

The mystery of ticklish laughter.

by Christine R. Harris

Scientists are trying to find out why people laugh when they are tickled. The intriguing nature of tickling is made more complex by the fact that people almost always break into laughter when tickled by others but not when they tickle themselves. Psychologist G. Stanley Hall classified tickle into two types, namely, knismesis or light tickle and gargalesis or heavy tickle, thereby explaining in part why tickling does not always elicit laughter. One plausible theory suggests that tickle may be an evolutionary adaptation, evident as it is in the social interaction among primates. Thus, the discomfort and pleasure elicited by tickling might be adaptive and help a child develop skills that can be used in defense and combat.

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Pleasure or pain? Social response or reflex? Tickling and the laughter it induces are an enigmatic aspect of our primate heritage

Why do we laugh when we are tickled? Perhaps we enjoy being tickled or find it funny. But if so, why do most people, especially adults, say they hate to be tickled? And why do I not laugh when I try to tickle myself? If the answer to the peculiar riddles of tickling (or, to use the term preferred by some writers, tickle) were simple, the topic might not have engaged many of the great minds of the past. In fact, illustrious thinkers have pondered tickle's mysteries for over two millennia. Plato, Bacon, Galileo and Darwin ventured opinions about the nature of tickle and ticklish laughter. Among the ancients, Socrates suggested that the tickle sensation is to some degree pleasant - but to a greater degree painful. Aristotle raised the question of why one cannot tickle oneself:

Is it because one also feels tickling by another person less if one knows beforehand that it is going to take place, and more if one does not foresee it? A man will therefore feel tickling least when he is causing it and knows that he is doing so. Now laughter is a kind of derangement and deception ... that which comes unawares tends to deceive, and it is this also which causes the laughter, whereas one does not make oneself laugh.

Francis Bacon (1677) and Charles Darwin (1872) agreed that humorous laughter requires a "light" frame of mind. But they differed on ticklish laughter: Darwin thought that the same light state of mind was required, whereas Bacon said no: When tickled, noted Bacon, "men even in a grieved state of mind, yet cannot sometimes forbear laughing."

Scientists of this century have seemed less intrigued by the questions of tickle, but recently the topic has lent itself to empirical study that is beginning to produce clues to this enigmatic feature of human behavior. Although I rather dislike tickling, I have found it a challenging research topic.

Here I would like to share some of the clues and curious possibilities emerging from my own work and that of others.

What Is Tickle, Anyway?

There are two phenomena that we describe as "tickle." One is the sensation caused by a very light movement across the skin, sometimes characterized as a moving itch. This sensation can be elicited almost anywhere on the body by moving a feather or cotton swab lightly across the skin. Oddly, the annoying sensation often outlasts the stimulation, sometimes by many seconds, causing an intense desire to rub the affected area (which seems to relieve the sensation). This type of tickle usually does not make people laugh. The tickle that causes laughter is different: a higher pressure repeatedly applied to "ticklish" areas such as the ribs, armpits and belly.

The two types of tickle were given names in 1897 by the prominent psychologist G. Stanley Hall, writing with Arthur Allin. They called the feather-type tickle knismesis (light tickle) and the laughter-inducing tickle gargalesis (heavy tickle). Although these terms have not managed to find their way into common use, they are useful in defining questions for study. To begin with, light tickle seems less mysterious than heavy tickle. As noted above, it generally does not produce laughter, which in many ways is the most puzzling aspect of tickle. This distinction immediately refines Aristotle's question. One cannot make oneself laugh by heavy tickling, but it is possible to induce a knismesis response in oneself by light tickling. Finally, it is easy to imagine an evolutionary function for knismesis: If an insect or parasite were crawling on an animal's body, the annoying sensation would prompt the animal to scratch or rub the tickled spot, thereby removing the pest.

Knismesis, the response to very light touch, is widespread in mammals; one has only to watch a horse twitch its ear or flip its tail at the touch of a fly. Gargalesis, the heavy tickle associated with play and laughter and seemingly with pleasure, may be limited to the primates, but not solely to human beings. Most primatologists seem to agree that chimpanzees and perhaps other apes tickle each

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other in the course of rough-and-tumble play, producing the equivalent of laughter. As Robert Provine observed in these pages ("Laughter," January-February 1996), chimps cannot laugh like people; their vocal apparatus is capable of only a breathy panting sound. There is little doubt that tickling can induce such panting (possibly an evolutionary precursor of human laughter) in young chimps, and there are even anecdotal accounts of chimps signaling to their human caretakers a desire to be tickled.

Ticklish Laughter

To sort out the connection between tickle and laughter - and the double-edged nature of the human tickle response - it is necessary to probe the psychology of humor, pleasure and social interaction.

A person's outward response to tickle looks just like the laughter elicited by comedy and jokes. Is the inward experience similar, too? Probably not. Most people find humorous laughter enjoyable; by contrast, they report that they do not much like being tickled, and few adults actively seek it out. There is little doubt that prolonged tickle can be extremely unpleasant. It is reported that Medieval warriors sometimes tortured victims to death using nothing but unrelenting tickle.

Yet some people claim that there is something pleasant about being tickled, and many people seem convinced that other people enjoy being tickled. Furthermore, most people laugh when tickled. It may be, as Socrates suspected, that the experience incorporates both pleasant and unpleasant sensations. People may simply differ in which aspects they find most salient.

Alternatively, the outward signs of laughter may simply fool us into thinking that the experience has some pleasant aspect, whether or not it does. Even though I hate to be tickled and have done enough work on this topic to know that the laughter-pleasure connection is an uncertain one, I still sometimes find it hard to look into the ticklee's laughing, smiling face and not think, "he really is enjoying this."

Still another possibility is that it is precisely because tickle elicits laughter that it creates some positive response. (I laugh, therefore I must be enjoying this.) Social psychologists have found that when people mimic the outward expressions of an emotion, they often come to experience at least a mild form of the emotion. Thus, people instructed to contort their face into a smile on the pretext of holding a pencil between their teeth judged cartoons more humorous than they did when they contorted their faces into frowns (Strack, Martin and Strepper 1988).

Many writers have assumed that tickle is more pleasant for children than adults, noting that children sometimes ask to be tickled. This should be viewed with some skepticism. For one thing, each succeeding generation of children independently rediscovers "tickle torture" as an effective way to torment their playmates. It is true that children sometimes seek out tickling. But they likewise enjoy games in which parents play at startling or menacing them; do they also enjoy startle or fear? A combination of thrill seeking and pleasure in tactile contact might lead children to pursue what is an intrinsically aversive sensation.

These observations raise questions about the psychological state underlying ticklish laughter and how it is related to humorous enjoyment. A few years ago I set out, with Nicholas Christenfeld, to study these relations. We reasoned that if ticklish laughter and the laughter elicited by comedy and humor reflect the same internal psychological state, there ought to be a "warm-up" effect that transfers from one stimulus to another. A warm-up effect has been found with humorous laughter: Later jokes in a series are funnier than earlier ones. Presumably this is why top comedians insist on being placed toward the end of the program.

We brought student subjects into my laboratory at the University of California, San Diego, and had them watch a videotape composed of the highlights of several comedy films. Most of our subjects readily laughed and smiled while watching the videotape and reported that they found it humorous. We explored the connection between this laughter and tickle by having a research assistant tickle the subjects shortly before or shortly after they watched the tape.

The warm-up effect found with humor did not work for tickle. Subjects who had been "warmed up" with the comedy tape laughed, smiled and squirmed when tickled to the same extent as subjects who had not first seen the film. Likewise, having just been tickled did not make people laugh more while watching the funny film. We concluded that tickling does not lead to the same internal state of amusement as does comedy (Hams and Christenfeld 1997). Just as crying while cutting an onion has little in common with crying at a funeral, so the states associated with the two types of laughter may be fundamentally different.

The Ontogeny of Tickle

If it is not closely related to humor, what is the origin of ticklish laughter? A number of writers have suggested that in children ticklish laughter might somehow underlie the development of humor itself. Alan Fridlund and Jennifer Loftis (1990) have proposed that the tickle reflex may be

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the building block for the development of humor. Infants, they argue, may vary in how readily they laugh in response to tickling. Parents of easily tickled babies may engage in more physical play (since they are positively reinforced by their infants' laughter for doing so). The play that includes tickling then extends to other forms of humorous physical play and eventually to mental stimuli, thereby encouraging offspring to laugh at humor as well.

The idea that humorous laughter grows out of ticklish laughter has trouble accounting for certain facts. L. Alan Sroufe and Jane Piccard Wunsch from the University of Minnesota in 1972 charted the emergence of different forms of laughter over the course of the first year of life. Ticklish laughter was first seen at around six months. If anything, this was slightly after, rather than before, the emergence of the most primitive forms of humor - for example, laughter related to playful menacing, such as a parent saying, "I'm gonna get you!"

One recent study showed that ticklish laughter can trigger conditioning. Bobby Newman and his colleagues at Queens College (1993) paired tickling with a neutral verbal stimulus and found that the sound came to elicit laughter and smiling when later presented by itself. But there is also the possibility that ticklish laughter is itself a conditioned response - essentially the reverse of the previous proposal. Perhaps children come to laugh when tickled because tickling has always taken place in other playful situations in which laughter is occurring. The laughter becomes associated with tickling motions, as a Pavlovian conditioned response. Or perhaps children laugh when tickled because the tickler is laughing, which creates a contagious loop.

In a remarkable study in the early 1940s, Antioch College psychologist Clarence Leuba tried to separate these questions, asking whether laughter in response to tickling would emerge even if tickling were never paired with other laughter-inducing play. Leuba deliberately refrained from tickling his two children during playful situations and enlisted his wife to do the same. As a further precaution, he made sure to hide his face behind a mask whenever he tickled his children so that the infants would not associate tickling with smiles and laughter. Despite all this, laughter emerged in response to masked tickling in both infants around the age of six or seven months.

These studies suggest, then, that humorous and ticklish laughter may develop independently, even though both often occur in the same kinds of playful situations.

The Sociality of Tickle

How much of the tickle response is induced by the

interpersonal experience of tickling? Darwin, writing in 1872, thought a comfortable social context was important: "... the mind must be in a pleasurable condition; a young child, if tickled by a strange man, would scream in fear." Similarly, the writer Arthur Koestler suggested in 1964 that laughter only takes place when the person being tickled views it as a harmless and playful mock attack. Naturally, thinking of ticklish laughter as an interpersonal behavior might also explain why we cannot tickle ourselves.

This question is a readily testable one. At a minimum, a requirement for interpersonal context means that people should only laugh when they believe that a person causes the tactile sensation. Therefore, a person who believes she is being tickled by a machine should not laugh. Common sense seems to endorse this idea. Christenfeld and I surveyed a group of undergraduates and found that 50 percent thought a tickle machine could not produce laughter. Only 15 percent thought it would be as effective as a person who provided the same stimulation.

We then set about to fashion a tickle machine. However, we realized that having the machine actually tickle people would not provide good answers to questions about the interpersonal aspect of tickling. If people tickled by a machine did not laugh, one could never be sure whether the lack of laughter resulted from their knowledge that it was a machine or from the device's failure to accurately mimic the movements of a human hand. A more decisive experiment, we reasoned, required a mock tickle machine and a little deception. We created such a machine in our laboratory, complete with a robotic-looking hand, a vacuum-cleaner hose and a nebulizer (used in asthmatic therapy) to provide convincing sound effects. The hand did not actually move.

In the experiment, subjects were advised that they would be tickled twice, once by the human experimenter and once by the machine. They were then blindfolded, ostensibly to help them better attend to the tactile sensations.

As it happened, however, all the tickling was done by a human being - a hidden second experimenter who, throughout the experiment, lurked beneath a cloth-draped table adjacent to the subject. The tickler carefully applied the same stimulation during both the "machine tickle" and "human tickle" parts of the experiment, allowing us to determine whether the subject's belief that the sensations were caused by another person was critical to elicit laughter.

In fact, it was not: Subjects laughed just as much when they believed they were being tickled by a machine as when they thought they were being tickled by a person.

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For half of the subjects, the experimenter left the room during the machine-tickle phase. Even when subjects thought they were alone in the room with the tickle machine, they still readily laughed and smiled in response to being tickled (Harris and Christenfeld, in press).

The deception worked fairly well except in the case of one subject, who suspected that the machine had tickled her twice and another who figured out that the machine was actually a hoax (when the research assistant's hair clip became caught in the table, and the subject heard her efforts to free herself). When asked whether they noticed any differences between the tickling done by the human being and by the machine, subjects offered comments such as: "They were very, different. The machine felt more repetitious, tickling the exact same spot over again with the same amount of pressure and speed Also different because she [the experimenter] had nails and the machine didn't so it was sort of a scrapy feeling."

These results suggest that laughter elicited during tickling is not dependent on the belief that another human being is responsible for the stimulation.

An Involuntary Response?

If ticklish laughter is not the same as our response to humor and not inherently an interpersonal response, then what is it? Some ideas are more biological than psychological. One possibility is that gargalesis is akin to a reflex, a view suggested at the turn of the century by G. Stanley Hall and advocated by physicians in more recent writings (Stearns 1977, Black 1982).

This brings us back to the question of why I cannot tickle myself. One might think that if the response is a reflex, capable of being elicited by a machine, we should be able to stimulate ourselves into paroxysms of laughter. We can, after all, produce a perfectly respectable knee-jerk reflex by tapping our own knees. There is, however, another phylogenetically ancient reflex that one definitely cannot elicit in oneself: startle. The violent startle reaction produced by a loud sound requires unpredictability, and it can be inhibited by even a very faint warning signal (Dawson et al. 1997). It may be that ticklish laughter, too, requires appropriate and vigorous stimulation that cannot be anticipated in advance, just as Aristotle proposed. In our tickling experiments, subjects laughed more when they had their eyes closed than when they had their eyes open.

Another possible explanation for why one cannot induce gargalesis in oneself is a neurological process observed in vision. The world doesn't appear to jump every time you move your eyes, because the brain has taken into account the fact that it issued the command to move. Similarly,

perhaps when the brain issues the command to tickle, it cancels out the sensation of ticklishness.

One study has examined the neural responses to self-generated tickle of the hand. Using functional magnetic-resonance imaging (fMRI), the investigators found that responses exhibited in the brain's somatosensory cortex were different from those seen when the tickling was externally produced (Blakemore, Wolpert and Frith 1998). The study may or may not tell us about the specific inability to produce ticklish laughter in oneself, because it used light tickle (laughter would disrupt MRI scanning).

Given the unusual properties of tickle, though, some theorists have suggested that tickle is too complicated to be viewed as a simple reflex. Perhaps, as Robert Provine has suggested, it is a species-typical stereotyped motor pattern that requires a particular releasing stimulus or a fixed action pattern. It is a characteristic of reflexes that the response increases as stimulation becomes more intense, whereas fixed action patterns have an all-or-none quality. Although one study (McKimmin 1990) found that more intense tickling produced greater self-reports of ticklishness, it is unclear whether ticklish laughter follows the same pattern.

In sum, the results from the handful of studies done on tickle suggest that the inability to tickle oneself may reflect the inhibition of neural impulses at a relatively low physiological level - although the mechanism is undetermined. Our machine-tickle experiment hints that this inability does not have a merely interpersonal explanation, making physiological explanations more intriguing.

The Physiology of Tickle

As I mentioned above, one of the differences between knismesis and gargalesis is that whereas annoying light tickle can be elicited almost anywhere on the body, heavy tickling elicits laughter only when it is applied to certain ticklish spots. The differential response of body parts to tickle is a potential clue to the neural mechanisms underlying the laughter response.

More than a century ago, G. Stanley Hall and Arthur Allin surveyed 700 people, who reported that children were most ticklish on the soles of their feet, the underarms, the neck and under the chin. (They did not distinguish between types of tickle in the survey.) More recently, Vezio Ruggieri and his colleagues (1979) at the University of Rome measured the latency and duration of tickle on various body parts. Unfortunately, in this study a cotton wad was skimmed over the body surface, and there is no

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sign that laughter was elicited. Research in my own lab suggests that college students are most ticklish anywhere along the sides of the torso (beginning at the armpits and extending to the waist) and on the soles of the feet.

The difficulty with all of the existing studies is that the type of stimulation and degree of laughter have not been systematically examined. Still, some work provides clues to the neural mechanisms underlying tickle. In 1939 a pioneer in the study of cutaneous sensation, Yngve Zotterman of the Karolinska Institute, recorded action potentials in nerve fibers of cats whose skin had been very lightly stroked with a piece of cotton wool. His work suggested that the annoying sensation associated with light tickling depends, at least partially, on the nerve fibers that carry pain. Furthermore, when surgeons sever pain fibers in the spinal cord as a treatment for intractable pain, responsiveness to tickle (specifically, stroking the sole of the foot with cotton wool attached to a stick) seems to be reduced (Lahuerta et al. 1990). However, tickle-induced laughter is retained in at least some patients who have lost pain sensation as a result of similar spinal-cord surgery (Nathan 1990).

Tickle may also depend on nerve fibers related to touch. When limb circulation is arrested, sensitivity to touch and tickle is eliminated before pain sensitivity (Houssay 1951, cited in Steams 1972). Thus it appears that tickle may involve signals arriving on both pain and touch fibers. One might speculate that the most ticklish areas of the skin would be spots where our sense of touch is keenest, but this seems not to be the case. For example, pressure sensitivity is greater in the palm than the sole of the foot. And when people are asked to tell whether they have been touched on one or two nearby points, they can more accurately do so on the palm than on the sole (Weinstein 1968). However, as seen in Figure 4, the foot is a much better place to elicit ticklish laughter than is the palm.

So Why Do We Tickle?

Trying to unearth the evolutionary basis for peculiarities of psychology and physiology is a notoriously treacherous enterprise. But it is also irresistible and currently in vogue. What, we might wonder, could be the adaptive value of tickle?

One possible function has been mentioned earlier in this article: Tickling may help facilitate the bond between parent and offspring. A child smiles when tickled, which produces smiles in the caregiver. This reciprocal smiling and laughing produces positive social interaction. We like sharing such facial expressions with conspecifics, because it usually connotes positive motives. The one thing this doesn't help explain is why people usually find tickle

unpleasant, rather than pleasant, and why they so often resist it.

Another possible evolutionary function was bandied about by several writers at the turn of the century. Ticklishness, these writers suggested, is greatest in places on the body that are most vulnerable in arm-to-arm combat. Being ticklish in such spots confers an adaptive advantage by motivating individuals to protect these areas (Gregory 1924). Consistent with this notion is the 1984 observation by University of Iowa psychiatrist Donald W. Black that ticklish spots are also places where protective reflexes are often found. One difficulty with this hypothesis is that the hands and fingers are highly vulnerable to injury during fighting, but they are among the least ticklish spots. And although we might find them disarming, it is not clear what protective benefit the smiling and laughter might confer in a combat situation.

With some reservations, I offer a third suggestion that is basically a hybrid of the two proposals just mentioned. Consider again the basic, very odd facts of tickling. People exhibit defensive movements and generally report not enjoying the sensation of tickle, but they simultaneously display a facial expression suggesting "Boy, I'm having fun!" Perhaps the disconnection between outward expression and inward feeling is itself adaptive. The discomfort from tickling motivates the growing child or ape to develop combat skills in much the same way that other rough-and-tumble play does. The facial expressions, on the other hand, tell conspecifics "Keep doing what you're doing; I like it!" In other words, the smiling and laughter encourage the tickler to continue. If tickling produced a negative facial expression, conspecifics would be far less likely to engage in it during playful bouts - thus cutting off the development of combat skills that might have survival value.

Might not this arrangement leave the ticklish person vulnerable to enemies? Indeed, tickle-torture by children suggests it sometimes does. But recall, most tickling is done by parents, siblings or friends engaging in play. It is in this very context that, in my view, frequently fools us into thinking that the actual sensation of tickle is pleasant and has beguiled many theorists into assuming that certain conscious ideas (such as "this is a friendly source" or "this is a mock attack") must be in place in order for tickling to elicit laughter.

It may not be possible conclusively to test adaptive stories like the one I have just offered. However, my suggestion does make some predictions. Even among apes, if my suggestion is correct, we should be able to observe that the outward expressions of tickle actively promote the interactions. A close study of the role of tickle in the

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interactions of nonhuman primates thus should help to decide the plausibility of this hypothesis. Of course, as Stephen Jay Gould and others have noted, it is always possible that a biological phenomenon may be not adaptive per se, but merely a side effect of a mechanism designed for another function. If this is true, the mystery of this aspect of our primate heritage may long remain just that.

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