is perhaps what mathematics is. This is also why this relatively simple sum (which amounts to ten) is so nonsensical. While math is a collection of ones, we usually approach it in a form where the many ones have been summed into two or three groups, i.e. larger numbers. In the White Queen's problem they have fallen "back into separate ones" making the problem technically accurate, but otherwise confusing. By choosing a small sum and repeating it "a great many times in succession" (Lecercle 23) Carroll denies the reader the knowledge of what the numbers refer to, in other words their sum, thus making the problem confusing and nearly incomprehensible.

Later in the exam, the Red Queen asks Alice "Take a bone from a dog: what remains?" (*AA* 253). If one replaces "a bone" and "a dog" with the variables x and y, the problem looks like this: Take x from y. What remains?[26] This is pretty standard mathematical language and not a complicated problem if one knows the values of x and y. Carroll uses basic mathematical language, but instead of variables he uses real things, in this case "a dog" and "a bone." He follows the structure of a math problem, but creates nonsense by swapping variables or numbers out in preference of nouns. The Red Queen informs Alice that the answer to the problem is that "the dog's temper would remain…the dog would lose its temper" (254). She treats the dogs temper as if it is a physical thing, not something abstract. She follows the form of the expression "lose your temper," but allows a temper to be a real physical thing that one could misplace. The Red Queen treats "temper" as a word that does not refer to something abstract, but as an attribute that can exist without a thing (like a grin without a cat), therefore changing "temper's" referential value. Even Alice thinks they are talking "dreadful nonsense" (254).

iv. The Problem of Negative Numbers

There is one more example of nonsense math for Alice's Queen Test that must be discussed. Upon deciding Alice is incapable of addition, the Red Queen asks, "Can you do Subtraction? Take nine from eight," to which Alice replies, "Nine from eight I ca'n't, you know" (*AA* 253). This problem employs the mathematical language we see in "take a bone from a dog," but uses real numbers instead. So why is this nonsense? To any modern adult reader the answer to the subtraction sum is negative one. However, to a child or the Victorian reader, the answer is not so simple. Carroll made quips about negative numbers in *Alice's*

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[26] In equation form, this would be "y-x=?."

Adventures in Wonderland as well as in *Through the Looking-glass*. In explaining the history behind her argument in "Mathematics and Humor," Pycior states the following:

> Although regarded as somewhat questionable when introduced into European mathematics during the Renaissance, the negative and imaginary numbers emerged as a clearly defined problem only in the late eighteenth century, when critics declared that they could form no clear concept of either kind of number, and that the standard definitions of both were nonsensical. Textbooks of the period defined a negative number as a "quantity less than nothing…" (Pycior 151)

It seems Carroll found the logical paradox of a "quantity less than nothing" rather problematic because, as Pycior also points out, he seems to slip in many subtle "quips" about negative numbers throughout *Alice's Adventures in Wonderland* and *Through the Looking-glass*.

In *Wonderland,* Carroll points out the logically problematic side of negative numbers. How can you have less than nothing? The first example of this occurs at the Mad Tea Party. The Mad Hatter says in response to Alice's statement that she cannot take any more as she has not had any yet, "You mean you can't take *less* [than nothing]…it's very easy to take *more* than nothing" (*AA* 75). The Hatter "proclaims the impossibility of subtracting something from nothing" (Pycior 164) and forces readers to consider the concept of "less tea than contained in an empty cup" (165).

The concept of negative numbers comes up again when the Mock Turtle discusses his lessons with Alice. When Alice asks how many hours of lessons the Mock Turtle had a day, he replies "Ten hours the first day…nine the next, and so on" (*AA* 99). Alice inquires, "how did you manage on the twelfth?" (99), but the Gryphon, possibly unwilling to address or acknowledge the concept of less than zero hours of lessons, quickly changes the subject. In both the case of the Mock Turtle's lessons and the case of Alice's lack of tea, Carroll points out the logical paradox of having a "quantity less than nothing" by presenting physical, nonmathematical situations where the concept proves to be nonsensical. Even though negative numbers are now common place and do not seen to be problematic at all, these instances are still moments of nonsense, and they are still cases of mathematic paradox, albeit now historical ones.

In her book on nonsense, Elizabeth Sewell says, "In logic, nonsense takes the form of contradiction, the breaking of the rules of the game" (Sewell 2). By this definition, negative numbers can be seen as nonsense, purely by the definition assigned to them in the 1800s. The definition breaks the simply rule that 'you can't have less than nothing'. This rule is of course dependent on how 'nothing' is defined. Carroll probably found this definition logically problematic or contradictory, though I doubt that he found the concept of negative numbers so as their practical application in the idea of debt has been prevalent in economic structures for centuries. It is only when one insists that numbers are referential to things, such as cups of tea or lessons, that negative numbers becomes problematic. It is interesting that he, at least in the Mad Tea Party scene, mentions the definition of negative numbers, but does not address the concept itself.

This brings us back to the Red Queen's query, "take nine from eight." This is problematic and nonsensical on multiple levels. The fact that the answer is a negative number once again brings up the nonsensical, paradoxical definition of negative numbers. There is a certain amount of absurdity in such a subtraction sum being presented to a child Alice's age.

To any seven-and-a-half year old child, whether Victorian or modern, negative numbers exist outside the realm of comprehension. At such an age, numbers are still viewed as primarily referential to things. The language is what they have come to expect from a subtraction problem, and the numbers on their own make sense, but the order is "not quite right" (*AA* 52). The correct structure is followed, but meaning is lost because, similarly to the Hatter's statement "I eat what I see" (71), in subtraction sums order determines meaning, and this one, in Alice's young eyes, can have none.

v. The Final Feast

Alice's test is not the last instance of easily noticeable arithmetic. After Alice becomes Queen a great feast is thrown for her. It is the point in the book where all pretence of order is abandoned in favor of chaos. Knoepflmacher says that when Alice takes the Red Queen, and thus wins the game, in her eleventh move, "the victor is not Alice, but an invisible opponent who reasserts the *Wonderland* anarchy he has for so long kept in abeyance" (Knoepflmacher 219). He further states that the "systematic progression of the first eight chapters is brought to an abrupt halt" at the beginning of "Queen Alice" and that "anarchy now returns…the narrator reassumes his *Wonderland* persona" (Knoepflmacher 223-224). In the feast scene a song is sung for Alice, the final verse of which is:

> Then fill up the glasses with treacle and ink,
> Or anything else that is pleasant to drink:
> Mix sand with the cider, and wool with the wine—
> And welcome Queen Alice with ninety-times-nine! (*AA* 254)

There is a certain amount of absurdity in including an arithmetic problem in a poem. On this Sewell says, "two separate series are touched off in the mind. The second, the series of whole numbers, is not in any way related, by reference, to the first which is a series of things" (Sewell 67). Similarly to the twinkling bats and flying tea trays of "Twinkle, Twinkle little bat," none of the things in this poem seem to relate or have enough attributes in common to be paired together. The attributes that the things are paired with are entirely outside our perception of the world. Ink is not pleasant to drink, or rather it is not something that is drunk, and it would be more fitting to welcome a Queen with a cheer or raised glasses than an arithmetic problem. Additionally, "ninety-times-nine" does not fit in with the other "things" or subjects of the poem. While sand, cider, wool, and wine are all physical objects (either liquid or solid), the equation is a mental process. For it to fit in this poem it would need to be ascribed to something, be made an attribute of a thing, rather than a thing itself. Instead it is merely a collection of numbers with no referential value. Once again the Mad Adder has added math and literature and produced nonsense.

As Alice journeys across the chessboard landscape of the looking-glass world she comes across many instances of Carrollian nonsense. These occurrences demonstrate mathematical influence in both obvious and subtle ways. In her interaction with Humpty Dumpty and her encounter with "Jabberwocky" the nature of the referentiality of variables is reflected in the lack of known or consistent referential values of words and numbers. When she reaches her goal of crossing the entire chess board and being crowned queen, she encounters more examples of this. In this case, the forms of mathematical language and numbers are used to create mathematical queries with no logical, referential conclusions or purposes. Alice herself, as a little girl of seven-and-a-half, a pawn on the looking-glass chessboard, and a queen, is a figure whose referential value is toyed with, changed, and added to. While Alice is not a structure that nonsense is grafted onto as she was in

Wonderland, she is a variable in Carroll's game whose value is dependent upon the author's whims. It is a true combination of mathematics and literature in which the characters themselves are treated as variables.

The Red and White Queen take a nap after testing the newly crowned Queen Alice.

Final Thoughts

I started this project intending to answer the question "How does Lewis Carroll's mathematical background effect his nonsense in the *Alice* books?" This text is incredibly unique in many ways, but its most unique quality is the blend of mathematics and literature that form the majority of Carroll's nonsense. In *Alice's Adventures in Wonderland* Carroll treats words as variables he can interchange and rearrange to create new semantic meaning. He borrows the structure of mathematical properties as a form for his nonsense, and mimics proofs and logic to lead his readers to seemingly impossible conclusions. In *Through the Looking-glass* he continues to treat words as variables, but in a very different manner. He strips sentences of meaning by changing the definitions of words or providing nonsense words with no referential value, and creates arithmetic problems that have no other purpose than to confuse and entertain.

My original question led me down a rabbit hole of discovery in both a mathematical and nonmathematical sense. I originally expected Carroll's linguistic play to rely on many more distinct mathematical properties or theorems. While I did find many instances of mathematical properties, such as the multiplication table, proofs, commutative property, quaternions, and basic arithmetic language, I found that the most extraordinary instances of mathematical influence came from a general mathematical mindset in Carroll's approach to words as variables and referential meaning as something to be assigned by the author.

What led me to my initial question were the books themselves. I turned to them for the simple reason that they lie at the intersection of mathematics and literature. These texts exist in that intersection not just because Carroll's mathematics affected his works so much, but also because the *Alice* books have had an impact on the sciences (an area of study which shares a close relationship with math). It seems that these books, so nonsensical, fanciful, and seemingly entirely unscientific, have inspired many a scientist and mathematician, or been cited in order to explain a scientific or mathematic concept. Despite my curiosity about it, the scientific aspect was never a topic I was able to explore. Gardner added several notes to his *Annotated Alice* mentioning this topic. It is interesting to consider the possibility that these books, so heavily influenced by mathematics, may have gone on to have an impact on science, though I would not pretend to know what that impact is.

My curiosity about the *Alice* books' potential impact on science and mathematics is not the reason I bring this topic up. I mention it because it emphasizes the *Alice* books' unique position as an intersection between two areas of academics that are often entirely alien to each other. It is this that drew me to study the *Alice* books and it is the under appreciation of such rare intersection that committed me to these stories. I have a deep love and respect for both mathematics and literature, and, not unlike Lewis Carroll himself perhaps, I enjoy explorations of both topics. It is the "Mad Adder's" addition of these two seemingly unrelated subjects that makes *Alice's Adventures in Wonderland* and *Through the Looking-glass* so wonderful.

Alice emerges in the looking-glass world.

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