

a note that dominates the entire story. It would take too much space to list here all the instances, but the following examples make the point. To approach the Red Queen, Alice walks backward; in the railway carriage the Guard tells her she is traveling the wrong way; the King has two messengers, "one to come, and one to go." The White Queen explains the advantages of living backward in time; the looking-glass cake is handed around first, then sliced. Odd and even numbers, the combinatorial equivalent of left and right, are worked into the story at several points (e.g., the White Queen requests jam every other day). In a sense, nonsense itself is a sanity-insanity inversion. The ordinary world is turned upside down and backward; it becomes a world in which things go every way except the way they are supposed to.

Inversion themes occur, of course, throughout all of Carroll's nonsense writing. In the first *Alice* book Alice wonders if cats eat bats or bats eat cats, and she is told that to say what she means is not the same as meaning what she says. When she eats the left side of the mushroom, she grows large; the right side has the reverse effect. These changes in size, which take place so often in the first book, are in themselves reversals (e.g., instead of a large girl and small puppy we have a large puppy and small girl). In *Sylvie and Bruno* we learn about "imponderal," an antigravity wool that can be stuffed into parcel-post packages to make them weigh less than nothing; a watch that reverses time; black light; Fortunatus's purse, a projective plane with outside inside and inside outside. We learn that E-V-I-L is simply L-I-V-E backward.

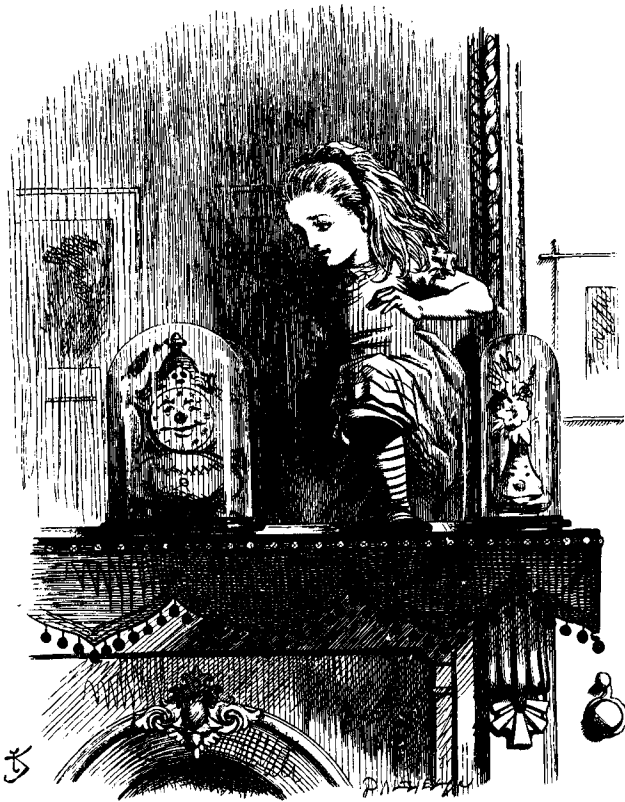
In real life also Carroll milked the notion of inversion as much as he could to amuse his child-friends. One of his letters speaks of a doll whose right hand becomes "left" when the left hand drops off; another letter tells how he sometimes goes to bed so soon after getting up that he finds himself back in bed *before* he gets up. He wrote letters in mirror writing that had to be held to a mirror to be read. He wrote letters that had to be read by starting at the last word and reading to the first. He had a collection of music boxes and one of his favorite stunts was to play them backward. He drew funny pictures that changed to different pictures when you turned them upside down.

Even in serious moments Carroll's mind, like

want so much to know whether they've a fire in the winter: you never *can* tell, you know, unless our fire smokes, and then smoke comes up in that room too—but that may be only pretence, just to make it look as if they had a fire. Well then, the books are something like our books, only the words go the wrong way: I know *that*, because I've held up one of our books to the glass, and then they hold up one in the other room.

"How would you like to live in Looking-glass House, Kitty? I wonder if they'd give you milk in there? Perhaps Looking-glass milk isn't good to drink⁶—but oh, Kitty! now we come to the passage. You can just see a little *peep* of the passage in Looking-glass House, if you leave the door of our drawing-room wide open: and it's very like our passage as far as you can see, only you know it may be





quite different on beyond. Oh, Kitty, how nice it would be if we could only get through into Looking-glass House! I'm sure it's got, oh! such beautiful things in it! Let's pretend there's a way of getting through into it, somehow, Kitty. Let's pretend the glass has got all soft like gauze, so that we can get through. Why, it's turning into a sort of mist now, I declare! It'll be easy enough to get through—" She was up on the chimney-piece⁷ while she said this, though she hardly knew how she had got there. And certainly the glass *was* beginning to melt away, just like a bright silvery mist.

In another moment Alice was through the glass,⁸ and had jumped lightly down into the Looking-glass room. The very first thing she did was to look whether there was a fire in the fireplace, and she was quite pleased to find that there was a real one, blaz-

that of the White Knight, seemed to function best when he was seeing things upside down. He invented a new method of multiplication in which the multiplier is written backward and *above* the multiplicand. *The Hunting of the Snark*, he tells us, was actually composed backward. The final line, "For the Snark *was* a Boojum, you see," came into his head as a sudden inspiration, then he fashioned a stanza to fit the line and finally a poem to fit the stanza.

Closely related to Carroll's inversion humor is his humor of logical contradiction. The Red Queen knows of a hill so large that, compared to it, this hill is a valley; dry biscuits are eaten to quench thirst; a messenger whispers by shouting; Alice runs as fast as she can to stay in the same place. It is not surprising to learn that Carroll was fond of the Irish bull, of which logical contradiction is the essence. He once wrote to his sister: "Please analyze logically the following piece of reasoning: *Little Girl*: 'I'm so glad I don't like asparagus.' *Friend*: 'Why, my dear?' *Little Girl*: 'Because if I *did* like it, I should have to eat it—and I can't bear it!'" One of Carroll's acquaintances recalled hearing him speak about a friend he knew whose feet were so big that he had to put his trousers on over his head.

Treating a "null class" (a set with no members) as though it were an existing thing is another rich source of Carrollian logical nonsense. The March Hare offers Alice some nonexistent wine; Alice wonders where the flame of a candle is when the candle is not burning; the map in *The Hunting of the Snark* is "a perfect and absolute blank"; the King of Hearts thinks it unusual to write letters to nobody, and the White King compliments Alice on having keen enough eyesight to see nobody at a great distance down the road.

Why was Carroll's humor so interwoven with logical twists of these sorts? We shall not enter here into the question of whether Carroll's interest in logic and mathematics is a sufficient explanation, or whether there were unconscious compulsions that made it necessary for him to be forever warping and stretching, compressing and inverting, reversing and distorting the familiar world. Surely the thesis advanced by Florence Becker Lennon in her otherwise admirable biography *Victoria Through the Looking Glass* is hardly adequate. She argues that Carroll was born left-handed but forced to use his right hand, and that "he took his revenge by

doing a little reversing himself." Unfortunately there is only the flimsiest, most unconvincing evidence that Carroll was born left-handed. Even if true, it seems a woefully inadequate explanation for the origin of Carrollian nonsense.

R. B. Shaberman, writing on the influence of George MacDonald on Carroll (*Jabberwocky*, Summer 1976), quotes the following passage from Chapter 13 of MacDonald's 1858 novel, *Phantastes*:

What a strange thing a mirror is! And what a wondrous affinity exists between it and a man's imagination! For this room of mine, as I behold it in the glass, is the same and yet not the same. It is not the mere representation of the room I live in, but it looks just as if I were reading about it in a story I like. All its commonness has disappeared. The mirror has lifted it out of the region of fact into the realms of art. . . . I should like to live in that room if I could only get into it.

6. Alice's speculation about looking-glass milk has a significance greater than Carroll suspected. It was not until several years after the publication of *Through the Looking-Glass* that stereochemistry found positive evidence that organic substances had an asymmetric arrangement of atoms. Isomers are substances that have molecules composed of exactly the same atoms, but with these atoms linked together in structures that are topologically quite different. Stereoisomers are isomers that are identical even in topological structure, but, owing to the asymmetric nature of this structure, they come in mirror-image pairs. Most substances that occur in living organisms are stereoisometric. Sugar is a common example; in right-handed form it is called dextrose, in left-handed form, levulose. Because the intake of food involves complicated chemical reactions between asymmetric food and asymmetric substances in the body, there often are marked differences in the taste, smell, and digestibility of left- and right-handed forms of the same organic substance. No laboratory or cow has yet produced reversed milk, but if the asymmetric structure of ordinary milk were to be reflected, it is a safe bet that this looking-glass milk would *not* be good to drink.

In this judgment on looking-glass milk only a reversal of the structure by which the milk's atoms are linked to each other is considered. Of course a true mirror reflection of milk would also reverse the structure of the elementary par-

ing away as brightly as the one she had left behind. "So I shall be as warm here as I was in the old room," thought Alice: "warmer, in fact, because there'll be no one here to scold me away from the fire. Oh, what fun it'll be, when they see me through the glass in here, and ca'n't get at me!"

Then she began looking about, and noticed that what could be seen from the old room was quite common and uninteresting, but that all the rest was as different as possible. For instance, the pictures on the wall next the fire seemed to be all alive, and the very clock on the chimney-piece (you know you can only see the back of it in the Looking-glass) had got the face of a little old man, and grinned at her.

"They don't keep this room so tidy as the other," Alice thought to herself, as she noticed several of the chessmen down in the hearth among the cinders; but in another moment, with a little "Oh!" of surprise, she was down on her hands and knees watching them. The chessmen were walking about, two and two!

"Here are the Red King and the Red Queen," Alice said (in a whisper, for fear of frightening them), "and there are the White King and the White Queen sit-



ting on the edge of the shovel—and here are two Castles walking arm in arm⁹—I don't think they can hear me," she went on, as she put her head closer down, "and I'm nearly sure they ca'n't see me. I feel somehow as if I was getting invisible—"

Here something began squeaking on the table behind Alice, and made her turn her head just in time to see one of the White Pawns roll over and begin kicking: she watched it with great curiosity to see what would happen next.

"It is the voice of my child!" the White Queen cried out, as she rushed past the King, so violently that she knocked him over among the cinders. "My precious Lily! My imperial kitten!" and she began scrambling wildly up the side of the fender.

"Imperial fiddlestick!" said the King, rubbing his nose, which had been hurt by the fall. He had a right to be a *little* annoyed with the Queen, for he was covered with ashes from head to foot.

Alice was very anxious to be of use, and, as the poor little Lily was nearly screaming herself into a fit, she hastily picked up the Queen and set her on the table by the side of her noisy little daughter.

The Queen gasped, and sat down: the rapid journey through the air had quite taken away her breath, and for a minute or two she could do nothing but hug the little Lily in silence. As soon as she had recovered her breath a little, she called out to the White King, who was sitting sulkily among the ashes, "Mind the volcano!"

"What volcano?" said the King, looking up anxiously into the fire, as if he thought that was the most likely place to find one.

"Blew—me—up," panted the Queen, who was still a little out of breath. "Mind you come up—the regular way—don't get blown up!"

Alice watched the White King as he slowly struggled up from bar to bar,¹⁰ till at last she said "Why,

articles themselves. In 1957 two Chinese-American physicists, Tsung Dao Lee and Chen Ning Yang, received the Nobel Prize for theoretical work that led to the "gay and wonderful discovery" (in Robert Oppenheimer's happy phrase) that some elementary particles are asymmetric. It now appears likely that particles and their antiparticles (that is, identical particles with opposite charges) are, like stereoisomers, nothing more than mirror-image forms of the same structure. If this is true, then looking-glass milk would be composed of "anti-matter," which would not even be drinkable by Alice; both milk and Alice would explode as soon as they came in contact. Of course an anti-Alice, on the other side of the looking-glass, would find anti-milk as tasty and nourishing as usual.

Readers who would like to learn more about the philosophical and scientific implications of left- and right-handedness are referred to Hermann Weyl's delightful little book on *Symmetry* (1952) and Philip Morrison's article "The Overthrow of Parity," in *Scientific American* (April 1957). On the lighter side there is my discussion of left-right topics in the last chapter of *The Scientific American Book of Mathematical Puzzles and Diversions* (1959) and my story "Left or Right?" in *Esquire* (February 1951). The classic science-fiction tale involving left-right reversal is "The Plattner Story" by H. G. Wells. And one must not overlook *The New Yorker's* Department of Amplification, December 15, 1956, page 164, in which Dr. Edward Teller comments with Carrollian wit on a previously published *New Yorker* poem (November 10, 1956, page 52) that describes the explosion that occurred when Dr. Teller shook hands with Dr. Edward Anti-Teller.

Recent nontechnical references on the symmetry and asymmetry of space and time include *Reality's Mirror: Exploring the Mathematics of Symmetry*, by Bryan Bunch (Wiley, 1989); my *New Ambidextrous Universe* (W. H. Freeman, 1990); and "The Handedness of the Universe," by Roger Hegstrom and Dilip Kondepudi, in *Scientific American* (January 1990).

There is considerable speculation among atomic scientists about the possibility of creating antimatter in the laboratory, keeping it suspended in space by magnetic forces, then combining it with matter to achieve a total conversion of nuclear mass into energy (in contrast to both fusion and fission in which only a small portion of mass is so converted). The road to

ultimate nuclear power may, therefore, lie on the other side of the looking glass.

7. For American readers: the chimneypiece is the mantel. A number of science-fiction writers have used the mirror as a device for joining our world to a parallel world: Henry S. Whitehead's "The Trap," Donald Wandrei's "The Painted Mirror," and Fritz Leiber's "Midnight in the Mirror World" are three such stories.

8. Tenniel's pictures of Alice passing through the mirror are worth studying. Observe that in the second illustration he added a grinning face to the back of the clock and to the lower part of the vase. It was a Victorian custom to put clocks and artificial flowers under glass bell jars. Less obvious is the gargoyle, sticking out its tongue, in the ornament at the top of the fireplace.

The pictures also show that Alice is not reversed on the other side of the glass. She continues to raise her right arm and to kneel on her right leg.

Note the name "Dalziel" at the bottom of both pictures, as well as on most of Tenniel's illustrations in both *Alice* books. The Dalziel brothers were the wood engravers for all of Tenniel's drawings. Observe also that Tenniel has reversed his monogram in the second picture.

We are told later on that the pictures on the wall near the fire seem to be alive. Peter Newell indicated this in his illustration of Alice emerging from the mirror. In the 1933 Paramount motion picture the pictures on the wall come alive and talk to Alice.

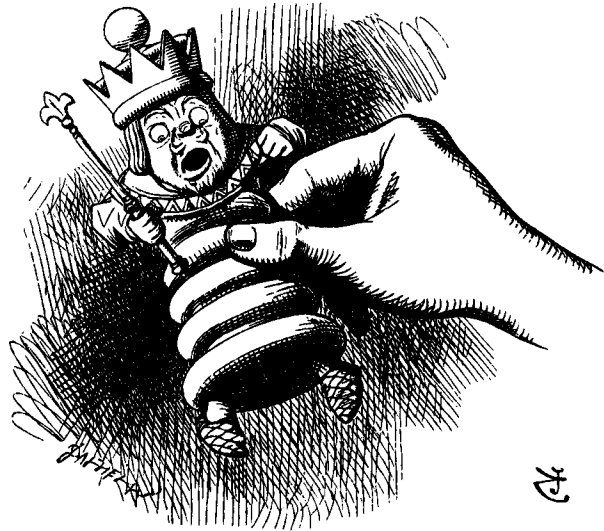
In all standard editions, the two pictures are on opposite sides of a leaf, as if the leaf itself was the mirror Alice passed through. A Puffin edition (1948) puts the pictures on its front and back covers, making the book the mirror.

9. Notice how Tenniel has suggested mirror reflections in his pairing of chess pieces in the illustration for this scene. Although Carroll never mentions bishops (perhaps out of deference to the clergy), they can be seen clearly in Tenniel's drawing. Isaac Asimov's mystery story "The Curious Omission," in his *Tales of the Black Widow Spiders*, derives from Carroll's curious omission of chess bishops.

10. The White King's slow struggle up the fender, from bar to bar, reflects the fact that although a chess king can move in any direction

you'll be hours and hours getting to the table, at that rate. I'd far better help you, hadn't I?" But the King took no notice of the question: it was quite clear that he could neither hear her nor see her.

So Alice picked him up very gently, and lifted him across more slowly than she had lifted the Queen, that she mightn't take his breath away; but, before she put him on the table, she thought she might as well dust him a little, he was so covered with ashes.



She said afterwards that she had never seen in all her life such a face as the King made, when he found himself held in the air by an invisible hand, and being dusted: he was far too much astonished to cry out, but his eyes and his mouth went on getting larger and larger, and rounder and rounder, till her hand shook so with laughing that she nearly let him drop upon the floor.

"Oh! *please* don't make such faces, my dear!" she cried out, quite forgetting that the King couldn't hear her. "You make me laugh so that I can hardly hold you! And don't keep your mouth so wide open! All the ashes will get into it—there, now I think you're tidy enough!" she added, as she smoothed his hair,

and set him upon the table near the Queen.

The King immediately fell flat on his back,¹¹ and lay perfectly still; and Alice was a little alarmed at what she had done, and went round the room to see if she could find any water to throw over him. However, she could find nothing but a bottle of ink, and when she got back with it she found he had recovered, and he and the Queen were talking together in a frightened whisper—so low, that Alice could hardly hear what they said.

The King was saying “I assure you, my dear, I turned cold to the very ends of my whiskers!”

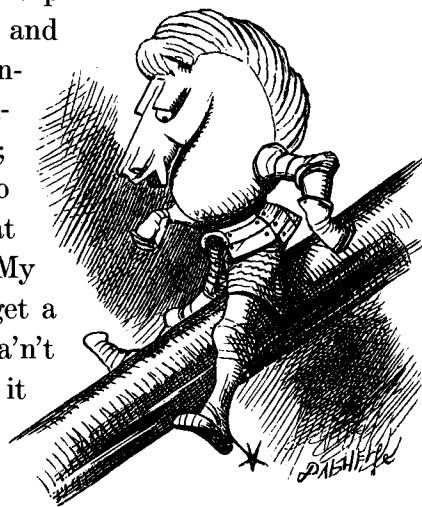
To which the Queen replied “You haven’t got any whiskers.”¹²

“The horror of that moment,” the King went on, “I shall never, *never* forget!”

“You will, though,” the Queen said, “if you don’t make a memorandum of it.”

Alice looked on with great interest as the King took an enormous memorandum-book out of his pocket, and began writing. A sudden thought struck her, and she took hold of the end of the pencil, which came some way over his shoulder, and began writing for him.¹³

The poor King looked puzzled and unhappy, and struggled with the pencil for some time without saying anything; but Alice was too strong for him, and at last he panted out “My dear! I really *must* get a thinner pencil. I ca’n’t manage this one a bit: it writes all manner of things that I don’t intend—”



like a queen, it is allowed to move only from one square to the next. A queen can go as far as seven cells in one move, which explains the ability of queens later on to fly through the air, but it takes a king seven moves to go from one side of a chessboard to the other.

11. In chess play the loser often signifies defeat by turning his king flat on its back. As we soon learn, this is a moment of horror for the King, who naturally turns cold, like a person slain in combat. The Queen’s suggestion about making a memorandum of the event suggests the practice of recording chess moves so that a player won’t forget the game.

12. American readers have been puzzled by the Queen’s remark because Tenniel’s illustrations show the White King, both here and in Chapter 7, with mustache and beard. As Denis Crutch has pointed out, the Queen meant that the King has no sideburns. Crutch quotes a remark in Carroll’s *Sylvie and Bruno* (Chapter 18) about a man’s face being “bounded on the North by a fringe of hair, on the East and West by a fringe of whiskers, and on the South by a fringe of beard.” In England, *whiskers* customarily means sideburns.

13. Automatic writing, as it was called, was a major aspect of the spiritualist craze in the nineteenth century. A disembodied spirit was believed to seize the hand of a psychic—Conan Doyle’s wife was an accomplished automatic writer—and produce messages from the Great Beyond. For my comments about Carroll’s interest in the occult, see *Alice in Wonderland*, Chapter 5, Note 7.

14. The poor balance of the White Knight on the poker foreshadows his poor balance on horseback when Alice meets him later in Chapter 8.

15. Carroll originally intended to print the entire "Jabberwocky" in reversed form, but later decided to limit this to the first verse. The fact that the printing appeared reversed to Alice is evidence that she herself was not reversed by her passage through the mirror. As explained earlier, there are now scientific reasons for suspecting that an unreversed Alice could not exist for more than a fraction of a second in a looking-glass world. (See also Chapter 5, Note 10.)

There are other reasons for assuming Alice was not mirror reflected. Many of Tenniel's pictures in the first book show her right-handed, and she continues to be right-handed in his pictures for the second book. Peter Newell's art is ambiguous on this point, though in Chapter 9 his Alice holds a scepter in her left hand, not in her right as Tenniel has it.

Alice has no difficulty reading the Wasp's newspaper in the long-lost "Wasp in a Wig" episode, so presumably, unlike "Jabberwocky," it was not reversed. Also unreversed are "DUM" and "DEE" on the collars of the Tweedle brothers, the label on the Mad Hatter's top hat, and "Queen Alice" over the door in Chapter 9. Brian Kirshaw sent a detailed analysis of the left-right aspects of the book, all of which lead to the conclusion that neither Tenniel nor Carroll was consistent about who or what was mirror-reflected behind the looking glass.

16. The opening stanza of "Jabberwocky" first appeared in *Mischmasch*, the last of a series of private little "periodicals" that young Carroll wrote, illustrated and hand-lettered for the amusement of his brothers and sisters. In an issue dated 1855 (Carroll was then twenty-three), under the heading "Stanza of Anglo-Saxon Poetry," the following "curious fragment" appears:

<p> 'Twas brillig, and the slithy toves Did gyre and gimble in the wabe: All mimsy were the borogoves, And the mome raths outgrabe. </p>

Carroll then proceeds to interpret the words as follows:

"What manner of things?" said the Queen, looking over the book (in which Alice had put "*The White Knight is sliding down the poker. He balances very badly*").¹⁴ "That's not a memorandum of your feelings!"

There was a book lying near Alice on the table, and while she sat watching the White King (for she was still a little anxious about him, and had the ink all ready to throw over him, in case he fainted again), she turned over the leaves, to find some part that she could read, "—for it's all in some language I don't know," she said to herself.

It was like this.

Jabberwocky
 'Twas brillig and the slithy toves
 Did gyre and gimble in the wabe:
 All mimsy were the borogoves,
 And the mome raths outgrabe.

She puzzled over this for some time, but at last a bright thought struck her. "Why, it's a Looking-glass book, of course! And, if I hold it up to a glass, the words will all go the right way again."¹⁵

This was the poem that Alice read.

*Jabberwocky*¹⁶

'Twas brillig, and the slithy¹⁷ toves¹⁸
 Did gyre¹⁹ and gimble²⁰ in the wabe:
 All mimsy²¹ were the borogoves,²²
 And the mome²³ raths²⁴ outgrabe.²⁵

"Beware the Jabberwock,²⁶ my son!
 The jaws that bite, the claws that catch!
 Beware the Jubjub²⁷ bird, and shun
 The frumious²⁸ Bandersnatch!"²⁹





*He took his vorpal³⁰ sword in hand:
 Long time the manxome³¹ foe he sought—
 So rested he by the Tumtum³² tree,
 And stood awhile in thought.*

*And, as in uffish³³ thought he stood,
 The Jabberwock, with eyes of flame,
 Came whiffling³⁴ through the tulgey wood,
 And burred³⁵ as it came!*

*One, two! One, two! And through and through
 The vorpal blade went snicker-snack!³⁶*

BRYLLYG (derived from the verb to BRYL or BROIL), "the time of broiling dinner, i.e. the close of the afternoon."

SLYTHY (compounded of SLIMY and LITHE). "Smooth and active."

TOVE. A species of Badger. They had smooth white hair, long hind legs, and short horns like a stag; lived chiefly on cheese.

GYRE, verb (derived from GYAOUR or GLAOUR, "a dog"). To scratch like a dog.

GYMBLE (whence GIMBLET). "To screw out holes in anything."

WABE (derived from the verb to SWAB or SOAK). "The side of a hill" (from its being soaked by the rain).

MIMSY (whence MIMSERABLE and MISERABLE). "Unhappy."

BOROGOVE. An extinct kind of Parrot. They had no wings, beaks turned up, and made their nests under sundials: lived on veal.

MOME (hence SOLEMOME, SOLEMONE, and SOLEMN). "Grave."

RATH. A species of land turtle. Head erect: mouth like a shark: forelegs curved out so that the animal walked on its knees: smooth green body: lived on swallows and oysters.

OUTGRABE, past tense of the verb to OUTGRIBE. (It is connected with old verb to GRIKE, or SHRIKE, from which are derived "shriek" and "creak"). "Squeaked."

Hence the literal English of the passage is: "It was evening, and the smooth active badgers were scratching and boring holes in the hill-side; all unhappy were the parrots; and the grave turtles squeaked out."

There were probably sundials on the top of the hill, and the "borogoves" were afraid that their nests would be undermined. The hill was probably full of the nests of "raths", which ran out, squeaking with fear, on hearing the "toves" scratching outside. This is an obscure, but yet deeply-affecting, relic of ancient Poetry.

It is interesting to compare these explanations with those given by Humpty Dumpty in Chapter 6.

Few would dispute the fact that "Jabberwocky" is the greatest of all nonsense poems in English. It was so well known to English school-boys in the late nineteenth century that five of its nonsense words appear casually in the conversation of students in Rudyard Kipling's *Stalky & Co.* Alice herself, in the paragraph following the poem, puts her finger on the secret of the poem's charm: "... it seems to fill my head with ideas—only I don't know exactly what they are." Although the strange words have no precise meaning, they chime with subtle overtones.