

Original Article

The Inner Eye Theory of Laughter: Mindreader Signals Cooperator Value

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Abstract: In this hypothesis paper, I propose a three-component set of jointly necessary and sufficient trigger criteria for all cases of involuntary laughter. The theory incorporates concepts from the theory of mind in cognitive science. I then examine the information content of the laughter signal from a game theoretic perspective. I conclude that laughter is a signal of cooperator value as it provides information on the laugher's empathy with the attributed mental states and her sympathy levels for all affected by the laugh-inducing situation. Laughter also indicates what types of mental representations children, autistic people, nonhuman primates and adults possess and can falsify.

Keywords: animal signal; false belief; consciousness; cooperation; empathy; evolutionary psychology; folk psychology; game theory; happiness; humor; instant utility; laughter; mindreading; morality; representation; smile; sympathy; theory of mind.

Introduction

Laughter is a universal and prominent feature of human communication. There have been scores of theories on laughter's underlying trigger mechanism and purpose (for a review see Roekelein, 2002). However, few have incorporated established concepts from cognitive science or evolutionary biology. None have generated deeper insights about the underlying trigger mechanism through empirical findings. This hypothesis paper proposes a trigger mechanism for all instances of involuntary laughter (hereafter, laughter) using concepts from the theory of mind in cognitive science and explains the information content of laughter using concepts from game theory.

1.1. Theory of Mind

People possess the ability to attribute mental states, e.g., beliefs and desires, to themselves and other beings. Premack and Woodruff, in their seminal paper, have termed this ability as having a “theory of mind” (Premack and Woodruff, 1978). So, possessing a theory of mind enables an individual to explain and predict others’ behavior in terms of their mental states.

Many, in both philosophy and psychology, have elaborated on this topic, also called folk psychology as it deals with how people commonly use psychological concepts. Some have referred to the use of the theory-of-mind ability as mindreading. While some are proponents of a theory of mind, i.e., attribution of beliefs and desires, in enabling explanation and prediction of others’ behavior (e.g., Gopnik and Wellman, 1992; Leslie and German, 1995; Perner and Howes, 1992; Stich and Nichols, 1992), others have proposed a different process, namely, simulation as a way of explaining and predicting others’ behavior (e.g., Goldman, 1989; Gordon, 1986; Heal, 1986). Simulation requires the subject to empathize, that is, “to put himself in the shoes of another”, to pretend to receive the same sensory inputs, engage the same processes that the subject would engage in the same situation and predict the behavior based on what the subject, himself would do. Many have noted that these two methods of explaining and predicting behavior are not mutually exclusive and some have proposed hybrid positions (e.g., Heal, 1995). The following proposed trigger mechanism of laughter suggests that people use both representations of mental states and simulation.

One of the classic experiments for those who study the theory of mind is the false belief task, first used by Wimmer and Perner (Wimmer and Perner, 1983). In the false belief task, the subjects watch a story like the following (Baron-Cohen, Leslie, and Frith, 1985). In the story, Sally places her marble in a basket, covers the basket and departs. After Sally has departed, Ann moves the marble from the basket and places it in the box. The subject is then asked where Sally would look for the marble when she comes back. To pass this task, the subject must attribute a false belief to Sally that the marble is in the basket and predict her to look there. Around at the age of 4, children become able to pass this task and also show in a variety of other tasks, that they have developed an ability to understand others’ mental states, more like that possessed by adults (Baron-Cohen et al., 1985; Gopnik, 1993). Furthermore, autistic children, even after controlling for mental age and general cognitive ability, tend to fail the false belief task (Baron-Cohen et al., 1985). Such experiments have allowed Leslie and colleagues to propose a model of an innate, domain-specific processing mechanism dealing with intentional mental states such as believe, desire and pretend (Leslie, 1987, 1991, 2000; Leslie and Roth, 1994). The following trigger mechanism of laughter is consistent with the idea that domain-specific representational systems exist for different types of mental states.

Lefcourt has stated that, “joking and laughter probably require the ability to perceive the state of mind of the person or creature with whom one is in communication and with that of the object or target of the joke” (Lefcourt, 2001, p. 45). Howe has recently proposed in a brief description of the “Mind Reading Hypothesis” that all humor involves an observer reading the mind of the target of humor and making the observation that the target of humor resolves “the collision between old perception and new reality” (Howe, 2002). In addition, previous studies have shown that discriminating jokes from lies requires the listeners to make second-order mental attributions, such as that the speaker does not know that the listener knows something (Leekam, 1991; Sullivan, Winner, and Hopfield, 1995; Winner and Leekam, 1991).

Howe limits the “Mind Reading Hypothesis” only to humor and not generally to all cases of laughter (Howe, 2002). Howe states, “one must separate laughter and humor. Laughter that comes from a relief of tension is best viewed as a simple reflex action, much like the laughter response from tickling. Humor on the other hand is far more intricate and includes so much more social interaction than a simple relaxation of fear” (Howe, 2002). The theory described below, which I will call the Inner Eye Theory, borrowing the term “inner eye” from Humphrey (Humphrey, 1986), is an extension and elaboration of the idea that mindreading ability is critical in the generation of laughter and incorporates mindreading in all three components of the proposed trigger mechanism for laughter. The theory is also an extension of the idea that the human brain attributes mental states to itself and others in a similar manner through inference (Gopnik, 1993) and the idea that there may be an evolutionarily designed brain module or modules assigned to this mindreading task (Baron-Cohen, 1995; Humphrey, 1986).

First, I will provide an overview of the proposed trigger mechanism of laughter and then examine it in the context of previous theories and examples. In the following discussion, the potential laugher will be called the subject while other beings involved in the funny situations are called agents. Then, I will examine the information content of laughter from a game theoretic perspective to provide a further support for the elements of the proposed trigger mechanism. Finally, I will examine previous studies of laughter in children, autistic people, and nonhuman primates as well as anatomical and functional imaging studies, in the context of discussing the implications of the theory and future directions. The hope is that this theory will encourage scientific investigations of laughter as an evolutionarily designed signal used to facilitate cooperation.

2. The Inner Eye Theory of Laughter

2.1. The First Trigger Criterion: Falsification of Belief Representations (FB)

Mental states such as belief and desire are called propositional states since

each such mental state has an associated proposition that is either true or false in reality, independently of the mental state. The following are two examples expressed in the usual form, “Agent-Attitude-‘that’-Proposition”. The true/false state of the proposition is indicated in parentheses:

1. The author of this article believes that he owns books (true).
2. The author of this article believes that he can afford a new car (false).

The first required trigger criterion of laughter is the falsification by the subject of a belief representation (hereafter, belief) held by self or others. As Searle noted, beliefs are mental states with a “mind-to-world” direction of fit (Searle, 1983). So, beliefs are representations that are supposed to reflect the states of the world as they are, unlike desires, which have a “world-to-mind” fit and represent the desired states of the world.

The falsified belief (FB) can be found in the past or in the present. It can be found in real or fictional characters. Often the subject detects a belief that is to be falsified when the belief is implied or expressed by another through actions including speech and facial expressions. Also commonly, the FB can be that of the subject when his own expectation or intention is broken. There can be multiple beliefs falsified in close temporal proximity. Such temporally proximate false beliefs add up to increase the strength of the laughter.

In all cases, it is the subject’s current view of the world that falsifies a belief. The subject’s current view itself can be false. However, to simplify the following discussion, the subject will be assumed to always correctly view the world when the laughter is triggered.

Propositional attitudes related to belief, namely expectations and intentions, can be subsumed under the belief category by using the following definitions of those terms. An expectation can be defined to contain the belief that a certain outcome would occur when certain other conditions are met. Expectation can be falsified by the outcome not coming true. An intention can be defined to contain the belief that a certain outcome would occur if the holder of the intention takes a particular set of actions. An intention can also be falsified by the outcome not coming true.

I will argue that, in all laugh-inducing circumstances, the state of the world that was or is believed or expected or intended, lacks and thus is falsified by, events that the actual or eventual state of the world possesses. These falsifying events must also result in differences in the wellbeing of some agents. These differences in wellbeing will be discussed in greater detail in the description of the third criterion. The emphasis here is that laughter requires the falsification of a particular belief or a null belief (ignorance) by events present in the actual or eventual state of the world. Greater the strength of the falsification, the stronger the laughter is. That is, the less activated the representation of the falsifying event

from the perspective of the false belief, the stronger the laughter is.

2.2. The Second Trigger Criterion: Empathy (E)

At this point, it is important to distinguish between two related terms, empathy and sympathy as numerous authors have done (de Waal, 1996, pp. 40-3; Wispé, 1991, p. 80). Empathy means sensing, feeling and thinking in imagination from the perspective of another while sympathy implies empathy plus caring for the wellbeing of the sympathized. Wispé's statement is particularly relevant to the present article: "The object of empathy is understanding. The object of sympathy is the other person's well-being" (Wispé, 1991, p. 80).

For laughter to be triggered, the subject must understand the causes of the laugh-inducing state of the world. The laugh-inducing state often includes a combination of temporally proximate actions including speech and facial expressions, often by multiple agents. The subject must understand each of the actions. That is, the laugher must be able to attribute to the agents, mental states (desires and beliefs), consistent with the agents' other known characteristics that could have caused the agents to take the observed actions.

Often, a straightforward statement that would not have been funny by itself (e.g., "The writer of this statement is stupid") is funny when accompanied by a real person or cartoon strip character expressing it or put in an appropriate context to engage the mindreading ability of the observer and the observer understands the mental states causing the behavior. Unexpected behaviors by others tend to engage the observers' mindreading ability although not all situations in which people use the mindreading ability, involve unexpected behaviors.

Based on the discovery of mirror neurons in macaque monkeys and other anatomical evidence, Gallese and Goldman have proposed a process for such attribution of mental states from observation of actions (Gallese and Goldman, 1998). The mirror neurons, in premotor area F5, fire, both when the monkey takes a particular action (such as grasping something with a hand) or when the monkey observes another individual taking the same action (Gallese, Fadiga, Fogassi, and Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, and Fogassi, 1996). Gallese and Goldman hypothesize that such neurons can be used to get "the observer into the same 'mental shoes' as the target" as occurs in a simulation of another (Gallese and Goldman, 1998). They also propose a "'pretend' belief and desire generator" that can be used during a simulation of another individual who has different beliefs or desires than the simulator. Preston and de Waal, in their Perception-Action Model of empathy, propose a similar process in which observation of another's state activates the observer's representation of the state (Preston and de Waal, 2002).

The characteristics that the laugher must take on during a simulation of another individual are varied and include different sensory inputs (e.g., a different visual

perspective), different beliefs and different desires. When it is not necessary to use ‘pretend’ beliefs or ‘pretend’ desires during a simulation by a laugher, the laughter seems to increase in strength. The mechanism behind this may simply be the availability of the mental states within the laugher. The more easily available the mental states are, the stronger the laughter. Such examples will be provided below.

In many cases, the causal agent is perceived to be random chance (or nature). In such cases, the fact that the outcome actually takes place makes the outcome understandable.

To laugh at a joke requires understanding the desires or the beliefs of the joke-teller and those of the characters in the joke. Sometimes the subject must use heuristics such as representativeness (the probability of A being B is evaluated by “the degree to which A resembles B”) or availability (the probability of an event is assessed by “the ease with which instances of that coming to mind”), proposed by Kahneman and Tversky (Tversky and Kahneman, 1982). Such heuristics are often used in understanding jokes that involve stereotypes.

2.3. The Third Trigger Criterion: Sympathetic Instant Utility (SIU)

I’ve termed the third criterion, sympathetic instant utility. I borrow the term “instant utility” from Kahneman, who uses it to mean the pleasurable or painful attribute of an experience at a particular moment (Kahneman, 1999). I define SIU to be a momentary positive or negative emotion produced in the following way. Two different states of the world need to be compared: the state believed or expected or intended from the perspective with the false belief (the false-belief state) and the actual or eventual state. The subject assesses the actual or eventual state with respect to the false-belief state. If there are differences in the fulfillment of particular desires for particular agents between the two states, these differences become factors in the calculation of SIU for the potential laugher. For example, let’s say that the potential laugher expected a state of the world, A, to happen, but a different state of the world, B, actually took place. If, for an agent found in both states (let’s name him Aaah), a particular desire (e.g., a particular level of social status) is fulfilled in state A, but not in state B, such difference in the wellbeing of the agent, Aaah, affects the SIU of the subject.

The direction in which such a difference in wellbeing of Aaah affects the SIU of the subject depends on what the fulfilled or unfulfilled desire is and how sympathetic the subject feels towards Aaah. That is, SIU reflects the subject’s understanding of the Aaah’s value system (often assumed to be the same as that of the laugher unless known to be otherwise) and the laugher’s sympathy level for the Aaah. In a simple generalization, when good things happen to those the laugher likes and bad things happen to those whom she dislikes, the state is satisfactory to her and her SIU is positive while when bad things happen to people

she likes and good things happen to people she dislikes, the state is dissatisfactory to her and her SIU is negative. Also, one of the affected agents can be the subject, herself, for whom she would be expected under most circumstances and for most different domains of desires, to have the highest level of sympathy.

SIU can be expressed mathematically as a utility function in a similar way as has been done by others to incorporate the effect of others' welfare into one's utility function (e.g., Binmore, 1994, p. 110). For example, the SIU function for a subject could follow a form like the one shown below for a laugh-inducing outcome x , involving the wellbeing of n individuals where $U_n(x)$ indicates the utility of outcome, x , for the individual, n , and $S_n(x)$ indicates the level of sympathy the subject has for the individual, n :

$$SIU(x) = U_1(x) \cdot S_1(x) + U_2(x) \cdot S_2(x) + \dots + U_n(x) \cdot S_n(x).$$

If $S_1(x)$ is negative, the positive wellbeing of the individual, 1, negatively affects the subject's SIU while if $S_1(x)$ is positive, the positive wellbeing positively affects the SIU. Sympathy levels for any individual, n , may vary depending on the domain of desire the outcome involves. In other words, while the subject may like to see Aaah get embarrassed (indicating a frustrated desire for status), the subject may not want to see Aaah get shot (indicating a frustrated desire for health). The minimum threshold for the trigger of laughter using such a function of SIU can be set at zero, with positive values indicating good outcomes and negative values indicating bad outcomes. There is some experimental support for the evaluation of stimuli on such a continuous good/bad scale (for reviews, see Davidson, 2002 and Shizgal, 1999). Also, measuring utility with respect to a reference point (the false-belief state in this case) is consistent with previous psychological findings showing that people make exactly such comparisons of reality with simulated "counterfactual alternatives" to make decisions or evaluate experiences (Kahneman and Miller, 1986; Kahneman and Tversky, 1982; Kahneman and Varey, 1990).

Commonly, when someone is joking or kidding, he is playing a 'pretend' character with a different set of beliefs and desires than his real set of beliefs and desires. People seem to have very low sympathy levels for such 'pretend' characters.

It is important to note that the SIU criterion always requires the laugher to use the mindreading ability. That is, she must attribute particular desires and fulfillment or frustration thereof to herself or others.

2.4. Jointly Necessary and Sufficient Criteria

Each of the three criteria described above, specifies a minimum threshold and can be met to varying degrees beyond the threshold. Each criterion is a necessary

condition for the trigger of laughter and I argue that the different degrees to which the criteria are met explain the various degrees of laughter and that the three criteria are jointly sufficient to explain all laughter.

There are modulating factors of laughter, such as attention, mood and others' laughter. Here I will briefly speculate on how these modulators could work.

The subject has to pay attention to the potentially laugh-inducing events. More specifically, the subject has to be interested and attentive enough to predict and explain the events by using his mindreading ability as necessary. When someone is trying to make you laugh, the best thing to keep yourself from laughing may be to pay no attention at all.

Mood likely affects one's tendency to laugh (reviewed in Deckers, 1998). Cheerfulness seems to facilitate humor (Ruch and Carrell, 1998) and funniness of jokes tends to correlate with self-rated moods of surgency, elation and vigor (Wicker, Thorelli, Barron, and Willis, 1981). Mood affects laughter possibly through the calculation of SIU. For example, one possibility when someone is depressed is that she is constantly engaged in comparison of her current state to that of her ideal reference point and this process could affect the SIU calculation by a constant addition of a negative component for herself.

Others' laughter and laugh tracks are well known to affect laughter, usually making laughter more likely (Donoghue, McCarrey, and Clement, 1983; Martin and Gray, 1996; Provine, 1992, 1996). I propose that this also works through the SIU criterion. Others' laughter is often the best proof that the target of a laugh-inducing event is undergoing a change in wellbeing (particularly in status which is not directly observable). In other words, others' laughter is interpreted by the potential laugher as a proof of changes in wellbeing of the target and other laughers and helps satisfy the SIU criterion. It is also possible that others' laughter activates the subject's laughter through a process of empathy as the subject uses her mindreading ability to explain others' laughter and in the process, the mental states she attributes to others to explain the laughter cause the subject to laugh herself.

3. Previous Theories and Examples

3.1 Gedankenexperiments and Beyond

Before we examine the above theory in the context of previous theories and examples of laughter, I would like to comment on my approach briefly. This theory is partly a product of many thought experiments of the following kind. First, I observe myself and/or others laughing. Then, I seek a false belief belonging to some agent involved in the situation (including myself). In all cases so far, I've been able to convince myself that someone in the situation has held a belief falsified by the laugher. One of my tasks here is to convince the readers of

the same, using the following examples. At the same time, I will attempt to demonstrate through the examination of the examples that the ways people interpret others' laughter suggest that the interpreters implicitly understand that the laughter occurred when the three criteria were met in the mind of the laugher.

3.2. Theories and Examples

I explain the following previous theories of laughter from the perspective of the Inner Eye theory. I will also bring up some examples and explain them in the context of the Inner Eye theory by showing how the three criteria would be met in the laugher's mind.

It is appropriate to begin with Darwin's observation on laughter, "Many curious discussions have been written on the causes of laughter with grown-up persons. The subject is extremely complex. Something incongruous or unaccountable, exciting surprise and some sense of superiority in the laugher, who must be in a happy frame of mind, seems to be the commonest cause" (Darwin, 1872/1965, p. 198).

Surprise Theory: this is a common component of many theories or descriptions of laughter, including Darwin's. The element of surprise can easily be observed in common jokes in which the readers are led to expect one outcome, but encounter an unexpected outcome, which they must make sense of. Here are a couple of examples.

Example 1.

Question: How do you get a philosopher off your porch?

Answer: Pay for the pizza.

FB criterion: a belief of the reader, (e.g., that there is a professor-like philosopher on the porch), is falsified by the reader, as he realizes the philosopher is a pizza deliverer.

E criterion: A laugher understands the mental states that would cause the joke-maker to tell this joke even if she may think it's an exaggeration. The relevant mental state is the belief that philosophers have a hard time finding high-paying jobs. The more easily available the particular belief is to the laugher, the stronger the laughter would be.

SIU criterion: Philosophers are pizza deliverers in the final outcome compared to professors in the false belief. Observers will interpret the laughter to signal that the laugher is fine with this lowered status for philosophers.

Example 2.

I'd like to die in my sleep like my grandfather did, not screaming at the top of my lungs like the passengers in his car. – Emo Phillips (quoted in Friend,

2002).

FB: A belief by the reader, (e.g., that Emo Phillips is about to extol the merits of dying in sleep), is falsified when the reader realizes that the grandfather died in a sleep-at-the-wheel crash. This is a case of multiple false beliefs. The second false belief is expressed by the passengers who indicate by screaming, a previous expectation of being fine in the car, but having that expectation falsified by the impending crash. I propose that such temporally proximate false beliefs strengthen the laughter.

E: A laughter understands and attributes plausible causes and mental states to all actions involved including the grandfather falling asleep, the passengers yelling and the comedian joking.

SIU: I propose that most laughers in this case would assume, possibly incorrectly, that Emo Phillips is talking about imaginary characters in an imaginary scenario. In other words, he is joking. He is telling us about ‘pretend’ characters. So laughers are fine with these imaginary characters in an imaginary crash.

Frame shift theory: this is a component proposed by Koestler, who states, “the pattern underlying all varieties of humor is ‘bisociative’—perceiving a situation or event in two habitually incompatible associative context” or ‘frames of reference’ (Koestler, 1964, pp. 95-96). The following are two of the examples that Pinker used to describe Koestler’s theory (Pinker, 1997, pp. 545-550).

Example 3.

Lady Astor said to Winston Churchill, “If you were my husband, I’d put poison in your tea.” He replied, “If you were my wife, I’d drink it” (Pinker, 1997, p. 550).

FB: the more surprising Churchill’s answer to a reader, the stronger the laughter is likely to be. The Inner Eye theory states that an expectation can be falsified by an outcome that possesses a change in the wellbeing of an agent compared that in the false-belief state. In this example, a laughter does not initially expect the lowered status of Lady Astor that occurs in the actual outcome but not in the expected false-belief state.

E: a laughter understands the mental states behind Churchill’s statement, in particular the desire of Churchill to commit suicide in a hypothetical marriage to Lady Astor based on the belief that he would be suffering a great deal in such a scenario.

SIU: a subject would only laugh if she were fine with Lady Astor’s lowered status.

Example 4.

W. C. Fields was once asked, “Do you believe in clubs for young people?” He answered, “Only when kindness fails” (Pinker, 1997, p. 550).

FB: the belief that ‘clubs’ mean a kind of social groups is falsified by the belief that ‘clubs’ are those things that you hit people with.

E: more easily available the desire to use corporal punishment for young people, the stronger the laughter would be. Those who find corporal punishment unthinkable immoral as a repertoire in human behavior and do not understand a desire to use it will not laugh.

SIU: the possibility of frustrating the desire of young people to be free of corporal punishment is okay with a laugher. It is also possible that the laugher construes the whole scenario as ‘pretend’ (i.e. a joke), a case impossible to actually happen.

Generally, the Inner Eye theory explains the frame shifts required by many jokes, by having one ‘frame of reference’ falsify another. When a subject falsifies a previously held belief or a belief held by another, the subject must possess a belief to falsify the false belief with. In the above jokes, the reader falsifies her own belief with a new belief. In some cases, the reader falsifies others’ beliefs with her own belief. In other cases, it is an agent’s new belief that falsifies the agent’s old belief as in the joke below.

Example 5.

The assassin of Dr. Martin Luther King, James Earl Ray, is dead. And what a practical joke on him when he finds out that hell is integrated. – Bill Maher (quoted in J. Brown, 1998).

FB: James Earl Ray’s expectation is falsified by the observation of the integrated hell. The surprise is borne most obviously by an agent in the joke rather than the reader of the joke.

E: the laugher has to understand the mental states behind all actions, including the aforementioned frustrated desire of J. E. Ray. Laughter will be stronger if the laugher actually possesses such a desire, but a chuckle can happen even if the desire is attributed to J. E. Ray as a known characteristic of J. E. Ray, i.e., a ‘pretend’ desire required for a laugher to understand the frustration.

SIU: the desire of J. E. Ray to live in a segregated world is frustrated. Laughers are at least fine with this. The more the laughers enjoy the frustration, the stronger the laughter. Someone sympathetic enough to J. E. Ray will not laugh and may even make angry faces signaling the corresponding emotional states.

Superiority Theory: Thomas Hobbes was a proponent of this theory. He stated,

“The passion of laughter is nothing else but sudden glory arising from a sudden conception of some eminency in ourselves by comparison with the infirmity of others, or with our own formerly: for men laugh at the follies of themselves past, when they come suddenly to remembrance, except they bring with them any present dishonor” (Hobbes, 1650/1994, pp. 54-55).

Example 6.

“Sign outside a church:

Next Sunday: “Do You Know What Hell Is?”

Come in and hear our organist” (Gruner, 1997, p. 3).

FB: the laugher’s expectation is falsified by the unexpected insult on the organist, i.e., the lowering of his status.

E: the laugher understands the mental states behind everyone’s actions including the one who wrote the sign.

SIU: the laugher is at least fine with such an insult of the organist.

Example 7.

My wife and I were happy for twenty years. Then we met. – Rodney Dangerfield (quoted in R. Byrne, 1990).

FB: the belief after reading the first sentence that the couple was happy during a marriage is falsified by the second sentence.

E: the laugher understands the mental states behind the statement including Rodney Dangerfield’s supposedly frustrated desire to be in a happy marriage.

SIU: the laugher again is at least fine with an unhappy (‘pretend?’) marriage of Rodney Dangerfield.

Incongruity Theory: “disjointed, ill-suited pairings of ideas or situations or presentations of ideas or situations that are divergent from habitual customs form the bases of incongruity theories” (Keith-Spiegel, 1972). This idea is incorporated in the Inner Eye theory’s FB criterion. Incongruity occurs when an observed situation contains some aspects that are not expected to occur together. In other words, the subject perceives an aspect in a situation and forms an expectation that is then falsified by the second (the incongruous) aspect that was absent in the expectation.

Example 8.

When I was growing up, we had a petting zoo, and well, we had two sections. We had a petting zoo, and then we had a heavy petting zoo. For people who really like the animals a lot. – Ellen DeGeneres (quoted in J. Brown, 1998).

- FB: the incongruity occurs when the reader imagines the existence of a “heavy petting zoo” section, which doesn’t exist in reality and doesn’t usually go with a zoo. This is another example of multiple false beliefs. There are two beliefs that falsify one another. If the reader were to take her statements literally, then the false belief is the normal expectation that a zoo doesn’t really have a “heavy petting zoo.” If the reader were to assume that she is joking (playing a ‘pretend’ character), then the false belief is her ‘pretend’ character’s belief that there really is a zoo that has a “heavy petting” section. The subject shifts between these perspectives. Also, there may be an expectation that the description of the heavy petting zoo would involve a description of human heavy petting. This expectation is broken with the less explicit “like the animals a lot.”
- E: the laughter understands the complex set of mental states behind the joke, including the belief that a “heavy petting” zoo section exists for certain special people.
- SIU: the laughter is at least fine with the lowered status of Ellen DeGeneres’ ‘pretend’ character that has a false belief.

Example 9.

I have a new book coming out. It’s one of those self-help deals; it’s called *How to Get Along with Everyone*. I wrote it with this other asshole. – Steve Martin (quoted in J. Brown, 1998).

- FB: the incongruity is between the second and the third sentence. You don’t expect the third after reading the second.
- E: the laughter understands the mental states behind the statements. The laughter would be stronger if the laughter empathizes with the last sentence, possibly due to an extensive experience with people of that type.
- SIU: the laughter is at least fine with any status lowering of Steve Martin’s ‘pretend’ character and his co-author.

Conflict theory: this theory is closely related to the superiority theory and argues that all laugh-inducing situations involve conflicts: winner versus loser or winning perspective versus losing one (e.g., Gruner, 1997). This theory is incorporated in the Inner Eye theory in the forms of the contrast between the false belief and the current belief of the laughter and the conflict between those who undergo relatively positive welfare changes and those who undergo relatively negative welfare changes.

Example 10.

Frankly, I don’t believe people think of their office as a workplace anymore. They think of it as a stationery store with Danish. You want to get your pastry,

your envelopes, your supplies, your toilet paper, six cups of coffee—and then you go home. – Jerry Seinfeld (quoted in J. Brown, 1998).

FB: the whole scenario is incongruous with how people really behave or at least how they are expected to.

E: the laugher laughs harder if she empathizes with stealing stuff from the workplace. A reader who steals toilet paper from her workplace is more likely to find this joke funny than one who doesn't, everything else being equal.

SIU: the hidden agent in this scenario is the boss (or the company) who pays for all the stuff. A laugher is at least fine with the boss losing expenses in this manner. Bosses concerned with such expenses are less likely to laugh at this joke. They side with the losers in this scenario, other bosses. The winners are the underlings who use the company as a source for various supplies.

Conversational laughter: it has been observed that when people laugh in typical conversations, the things that trigger laughter do not resemble jokes at all (Provine, 1993). Typical 'prelaugh' comments observed by Provine's group, are: "I'll see you guys later." "Can I join?" "I know!" "What is that supposed to mean?!" (Provine, 1993). My experiences are that all such comments put in the actual contexts all involve the falsification of beliefs, expectations or intentions.

Example 11.

A little girl (possibly about 6 years old) is asked by Al Roker, on the Today show about a boy standing next to her, "Do you think he's cute?" The girl says, "No." All others, except the boy and the girl, laugh.

FB: The answer is unexpected by all except the girl. People are not expected to make such definitive statements about others' cuteness in their presence.

E: People understand the mental states behind the girl's "No", including her belief at a kindergarten age about a boy's attractiveness.

SIU: the boy doesn't laugh because he doesn't like his own lowered status. Others are less concerned, but the laughter is not strong enough to indicate a particularly strong enjoyment, which would result in ridicule.

Example 12.

Near the end of a year, as I was walking out of one of the offices at work, I yelled to someone hard at work, "Happy New Year!" She looked up and laughed.

FB: she didn't expect someone to interrupt her work with a "Happy New Year!"

E: she immediately read my mind and understood the mental state causing me to shout, "Happy New Year!"

SIU: she was fine with being interrupted in such a manner.

Example 13.

Very long ago, I asked someone, “How do you like your job?” She said, “I hate it.” I laughed.

FB: I didn’t expect the answer.

E: I understood the mental states behind hating a job. I believe she interpreted my laughter as laughter basically of empathy rather than of empathy plus an excessive enjoyment of her situation. I propose that the strength of the laughter helps the interpretation of the laughter. The topic of how different degrees and types of laughter facilitate the interpretation of laughter needs to be investigated further.

SIU: I liked/didn’t mind the fact that she has a job she hates, a condition, which I believe is widely shared. This may be an example of the author’s schadenfreude.

Moral theory: This is an interesting theory proposed by Veatch (1998). Although it lacks a mindreading component, it is similar to the Inner Eye theory. The theory states that all laugh-inducing situations must meet the following three necessary and mutually sufficient criteria. One, a “subjective moral principle”, i.e., “some affective commitment of the perceiver to the way something in the situation ought to be”, gets violated (Veatch, 1998). Two, the laugher perceives that “a predominating view of the situation as being normal” (Veatch, 1998). The third condition is that the first and second conditions are met in the mind of the perceiver at the same time.

The Inner Eye theory incorporates the moral theory in the following way. The satisfaction of the FB criterion often involves an expectation broken and the satisfaction of the SIU and the E criteria entail an affective commitment, together composing the moral theory’s first condition. The SIU and the E criteria compose the moral theory’s second condition, if one were to define ‘normal’ as having the quality one can like or empathize with. The temporal proximity requirement for the Inner Eye theory’s criteria is implicit within the theory since the E criterion requires the understanding of the false belief (the FB criterion) and the SIU criterion requires the comparison of the false-belief state (the FB criterion) to the actual state. All three criteria must thus be met in close temporal proximity since they all involve the FB. The Inner Eye theory explains the phenomena of laughter produced by peek-a-boo and tickles in similar ways as the moral theory.

Example 14.

Peek-a-boo laughter can be explained if babies do not understand object permanence and believes that the objects that are no longer perceived, have gone

out of existence. In a peek-a-boo, the face of the baby's mother, for example, is first visible to the baby, and then is hidden behind something (e.g. hands), and when the face reappears to the baby, the baby laughs.

FB: The belief that the mother has gone out of existence is falsified when the face reappears.

E: The underlying mechanism that allows the attribution of this type of mental states may be developed so that the baby can 'understand' the false belief that the mother has gone out of existence and the new belief that she does exist.

SIU: The baby likes the reappearance of the mother.

Example 15.

One laughs while being tickled.

FB: The false belief is that one is being attacked at vulnerable points of his body as his sensory system gives him signals indicating this possibility.

E and SIU: He, the tickled one, is at least fine with being tickled since he understands the mental states of the tickler and believes the tickler has no intention to harm him. So laughter signals trust in this case.

The following are more categories of laughter and explanation of them using the Inner Eye theory.

Example 16.

One laughs while in a rough-and-tumble play.

FB: The false belief is that one is being attacked, being beaten up and being chased from danger.

E and SIU: She, the individual playing, is fine with the situation as she understands the mental states of others and believes that others do not have an intention to harm her. This kind of laughter signals trust as for tickle.

Example 17.

One laughs immediately after an embarrassing incident (like walking right into a clean glass door, banging the nose) or an admission of an embarrassing past act.

FB: the laugher falsifies a belief (e.g., there is no glass there) that he held when he did the embarrassing act. These embarrassing acts are embarrassing exactly because they cause unintended consequences (in some cases only when they are caught). The unintended consequences falsify the beliefs that have contributed to causing the embarrassing acts.

E: empathy is strong, as the laugher himself has had the mental states causing the

embarrassing act.

SIU: this condition can be met if the laugher sufficiently detaches himself from his past self to tolerate a frustrated desire of his past self (e.g., walking into glass and feeling pain). Or this may be an exceptional case in which the strongly met E criterion overcomes a possibly unmet SIU criterion and produces a small laughter. Observers of this type of laughter read the mind of the laugher and if they empathize with the mental states causing the laughter, then they laugh a little, indicating that they understand and empathize. If the observers laugh too hard, they are ridiculing the embarrassed person, since for them, SIU is strongly satisfied, indicating a significant enjoyment of the perceived reduction in wellbeing for the initial embarrassed laugher.

Example 18.

An evil scientist laughs at the impending doom of the world, that he has planned (the evil laugh).

FB: the evil scientist detects the ignorance of the world about the planned doom.

E: the evil scientist understands the cause of the lack of knowledge by the world. He hasn't told the world of his plan.

SIU: the evil scientist is very happy about the impending doom compared to the peaceful world (the false-belief state) that the rest expects.

Example 19.

Very young children watching a Punch and Judy show squeal in anticipatory delight as Punch prepares to throw the box over the cliff. Why? Because they know Punch thinks Judy is still in the box. They know better; they saw Judy escape while Punch's back was turned. We take the children's excitement as overwhelmingly good evidence that they understand the situation – they understand that Punch is acting on a mistaken belief (although they are not sophisticated enough to put it that way) (Dennett, 1978).

FB: Punch falsely believes that Judy is in the box. I include this example to argue that laughter does not require either the subject or an agent going through a state of surprise. Punch does not go through a surprise in this scenario. The children would have laughed even if they expected Punch to live the rest of his life blissfully unaware of Judy's fate and never find out (and get surprised). Laughter requires a falsification of belief, not necessarily a surprise.

E: the children understand the situation

SIU: the children are happy about the real situation compared to the false-belief state.

Example 20.

“The entire Duke half of the Coliseum erupted in a hurricane of cheers, laughter, screams, back-pounding, and high fives” (Gruner, 1997, p. 5).

Gruner describes Duke’s thrilling win by overcoming a point deficit with 2.7 seconds left in the 1992 NCAA basketball tournament. The winning shot involved a Duke player, Christian Laettner, making a shot at the buzzer after catching a pass from another player, Grant Hill, the length of the court away.

FB: the belief by the observers that the point deficit couldn’t be overcome (or that it is very unlikely with such a little time left) is falsified.

E: one of the relevant agents is nature (or random chance). People understand this event because the event happened.

SIU: Duke fans laugh. Duke haters don’t.

I will use the following examples to discuss certain aspects of laugh-inducing situations. They meet all three criteria, but not all three may be discussed.

Example 21.

On *Late Night with Conan O’Brien* (4/4/2003), Vin Diesel says, “I was never a pretty boy, obviously.” Conan O’Brien responds, “Take it from me. It’s not easy. You know what I’m saying?” The audience laughs.

Conan’s ‘pretend’ character has the false belief that Conan is a ‘pretty boy’. I use this example to further argue that a false belief, not a surprise, is required. The laughs don’t need to imagine Conan’s ‘pretend’ character in a situation that makes him realize he’s not a ‘pretty boy’.

Example 22.

I recently attended a pro-drug rally—in my basement. – David Cross (quoted in J. Brown, 1998).

Example 23.

An Australian man won the 26th Annual Empire State Building Run-up Tuesday taking just 9 and a half minutes to run up the 86 floors to the observation deck. Nobody was more surprised than the handyman caught masturbating on the 73rd floor stairwell. -- Jimmy Fallon, *Saturday Night Live*, February 8, 2003.

Example 24.

Congress says that half of Americans use the Internet. The other half has sex with real partners. – Jay Leno (quoted in J. Brown, 2002).

Examples 22-24 are jokes that can be embarrassing if you laugh too hard at them. Strong laughter in these cases indicates extensive experience with the mental states that produce drug use, masturbation at workplace and consuming internet

pornography, respectively. Also, the appreciation of example 22 is greatly facilitated by being shown the image of the handyman caught in the act, as actually done by the show (just the back and the turned surprised face). I argue that seeing the image facilitates the empathy process and results in a stronger activation of the relevant mental states, one of which is the intention to masturbate secretly at work.

Example 25.

Impressions and fake news articles produce laughter.

Impressions of famous people are in the arsenal of many comedians. The FBs in these cases are the beliefs activated within the subjects that they are actually observing the people who are being imitated. Certain characteristics of voice such as frequencies and intonations and also movement traits may be associated with certain people. The representations of these people may be activated, but must be recognized as false by the subjects. Fake news articles (e.g., at www.theonion.com), possess much of the looks and styles of real newspapers and raise to some extent, within the readers, expectations of real news material. These expectations are falsified by the obviously false or very mundane non-newsworthy details of the stories, most involving some actions that can be empathized with.

Example 26.

Mom and Pop's plan was to move into the neighborhood...establish trust...for 48 years. And then, run off with Jerry's sneakers. – Elaine in *Seinfeld*, “the Mom and Pop Store” episode.

Elaine's statement is in response to Kramer's theory of Mom and Pop (of the Mom and Pop Store, a shoe repair business) planning all along to steal Jerry's sneakers. Elaine provides the evidence with which to falsify Kramer's belief and the audience laughs (at least I did along with the well-timed laugh tracks) while the statement is being made, during pauses. Kramer responds, “Apparently.” This is the third example to demonstrate that a surprise is not required, only a falsified belief.

Sarcasm works in a way similar as Elaine's statement in that an obviously false statement is made. The real state of events involves someone's reduction in wellbeing compared the state of events consistent with the sarcastic false statement.

Example 27.

In the *Seinfeld* episode called “the Doorman”, Kramer and Frank (George's father) pitch Kramer's new invention, the bro (bra for men; called ‘mansiere’ by

Frank), to Sid, a potential business partner. Sid asks, “So uh, what do you see in the back? Hooks? Velcro?” Frank answers, “Definitely Velcro.” Kramer adds, “Say you're getting intimate with a woman uh, you don't want her fumbling and struggling back there. I think we've all experienced that.” All three laugh very loudly (the first laughter). Later in the episode, a bunch of German tourists chase down Kramer into a corner because they think Kramer is a thief. Then one of them notices the bro in Kramer's pocket and asks what it is. Kramer demonstrates. The same tourist asks, “How does it connect in the back? With a hook?” Kramer responds, “Oh, no, no, no. Here, Velcro.” The German tourists are very happy and laugh, trying it on (the second laughter).

The first laughter signals the empathy that the three characters feel at the “fumbling and struggling.” To understand the second laughter, the viewers have to understand the mental states behind the joys of having the bro and the convenient Velcro. Viewers are primed to access these mental states from the previous incident that results in the first laughter and are thus more likely to laugh with the tourists. Often comedians' setups for jokes, work in a similar way by bringing up mental states that will later be used.

Example 28

In the *Seinfeld* episode called “the Jimmy”, Mel Torme sings a special song for the special guest, Kramer, at a benefit for the AMCA (Able Mentally Challenged Adults). People at the benefit including Mel Torme, think that Kramer's mentally challenged, due to Kramer's earlier visit to the dentist and the earlier injury to Kramer's mouth inflicted by Jimmy, each resulting in mumbled speech. The viewers laugh throughout the song (at least I did along with the laugh tracks), as Mel Torme constantly signals the false belief and Kramer constantly signals the belief that everything is normal.

The multiple falsified beliefs are that of Torme and that of Kramer. They never find out the truth so only the falsified beliefs from the viewers' perspective, not a surprise, must be enough.

Example 29.

Often people laugh at exaggeration or understatements.

Exaggeration and understatements are by definition technically false. People recognize these as false beliefs, but also understand the mental states behind such statements. If any wellbeing changes involved are satisfactory to them, they laugh.

Example 30.

In a skit on *Late Night with Conan O'Brien* (1/22/2003), Simon Cowell, a judge on *American Idol*, a talent show, is evaluated on his performance as a guest by a

three-member panel of ‘experts.’ The first judge says, “I thought he stunk and I would love to smash him in his head with this waffle iron” as he swings it out from under the table. The audience laughs.

The use of the “waffle iron” is worth a short discussion. In this context, a ‘waffle iron’ is likely funnier than a bat or just saying “I want to beat him up” because it’s more specific and thus unexpected. That is, the representation of “waffle iron” is less likely to be activated as a part of the subject’s expectation and is somehow a stronger falsifier of the expectation. Apparently, the use of a greater but recognizable level of specificity is a trick of the comedy trade, as Friend states, “A joke is funnier if you say “Tropicana” rather than “orange juice” (Friend, 2002).

Example 31.

Man: “You will never see me in a dress!” Smash cut to the man in a gown: “Does this make my ass look fat?” (Friend, 2002).

This is another trick of the comedy trade mentioned by Friend, called ‘whee wohn’ (Friend, 2002). The belief (e.g., “You will never see me in a dress!”) is falsified immediately with a quick editing to a situation that falsifies the initial belief.

Example 32.

Gay rights groups are calling for Santorum's resignation because he compared homosexuality to bigamy, polygamy, adultery and incest. It's not just the gay groups that are insulted. Well, the Mormons are insulted because he included polygamy. Congress was insulted because he included adultery. And Arkansas was insulted because he included incest. -- Jay Leno on the Tonight Show (4/23/2003)

This joke packs a few stereotypes. To understand the mental states involved in writing or telling this joke, the subjects must use heuristics such as representativeness (how does polygamist fit a description of a generic Mormon?) and availability (how many congressmen can you quickly think of who’ve committed adultery?).

Example 33.

A friend of mine got invited to a “Bon Voyage” party for his junior high school friend. At the party, he meets a very famous actor, who happened to be a friend of the mother of the person leaving. My friend was surprised and delighted. He and I both laughed as he told the story. My friend’s desire to meet somebody really famous is satisfied in the actual state compared to the false-belief state.

Example 34.

In the movie, *Finding Nemo*, Marlin, Nemo's father, laughs out loud and then shouts, "We are alive!" after he and his friend, Dory, get ejected through the blowhole from inside a whale. Marlin had been afraid that he and Dora were headed towards the stomach.

Examples 33 and 34 are cases in which SIU is positive because something good, not found in the FB state, happens to the laugher or his friends. In most of the other examples, something bad happens to someone else, for whom the laugher doesn't have much sympathy.

There is no way to exhaust examples of laughter as laughter can occur in any situation where falsifiable beliefs accompany both understandable agents and changes in wellbeing. No category of human affairs or world events would be immune from the possibility of laughter as laughter depends on how a laugher reads the minds of others and understands the causes of actions and events.

3.3. Humor and Laughter

The three criteria of the Inner Eye theory can be used to see the relationship between humor and laughter. Humorous, amusing situations can occur without producing laughter in observers. According to the Inner Eye theory, humorous situations that do not elicit laughter do not satisfy all three conditions sufficiently. The situation may not be adequately incongruous or surprising and thus produces insufficient falsification in the subject (the FB criterion). The situation may also involve causal agents that are not adequately understandable (the E criterion). The situation may also involve outcomes that are not sufficiently positive for the subject (the SIU criterion).

Laughter can also occur without obviously humorous elements. As mentioned above, Howe states, "Laughter that comes from a relief of tension is best viewed as a simple reflex action, much like the laughter response from tickling. Humor on the other hand is far more intricate and includes so much more social interaction than a simple relaxation of fear" (Howe, 2002). According to the Inner Eye theory, the major difference between laughter produced by tickling and that produced by other forms of humor such as verbal humor or humorous social situations is the type of belief representation falsified in each case. In other words, laughter always involves falsification of some belief representation and humor is commonly defined in such a way so that laughter triggered by humor involves only some types of mental representations such lexical representations in verbal humor or theory-of-mind representations in many social situations. Different types of representations will be further discussed in Section 5 below.

4. Game Theory

4.1. Signal of laughter

So how does this theory make sense from an evolutionary perspective? I begin with the following two points that Pinker has made, first, that laughter carries information and secondly, that the involuntary nature of laughter supports the trustworthiness of the signal (Pinker, 1997, pp. 545-550). Laughter's involuntary nature is evident in 'bloopers,' in which actors and actresses cannot stop laughing, resulting in multiple false takes. Let's examine what role each trigger criterion plays in the generation of the information content of the laughter signal, i.e. what information is transferred and when. I will discuss the criteria in this order: E, SIU and then FB.

4.2. The E criterion

Binmore has argued that empathy provides the "if-I-think-that-you-think-that-I-think chains of reasoning necessary to achieve equilibrium quickly" in game theoretic models of coordination and cooperation (Binmore, 1994, p. 57). Equilibrium (Nash equilibrium) arises when each player's strategy is the best strategy (maximizes payoff for her) in response to other players' chosen strategies. Often multiple equilibria are present in these models. One of the many examples is a game called the "battle of the sexes" (BOTS).

In BOTS (my version), player 1 and player 2 agree on the phone to attend either an opera or a movie that evening. However, before deciding on which, the cell phones stop working. Neither wants to attend one of the events alone or stay home. Player 1 prefers an opera to a movie while player 2 prefers a movie to an opera. Where should each player show up that evening? The payoff matrix that defines the game is shown below.

		Player 2	
		Opera	Movie
Player 1	Opera	2, 1	0, 0
	Movie	0, 0	1, 2

An equilibrium is achieved either when both attend the opera (in which case the payoff is 2 for player 1 and 1 for player 2) or when both attend the movie (in which case the payoff is 1 for player 1 and 2 for player 2). The other outcomes are not equilibrium since neither player's strategy is the best response to the other's chosen strategy. So again, where should each attend? The way this game

has been defined, each player has 50% chance of getting it right. Played multiple times, each player will spend a lot of time standing alone outside the opera house or a movie theater.

The point here is to call attention to what everyone knows, that a better thing to do is not to play this game at all, but play a different game by first exchanging information. They need to make known their beliefs and desires and also make known that they understand the other's beliefs and desires. In this case, they need to share their beliefs about where each will be. Simply put, they need to come to an agreement.

The E criterion serves such a function of signaling the laugher's own mental states as well as his understanding of others' mental states. For the E criterion to be satisfied, the laugher must understand other's mental states. The increased level of laughter when such a mental state is more easily available to the laugher indicates how prevalent the relevant mental state is in the laugher's social environment and may correlate with how influential the relevant mental state is in the production of the laugher's own behavior. The receivers of the signal use the information in predicting the laugher's future behavior and in deciding whether to join in a cooperative venture with the laugher and if so what strategy to use.

4.3. The SIU criterion

The SIU criterion signals how satisfaction of others' desires affect the subject's own utility (happiness or payoff). The domain of the desire (which desire is being satisfied) and the agent holding the desire (whose desire is being satisfied), both matter in the calculation of SIU for the laugher.

As applied to the BOTS, player 1 could tell him/herself, "If player 2 really loved me, player 2 would get a great enjoyment from my enjoyment of the opera." Such belief, if true, would change the payoff structure of the game, for example, as follows. In the following case, player 2 prefers an opera to a movie possibly because of his or her high sympathy level for player 1.

		Player 2	
		Opera	Movie
Player 1	Opera	2, 3	0, 0
	Movie	0, 0	1, 2

There are still two equilibria, but the Opera-Opera outcome is Pareto-efficient, i.e. that outcome results in at least the same or higher payoff for each player, compared to other possible outcomes.

Once again, the players must share their beliefs and desires to achieve the

efficient Opera-Opera (O-O) outcome. The E criterion and the SIU criterion together signal the laugher's utility function (how the payoffs are determined in the game) and what the laugher perceives others' utility functions to be. The receivers again use such information to predict the laugher's future behavior and to decide whether to join in a cooperative venture with the laugher and if so what strategy to use.

Communication occurs when the information changes the behavior of the receiver for the benefit of the signaler (Wilson, 1975, pp. 194-200). The information provided by the E and the SIU criteria encourage some others to join in cooperative ventures with the laugher, by providing critical information about the laugher's mental states, namely desires and beliefs.

4.4. The FB criterion

In game theoretic models of coordination and cooperation such as the BOTS or the Prisoner's Dilemma, non-equilibrium outcome would result if a player has a false belief about the strategy the other player would use. In other words, non-equilibrium outcomes falsify the expectations of at least one player.

In combination with the SIU criterion, the FB criterion limits the use of the laughter signals to those situations in which some agent's belief is falsified and some agent has a change in wellbeing in the actual state compared to the false-belief state. Such situations would include all non-equilibrium outcomes of game theoretic models of coordination and cooperation.

So the laughter occurs when someone is out of sync in beliefs with the others contributing to the outcome. Laughter signals the laugher's approval (the SIU criterion) of a situation that the laugher understands the causes of (the E criterion), in which someone's belief or expectation is falsified (the FB criterion.) Bergson's idea of laughter as a social corrective signal fits well with this aspect of the Inner Eye theory (Bergson, 1911). Laughter-like signal triggered, not specifically in presence of a FB, but in all situations including ones in which everyone is behaving exactly as expected would occur profusely. Possibly people would "laugh" as often as they smile. I will discuss smile as a signal of joy and empathy below.

It may seem to others that laughter still occurs too often including in situations in which the information provided isn't useful. However, laughter is an involuntary signal and no conscious decisions are made whether or not it's a good time to laugh, unless one is trying to fake laughter or suppress an already triggered laughter. The mechanism underlying the trigger of laughter, thus, may necessarily be simple, especially considering that natural selection works on variations of previously available mechanisms. So laughter is produced when the simple conditions are met, accompanying no conscious awareness that laughter transfers information while the information itself may be available. The

prevalence of laughter is also consistent with Wilson's observation that "animal displays as they really occur in nature tend to be very repetitious" (Wilson, 1975, p. 200). The benefit of the communication triggered by a simple mechanism, may simply outweigh the cost of excess or redundancy.

It is also important to point out that laughter in situations where one of the players is nature or chance is not irrelevant to the evolutionary purpose of laughter as a cooperator value signal. Some of the most important moral codes of a society regulate how the members of the society distribute desired things (status, job opportunity and others) based on personal characteristics that are in some part out of the person's control (sex, race, disability, obesity, injury due to accidents and many others). Each such moral code produces winners (those who benefit from the successful enforcement of the code) and losers (those who would benefit if the code were to disappear from everyone's minds). Laughter indicates that the laughter sides with the winner in situations where somebody successfully breaks such a moral code and gets away with it or where somebody expects to get away with breaking the rule, but fails. Thus, laughter indicates the laughter's allegiance to specific moral codes by signaling the laughter's sympathy levels for those who benefit from and sacrifice for the rules.

5. Implications and Future Directions

The Inner Eye theory of laughter raises many questions that can be addressed experimentally. The discussion below brings up only some of these in the categories of children's laughter, autistic people's laughter, nonhuman primates' laughter and adults' laughter.

5.1. Children's laughter

As children grow, they develop the mindreading ability to represent beliefs in themselves and in others, more like adults do. The Inner Eye theory predicts that the types of mental state representations that children can make would limit the types of laughter they can produce. One-year-old infants laugh in games of tickling, chasing and peek-a-boo (Shultz, 1976). These all are instances, in which the infants' own senses are falsified. By 18 months of age, children start engaging in pretend play by treating objects as things different than what they are and show this understanding by laughter (Leslie, 1988). Between the ages 3 and 5, children become able to attribute a false belief in a situation humorous to kids at those ages (Mayes, Klin, and Cohen, 1994). Between the ages of 5 and 7, children become able of attributing second-order ignorance and this ability is required to discriminate between a lie and a joke (Sullivan et al., 1995). These findings suggest that as the ability to represent different types of mental states belonging to self and others develops, the developing ability allows the

occurrence of corresponding types of laughter. It is important to note that the ability to falsify the different types of belief representations seems present throughout. Such a falsification mechanism is likely involved in development and learning.

5.2. Autistic people's laughter

Autism is thought to result from a deficit in the mindreading ability, and shows a triad of symptoms: social incompetence, poor communication skills, and a lack of pretend play (Baron-Cohen, 1995; Leslie, 2000). Baron-Cohen has proposed 4 separate components of the mindreading system: the intentionality detector (ID) which allows interpretation of moving stimuli as possessing desires and goals; the Eye-Direction Detector (EDD) that allows the detection of presence and direction of eyes and whether they are “looking at me”; the Shared-Attention Mechanism (SAM) that allows the representation of the kind, “Mummy-sees-(I-see-the bus)” and the “theory-of-mind mechanism” (ToMM) that allows the representation of the kind, “Agent-Attitude-Proposition” mentioned above (Baron-Cohen, 1995; Leslie, 1987, 1991, 2000; Leslie and Roth, 1994). He argues that people with autism lack the latter two mechanisms (Baron-Cohen, 1995). The Inner Eye theory requires falsification of belief representations and if people with autism do not have the ability to represent particular types of beliefs, they won't be able to laugh in situations that require falsifying them. Current evidence is consistent with this. According to a study of pre-school children with either autism or Down's syndrome, parental reports reveal no group difference in laughter at tickling, peek-a-boo, or slapstick (Reddy, Williams, and Vaughan, 2002). Autistic children, however, rarely laugh at socially inappropriate acts and laugh much more often for reasons the parents cannot understand (Reddy et al., 2002). Autistic adults also seem to appreciate jokes involving lexical or phonological ambiguities (van Bourgondien and Mesibov, 1987). Laughter can be used to reveal the kinds of representations that are available to be falsified in autistic people. In some situations, autistic people unable to predict and explain others' actions in terms of psychological states, may predict and explain them as events involving moving physical objects by using the types of representations available to them.

Autism affects males at a significantly higher rate than it does females (Baron-Cohen, 2000). It has been hypothesized that autism is an extremely male condition with a superior systemizing ability and an impaired empathizing ability (Baron-Cohen, 2002). This hypothesis is partly based on the findings that show female superiority in a variety of empathizing abilities (Baron-Cohen, 2002). Consistent with these findings are that women tend to laugh more often than males either as a speaker or as a listener and that women tend to smile more often (LaFrance, Hecht, and Paluck, 2003; Provine, 1993).

5.3. *Nonhuman primates*

It has been a controversial topic as to whether nonhuman primates possess a theory of mind ability similar to humans (e.g., R. W. Byrne, 1995; Gallup Jr, 1998; Heyes, 1998; Povinelli, 1998). They exhibit a variety of behaviors thought to require a theory of mind, but some have argued that these can be explained in other ways such as associative learning (Heyes, 1998). Chimpanzees, gorillas and orangutans produce laughter-like vocalizations during activities like tickling, play-biting and play-chasing (Caron, 2002). There are a few reported instances where nonhuman primates seem to appreciate higher forms of humor. Chimpanzees have been reported to express joy “making a play face, hooting, clapping and stamping around” after throwing feces at people (Butovskaya and Kozintsev, 1996). It also has been reported that Washoe, a chimpanzee, signed “funny” and snorted after urinating on Roger Fouts (McGhee, 1979). It has also been reported that Koko, a gorilla that was taught sign language, smiled after calling a former partner, “stinker” (Patterson and Linden, 1981). Koko also laughed after the following “conversation” (Hiller, 1986 as cited in Gamble, 2001).

B. (Hiller): What does Penny use to clean your teeth? Koko: Foot.
B.: That’s silly. She uses a toothbrush. Koko: Toothbrush.
B.: What does Penny put on your toothbrush? Koko: Nose.
(Then she put her foot up to her nose and laughs.)
B.: You’re a goof. Koko laughs.

These instances are obviously anecdotal, but it is tempting to speculate that some nonhuman primates’ laughter may involve falsification of others’ beliefs and expectations.

I will briefly speculate on the evolution of laughter here. Frank and Ekman have made a distinction between two groups of smiles: the enjoyment smile and the non-enjoyment smile (M. G. Frank and Ekman, 1993). I propose that smiles signal the combination of enjoyment and empathy, the latter signaling “I understand your actions,” or “Your actions activate strongly the representations for the same actions in my mind,” or “I may have done the same as you, if I were in your shoes.” Smiles that don’t seem to be triggered by joy are likely strongly triggered by empathy. In Ekman’s earlier work, his description of the *coordination* smile as ‘a polite, cooperative smile that serves to smoothly show agreement, understanding, intention to perform, or acknowledgment of another’s proper performance’ fits well with the proposed general interpretation of smiles (Ekman, 1985, p. 157). Although Ekman described eighteen different kinds of smiles (namely: *felt*, *fear*, *contempt*, *dampened*, *miserable*, *enjoyable-anger*, *enjoyable-contempt*, *enjoyable-sadness*, *enjoyable-fear*, *enjoyable-excitement*,

enjoyable-surprise, flirtatious, embarrassment, Chaplin, qualifier, compliance, coordination, and listener response smiles), I propose that joy and empathy are always involved in combination with other emotions in producing all these different types of smiles (Ekman, 1985, pp. 149-160).

Van Hooff has proposed that human smiling and laughter evolved from early primates by convergence of the silent bared-teeth display, and the relaxed open-mouth display (van Hooff, 1972). While the silent bared-teeth display is thought to be a submissive signal or, in some contexts a reassuring signal, the vocalized bared-teeth display is found in most mammals and associated with external threats (van Hooff, 1972). The relaxed open-mouth display is associated with play and is sometimes accompanied by vocalizations in some species such as chimpanzees (van Hooff, 1972). Van Hooff has also noted the similarity between the silent bared-teeth display and human smiles and that between the relaxed open-mouth display and human laughter (van Hooff, 1967). Perhaps, with the relaxed open-mouth display, the vocalization only occurs when a falsification of belief occurs in the animal's mind. Possibly, the ancestor vocalized bared-teeth display, was converged with the ancestor "relaxed open-mouth" display without a vocalization. Then the convergence of the underlying trigger mechanisms of the two signals would result in the mechanism of the Inner Eye theory. External threat followed by safety would entail falsification of a previous belief of the external threat and the addition of enjoyment and empathy by convergence with the smile-like silent bared-teeth display, would compose the proposed three components. Ramachandran used a similar line of reasoning (without the empathy component) when he hypothesized that smile evolved from a half-realized 'threatening grimace' in proposing his false alarm theory of laughter (Ramachandran, 1998). Laughter would take on the role of a cooperator value signal when some ancestors of humans became capable of the necessary belief representations.

Rats emit a 50-kHz ultrasonic vocalization in response to tickling or to play and in anticipation of rewarding electrical stimulation to the brain (Burgdorf, Knutson, and Panksepp, 2000; Burgdorf and Panksepp, 2001; Knutson, Burgdorf, and Panksepp, 2002; Panksepp and Burgdorf, 2000). Some have argued that this vocalization may act as a signal of positive affect and may be evolutionarily and functionally related to primate laughter (Panksepp and Burgdorf, 2000). The Inner Eye Theory is not inconsistent with this possibility as the neural mechanisms underlying the satisfaction of the three criteria may be commonly shared to some extent among all mammals although the types of mental representations available to each species are different.

5.4. Adult laughter

Often, laughter seems to be produced in combination with other facial expressions and bodily movements. This likely underlies the great variety of

types of laughter described. The different types would help others interpret the laughter correctly. The observers attempt to understand the mental states that produced the laughter and also other expressions and bodily movements accompanying or combined with the laughter. How the different expressions and their underlying mental states combine with the trigger mechanism of laughter to produce such a variety and whether the different types provide the correspondingly different types of information to observers need to be investigated. Besides the different types of laughter, another reason why people seem to interpret others' laughter without frequent or great deal of trouble, may be that people interact most often with others in the same culture, those with similar sets of beliefs and moral codes that allow expression of specific desires in specific contexts.

I expect the Inner Eye theory to be tested in a large part, with the use of functional imaging techniques, such as PET and fMRI. It has been found that a variety of mindreading tasks (reading either of own or others' mental states) activate among others, the right frontal lobe, particularly the areas along the border between rostral anterior cingulate cortex and medial prefrontal cortex (the paracingulate sulcus; BA8/9/32) (C. D. Frith and Frith, 1999). McCabe *et al.* found activation of this region during cooperative interactions (McCabe, Houser, Ryan, Smith, and Trouard, 2001). A study of patient with focal brain damages shows that the greatest disruption in humor appreciation results from damages to BA8/9 and "probably parts of BA10" (Shammi and Stuss, 1999). Comparison of brain activity during listening to subjectively funny jokes to that during listening to subjectively non-funny jokes results in the relative activation by subjectively funny jokes of BA10, a region involved in reward processing (Goel and Dolan, 2001). Comparison of brain activity during involuntarily laughing while watching a movie scene ("Mr. Bean") to that during faked laughter watching an unfunny scene of the same movie results in a relative activation of BA9 among others (Iwase *et al.*, 2002). These findings are all, on the surface, consistent with the Inner Eye theory. However, further studies are needed to more rigorously test the theory. The stimuli used to elicit laughter in these studies so far have been very unspecific. The challenge now is to design the appropriate tasks to isolate the required components.

Spontaneous smiles are thought to involve the right-hemisphere to a greater extent than posed smiles and result in greater displacement of the left corner of the mouth, making the smile more symmetrical (Wylie and Goodale, 1988). In a study involving split-brain patients, it was shown that only the left hemisphere is efficient in producing voluntary facial expressions (Gazzaniga and Smylie, 1990). In one study, icons with symmetrical smiles were given more resources by subjects than icons with less displacement of the left side of the mouth, consistent with the idea that smile asymmetry indicates the trustworthiness of the smile signal (W. M. Brown and Moore, 2002). The involvement of the right frontal

lobe used in mindreading may contribute to the displacement of the left side of the mouth in a smile.

Another critical issue is how the falsification process may occur. It may involve simultaneous activation of some belief representations and inhibition of others. It may also involve some sort of (true/false) tagging of a belief representation as in the proposed ToM module (Leslie, 2000). Both may occur or different representations may involve different falsification processes.

Another important question is whether people have a direct knowledge of their own beliefs and desires unlike the indirect knowledge of others' beliefs and desires that are gained through inference. Some have argued against the Cartesian proposition that people have a direct and accurate access to their own beliefs and desires. Churchland has proposed that the mind/brain is a theorizer from infancy, of how the internal (mental) world works (Churchland, 1984, p. 80). Humphrey has posited that an evolutionarily designed "inner eye" that observes the inner mental states, is the basis of consciousness (Humphrey, 1986). One line of support for the view against the Cartesian proposition has come from studies of children that show that, during development, children make exactly the same types of mistakes in attributing their own beliefs as in attributing others' beliefs (Gopnik, 1993; Wimmer and Hartl, 1991). It has also been noted that people use the same region of the brain, anterior paracingulate sulcus of the medial prefrontal cortex, in the attribution of both the self's mental states and others' (C. D. Frith and Frith, 1999; U. Frith and Frith, 2001). The Inner Eye theory is consistent with the view that the mind/brain uses innate and domain-specific representations in constantly theorizing the causal relationships between the mental states that it observes, including those within itself, and the events that it experiences, whether the emotional events occurring within or the sensory events originating from the outside world.

6. Conclusion

There have been other recent evolutionary accounts of laughter (for reviews, see Vaid, 1999, 2002). In his theory of humor as a disabling mechanism, Chafe has argued that the purpose of humor is to prevent people "from acting upon or 'taking seriously' conditions and conclusions into which they are misled by the misapplication of natural processes of human reasoning" (Chafe, 1987). Alexander has argued that the purpose of humor is to manipulate the status of the humorist and that of others, creating cohesiveness among some and ostracizing others (Alexander, 1986). Weisfeld has argued that laughter is a signal that encourages others to provide various types of socially informative stimulation (Weisfeld, 1993). Dunbar has hypothesized that humor is a form of 'vocal grooming', with the endogenous opiates being released during laughter and facilitating social bonding (Dunbar, 1996, p. 191). Miller has argued that laughter

shows off one's creativity and thus his or her fitness as a mate (Miller, 2000, pp. 415-416). Owren and Bachorowski have theorized that laughter is a complex signal of positive affect that has evolved after smiles have come under voluntary control (Owren and Bachorowski, 2001). Howe argues that sense of humor developed in humans because "those of our ancestors who could read the thoughts of others and get pleasure from being able to interpret their expressions would have achieved power within the community" (Howe, 2002). Unfortunately, none of these theories propose a unified trigger mechanism for all types of laughter and its relation to laughter's function. The Inner Eye theory attempts to do this in a manner consistent with available data. For examples, the Inner Eye theory can easily explain how laughter facilitates group bonding (Banning and Nelson, 1987; Terrion and Ashforth, 2002) and how people seek mates with their sense of humor (Buss, 1988; Murstein and Brust, 1985).

There have been many proposals to explain cooperative behavior, including reciprocity (Axelrod, 1984; Axelrod and Hamilton, 1981; May, 1981; Trivers, 1971), reputation (Lotem, Fishman, and Stone, 1999; Milinski, Semmann, and Krambeck, 2002; Nowak and Sigmund, 1998; Wedekind and Braithwaite, 2002; Wedekind and Milinski, 2000) and involuntary signals of emotional commitment (W. M. Brown, Palameta, and Moore, 2003; R. H. Frank, 1988; Hirshleifer, 1987). The Inner Eye theory proposes that laughter is a signal that facilitates cooperation by transfer of information on the laugher's empathy with attributed mental states and his sympathy levels for others. It is helpful to think of the brain as composed of different domain-specific modules each designed to solve a particular problem in the ancestral environment (Cosmides, Tooby, and Barkow, 1992). Laughter is a signal of cooperator value, which helps address the problem of finding trustworthy partners for successful coordination and cooperation ventures.

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