Intention

C Parkinson and T Wheatley, Dartmouth College, Hanover, MA, USA

Glossary

Alien hand syndrome A neurological disorder in which individuals perceive their limb(s) as autonomous agents performing actions independent of their own conscious volition.
Faux pas The unintentional violation of cultural norms or etiquette rules.
Joint attention The process of drawing another person's attention to an object nonverbally, often by looking to the person, then to the object, then back to the person.
Mentalizing The ability to connect overt behavior to subjective mental states.
Phantom limb The illusory sensation that a body part that has been amputated is still attached to the body.
Readiness potential Neural activity occurring in the movement-related areas of cortex ~1 s prior to voluntary muscle movement, and ~350 ms before the conscious desire to move.
Theory of mind (ToM) One's construal of the mental states of others. The development of a ToM requires the understanding that others have subjective mental states (beliefs, desires, intentions) and that these unobservable mental states are linked to their observable behavior.

Introduction

As Justice Oliver Wendell Holmes famously put it, "even a dog knows the difference between being stumbled over and being kicked." Intentions, rather than actions, are most informative about the character and likely future behavior of others. Accordingly, intent comprises the primary determinant of legal culpability for common-law crimes, such as murder and theft, in many legal systems. The Supreme Court affirmed in Morissette v. United States, "The contention that an injury can amount to a crime only when inflicted by intention is no provincial or transient notion. It is . . . universal and persistent in mature systems of law . . . [and] is almost as instinctive as the child's familiar exculpatory, 'But I didn't mean to.'" At the same time, scientific findings suggest that the relationship between intention and action is more complex than our intuitions might suggest. This article examines the study of intention from the developmental milestones that give rise to an understanding of intent to the nature of the relationship between intention and action.

Understanding the Intentions of Others: Developmental Milestones

Attending to Eyes

We come into the world hardwired to find other people interesting. From birth, newborns attend more to faces than to any other object. Within the face, newborns seem to find the eyes especially interesting, as they stare more at the eyes than at any other facial feature. Researchers have argued that this attentional bias occurs because the eyes are a useful source of information regarding what a person might do next. Indeed, at as young as 3 months of age, infants not only look preferentially at the eyes, but also track eye gaze direction. By the time they are 9 months old, infants will use their gaze to get another person to look at an object with them. This is accomplished by looking first at the person, then at the object, and then back at the person. This form of communication, and the ability to respond in kind, is called 'joint attention.' Joint attention appears to be an early precursor to an understanding of intent. At this age, infants cannot fully understand intent, as they have not yet developed a concept of another mind, but they are beginning to learn that gaze and behavior are linked. That is, by 9 months of age, infants have learned that looking at an object often precedes acting on that object. Even if joint attention may not indicate a true understanding of other minds, it appears to be foundational to this ability. Impairments in joint attention are among the earliest signs of autism. Moreover, the degree of individual impairments in joint attention predicts the intensity of an individual's autistic symptoms, responsiveness to therapeutic interventions, and long-term social outcomes.

Understanding Action Goals

Within the second year of life, children begin to understand that other people have goals and desires. One study by Andrew Meltzoff showed 18-month-old infants' videos depicting unsuccessful actions. In one such video, an adult tried to separate a dumbbell but his hands slipped. The infants were then given the same dumbbell. The authors' empirical question concerned whether the infants would mimic the adult's actual movement by letting their hands slip off of the dumbbell or attempt to separate the dumbbell. Only attempting to separate the dumbbell would suggest that the infants had understood the actor's goal. The infants' behavior indicated that they did indeed understand the goal of the action. This finding was later replicated with 15- and 12-month-old infants but not with 9-month-old infants, indicating that an important developmental change in action understanding occurs at approximately 1 year of age.

Although understanding the goals of actions may seem tantamount to understanding intentions, psychologists have pointed out a key difference – the inference of another mind. Action goals can be ascertained without considering another mind using the simpler metric of object-directedness. In the dumbbell example, it is likely that the motions employed to separate the dumbbell indicated effort and directedness while the slipping of the hands did not. Thus, the infants may have inferred which motions were related to the goal and which were not without having to represent the adult's mental state (i.e., his or her intention). An analogous process may occur when adults consider the actions of robots. The action goal of a Roomba, for example, is understood perfectly well from its observed action (vacuuming dirt). Inferring that the Roomba's action was mentally driven (intended) would be unnecessary and absurd. Inferences of intention go beyond understanding action goals, as they involve the attribution of an unobservable cause: a mind.

Mentalizing

Mind attribution is central to successful social functioning. The capacity to represent the contents of others' mental states is referred to as 'theory of mind' (ToM). An important component of ToM is the ability to understand that others have subjective desires. Wellman and Woolley demonstrated that 2-year-old boys possess this capacity using a 'Finds-Wanted' paradigm. Children in this study observed characters looking for target objects, and had to make judgments about the characters' feelings and subsequent actions in three conditions. The character either found what they were looking for in the first location ('Finds-Wanted'), found nothing ('Finds-Nothing') or found an attractive object that was not the particular object they had been searching for ('Finds-Substitute'). Children were asked to predict whether the character would continue to search, and how the character felt in each of the three conditions. By and large, the 2-year olds in this study performed well on the task. For instance, the children could infer that the character would continue to search for the desired object if he had not found it in the first location, and that the character would only be satisfied after finding the particular object he desired. These results suggest that children as young as 2 understand that the desires of others are subjective. The ability to understand desires that conflict with one's own, or to represent beliefs that conflict with reality, however, seems to arise later in development.

Children typically first demonstrate the ability to represent the beliefs of others as distinct from objective reality at around of 3 or 4 years of age. This developmental landmark has been delineated based on studies using false belief tasks. Success on such tasks often requires participants to solve an 'object transfer' problem in which the characters possess beliefs that differ from reality. A particularly popular false belief task is the Sally-Anne task (Figure 1), consisting of a simulated interaction between two dolls, Sally and Anne. Anne has a box, and Sally has a basket. Sally places a ball in her basket before leaving the scene briefly. While Sally is gone, Anne removes the ball from Sally's basket, and places it in her box. Then Sally returns. The participant observes all of this, and is then asked, "Where will Sally look for the ball?" Adults tend to respond that Sally will look in her basket, an answer that requires understanding that Sally holds a false belief. However, children younger than 4 years of age tend to predict that Sally will look in Anne's box, suggesting that prior to the age of 4, children lack the ability to understand that Sally has a belief that differs from physical reality. Developing a theory of mind is a critical milestone toward understanding intention because it enables a child to model another mind; a mind that is privy to different information, has a different psychological history, and may desire different things than one's own.

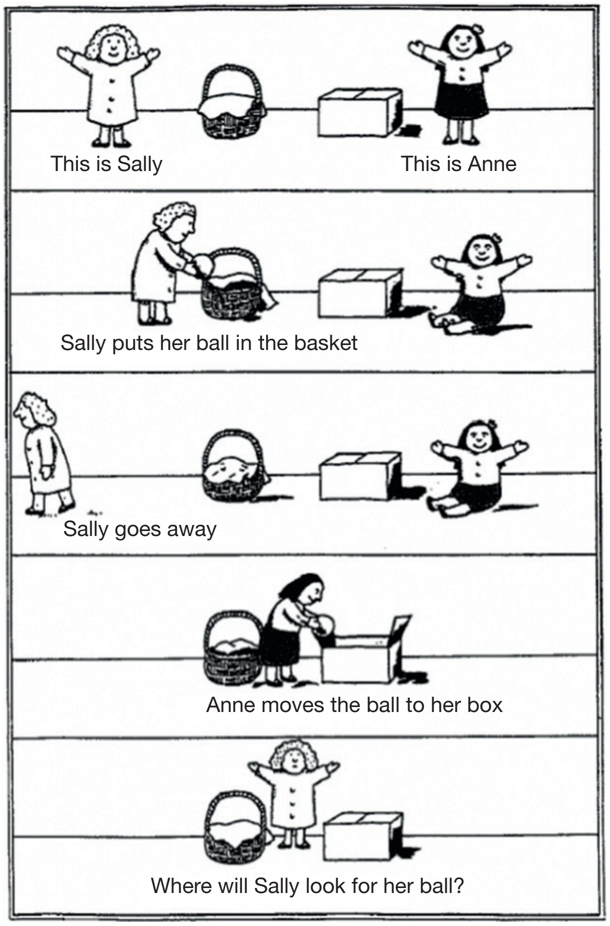

Figure 1 Illustration of the Sally-Anne paradigm. Drawing by Axel Scheffler reporduced from Frith and Frith (1999).

Advanced Mentalizing

As any parent would agree, understanding other minds is not perfected by kindergarten. It is not until at least 5 years of age that children can consider second-order mental states such as 'what Billy thinks that Sally thinks.' It is not until the age of 8 that children begin to develop an understanding of faux pas, the unintentional violation of a social norm. One recent study followed children from the age of 3 to the age of 12, measuring their levels of social understanding. In one task, the researchers used clips from the TV comedy 'The Office.' As the lead researcher, Dr. Yuill, explained, the boss character "is a typical example of someone who is very insensitive and reads social situations incorrectly. We cringe to watch it because we are embarrassed by his complete lack of social understanding." It was not until age 8 that children in the study began to cringe, rating scenarios with faux pas as more embarrassing than those without. By the age of 12, children in the study demonstrated as sophisticated an understanding of faux pas as their mothers.

Thus, understanding the nuances of social errors requires cognitive mechanisms that are not fully developed until late childhood. By the time they are teenagers, children have developed the understanding that a person's intentions are often more informative than, and can be contrary to, a person's actions.

In summary, a full understanding of intention requires a protracted development. Early on, babies monitor eye gaze direction. Later in development, young children exploit this attentional cue in order to infer and communicate intention. At around 1 year of age, infants differentiate goal-directed action from hapless mistakes, imitating only the former. By 2, children understand that the desires of others are subjective, and by 4, children understand that people can have thoughts that are distinct both from one's own and from objective reality. Theory of mind increases in sophistication over the childhood years, culminating in the understanding that nuanced social offenses can be committed unintentionally. Thus, by the teenage years, people have learned that actions are usually, but not always, preceded by intentions. Importantly, teenagers are able to detect and understand exceptions to this imperfect rule (e.g., Roombas, faux pas). The belated learning of these few exceptions underlines the utility and strength of the widely held intuition that intentions precede actions. However, science suggests that this link may be more tenuous than it may seem.

Understanding Our Own Intentions

A Social Psychological Perspective

According to Wegner and Wheatley's theory of apparent mental causation, an action feels intentional to the extent that it satisfies three criteria referred to as priority, consistency, and exclusivity. Specifically, we perceive ourselves as having intended to do something if we previously entertained a thought (priority) in line with the ensuing action (consistency), and if that thought appears to be the sole likely cause of that action (exclusivity). According to this view, the feeling of will is argued to be an inference that relies on the very same principles that govern our perception of causality in the external world. This position is not entirely new. Hume argued long ago that the belief that our intentions cause our actions is a mere perception, possibly rooted in fallacious inductive logic:

> Some have asserted, that we feel an energy, or power, in our own mind . . . But to convince us how fallacious this reasoning is, we need only consider, that the will being here consider'd as a cause, has no more a discoverable connexion with its effects, than any material cause has with its proper effect . . . In short, the actions of the mind are, in this respect, the same with those of matter. We perceive only their constant conjunction; nor can we ever reason beyond it. No internal impression has an apparent energy, more than external objects have. (1888: 400–401).

According to Hume and the theory of apparent mental causation, we perceive an action as intentional when we interpret a thought as the cause of that action.

If actions are interpreted as intentional based on the presence of a few key features, then manipulating those features should engender a false feeling of intent. Just such a manipulation was attempted in the following illustrative study. In this study (Figure 2), a participant and a confederate (a research assistant posing as another participant) manipulated the location of an onscreen cursor by moving a computer mouse together in sweeping circles while watching various objects displayed on the same screen (taken from the children's book 'I Spy'). The task, as it was explained to the participants, was to move the mouse together, stopping approximately every thirty seconds. Both wore headphones. The participant heard words related to the objects depicted onscreen, ostensibly as a 'mild distraction.' The participant was led to believe that the other participant (the confederate) heard different words. In actuality, the confederate heard instructions to force the cursor to stop at certain times. These stops were engineered to occur on specific objects at specific time intervals after the participant had heard a word related to that stop. For example, if the participant heard 'swan' the confederate might be told to force the participant to stop the cursor on the swan depicted on the screen. Following every stop, participants rated how much they had intended to make the stop relative to their partner on a one hundred-point scale.

Figure 2 Experimental setting from the 'I Spy' study. Image reproduced from Wegner DM and Wheatley TP (1999) Apparent mental causation: Sources of the experience of will. *American Psychologist* 54: 480–492.

In line with the principle of consistency, when participants heard a given word a few moments before the confederate forced a stop on a related object, they perceived that they themselves had engineered the stop. Consistent with the principle of priority, this held true only if the related word was heard a few moments before the forced stop engineered by the confederate, and not if the related word was heard well in advance of, or following, the forced stop. These results suggest that we can erroneously interpret an externally engineered event as intentionally caused by ourselves if we are made to think about that event immediately before it occurs.

Just as the 'I Spy' experiment demonstrates that we can experience will without performing an action, reports from clinical studies demonstrate that it is also possible to perform an action without experiencing the sensation of will. The uncoupling of conscious intention and action is the unfortunate everyday reality for individuals suffering from many psychological and neurological conditions. Schizophrenic patients often perceive their own subvocal speech as externally generated, or as if they are 'hearing voices,' and perceive that their own thoughts have been 'inserted' or controlled by others. Consistent with the general principles of causality outlined above, it has been suggested that this perception is rooted in a mismatch between these patients' conscious goals for thinking and behavior and their actual thoughts and behavior. Additionally, those suffering from alien hand syndrome perceive that their own 'alien' limb is in fact autonomous, acting according to a will of its own. The rogue limb is often perceived to be malicious, or possessed by an external force. Conversely, patients sometimes consciously will limbs lost to paralyzing injury or amputation to move to no avail in order to relieve unpleasant sensations in these 'phantom limbs.' Patients suffering from the later stages of Parkinson's disease also find their limbs frustratingly unresponsive to their motor intentions.

Anecdotal experiences from everyday life suggest that the uncoupling of action and intention does not only occur in specialized patient populations or in social psychology experiments. We often feel that we did not 'mean to' perform mindless gestures or habits, perhaps because we did not consciously hold a thought consistent with that behavior before engaging in that behavior. The fact that the perception of action and the sensation of intent can be carefully decoupled in experiments, are consistently dissociated in those suffering from a variety of medical disorders, and are imperfectly aligned in the behavioral minutiae of everyday life, suggests that Hume may have been correct. Intention and action may be merely correlated rather than causally linked.

A Neuroscientific Perspective

Neuropsychological research investigating the temporal relationship between brain activity and subjective conscious experience has also called the nature of the intention-action link into question. In a seminal study on this topic, Benjamin Libet asked participants to extend their right index finger whenever they 'felt the urge' to do so (his description of intent) while fixating on a rotating clock-hand. Participants were asked to note, and later report, the position of the clock-hand at the moment when they first felt the intention to move. Participants' reported feelings of conscious intention to move preceded the actual movement by approximately 200 ms. However, using electroencephalography (EEG) to measure event-related potentials (ERPs) on the scalp, Libet demonstrated that preparatory activity in movement-related brain areas precedes movement by a full second. Libet interpreted the finding that this preparatory neural activity – or 'readiness potential' – occurs well before the conscious experience of will as evidence that we may not consciously initiate our actions.

More recently, Chun Siong Soon and colleagues have suggested that the temporal relationship between brain activity and the conscious experience of intention may be even more remote than Libet's findings initially indicated. Reasoning that the readiness potential reflects activity in brain areas associated with relatively late stages of motor planning, these authors used functional magnetic resonance imaging (fMRI) to assess activity throughout the entire brain while participants completed a self-paced task with multiple possible behavioral outcomes. Participants watched a stream of letters that changed every 500 ms. Participants were told to press one of two buttons with either their left or right index fingers whenever they wanted to do so. Participants were then asked to report which letter was present on the screen when they had decided to move. Using statistical pattern recognition techniques to analyze fMRI data recorded throughout the whole brain, Soon and colleagues were able to predict which button a participant was going to push based on distributed patterns of brain activity measured between 7 and 10 s prior to the participants' conscious awareness of that 'decision.'

These findings have been taken by some to constitute evidence that the brain 'decides' to move well before the decision to move enters awareness. That is, conscious awareness of the decision to act may not be causal to the decision to act. Others have maintained that conscious awareness is causal to the decision to act, pointing out that the early patterns of neural activity observed in these experiments could merely reflect general anticipation of performing the task, or the preconscious beginnings of intentions. The early neural firing that constitutes the readiness potential, for example, might simply initiate a cascade of brain activity that prepares the brain to make a free, conscious decision. No currently available data can settle which interpretation is correct, and thus, whether or not conscious intentions play a causal role in action execution. However, the observation that action-related neural activity precedes awareness of a desire to make an action is a robust finding that must be incorporated into any contemporary model of conscious intention.

The readiness potential reflects a specific intention to move a particular body part within the next few seconds. This is, of course, a very narrow definition of intention. Humans are deliberative creatures who often plan courses of action well beyond the next 7–10 s, and certainly beyond a few 100 ms in advance. We also plan courses of action at levels of description far more nuanced and abstract than raising an index finger. Sometimes we have purely propositional intentions that lack specific action plans. For example, we may intend to 'go to college one day' or to 'be a good person.' We may also intend to 'get a cup of coffee,' an intermediate intention that launches a series of more specific motor plans toward that goal. Although neuroscientific research has focused largely on intentions to perform specific movements (e.g., finger raises) and associated cortical activity, recent evidence suggests that parietal and frontal regions may subserve intermediate and long-term plans, respectively.

A long-term, propositional intention, such as 'intending to retire early' requires imagining a time in the future when that intention will be realized. This ability to mentally time travel may be unique to human beings. While other animals are focused on here and now, as human beings, we spend much of our time remembering the past and wondering about the future. Consistent with the relative uniqueness to humans of mental time travel, long-range intentions are thought to be subserved by a region of the brain that is disproportionately larger in humans than other animals: the prefrontal cortex. Summarizing the evidence for the expansion and reorganization of prefrontal cortex in the course of human evolution, Flinn and colleagues suggest that this brain region is associated with self-awareness and the ability to project oneself into the future. This brain region also supports executive processes, such as reasoning and working memory, which may be critical to this kind of counterfactual thinking. Developmental evidence also points to the maturation of prefrontal cortex between the ages of 3 and 5 years as critical for the cognitive development of the ability to make plans, delay gratification, and understand intent.

A neural circuit that links the prefrontal cortex with the inferior parietal cortex may help translate propositional intentions in the prefrontal cortex into action plans in the parietal cortex. Activation of this prefrontal-parietal circuit may underlie the feeling of agency for a particular course of action. When Desmurget and colleagues stimulated the parietal cortex of epilepsy patients, they experienced an endogenously generated wish to move. That is, patients felt that they had spontaneously desired to create a movement. This phenomenology stands in contrast to stimulations of supplementary motor area (SMA), a region associated with the readiness potential. Stimulation of subdural electrodes in SMA causes an 'urge' to move that may also be described as the feeling of being 'about to move.' A strong stimulation of SMA, but not parietal cortex, will lead to actual movement. This suggests that SMA may play a key role in the feeling of being about to move while parietal cortex may play a key role in the feeling of generating an intention. Clearly, the word 'intention' belies its diversity. There are multiple levels of intention that range from long-term plans ('go to college') to specific motor plans ('pick up the cup'), which are subserved by distinct but interacting brain regions.

Failures of Intention

Try as hard as you can to not think of a white bear for the next 5 min. Go ahead. Were you successful? If you are anything like the participants in thought suppression experiments, you were dramatically unsuccessful, with thoughts of white bears popping into your mind every few seconds. Intending not to think or do 'x' can have the ironic effect of making 'x' more likely to occur. This is particularly true when we are tired or distracted. Wegner's ironic process theory accounts for this phenomenon by proposing that intentional control of the mind employs two processes: an operating process that directs conscious attention to whatever thought or action is intended and an automatic monitoring process that looks for failures of that intention. Stress, fatigue, and distraction have a disproportionate effect on one's ability to attend to something consciously, thereby disabling the operating process more than the monitoring process. The result is an unchecked monitoring system continues to search for failures of intention, continually bringing to mind the most unwanted thought. This ironic process has been used to explain the obsessive nature of unwanted thoughts and the tendency of athletes to 'choke' in a big game.

This article has focused on how intentions relate to actions and how an understanding of this relationship develops. However, most budding intentions never become actionable for good reason. Failures to inhibit intentions are just as damaging as failed intentions. Consider how much time people spend daydreaming; musing about everything from the motivational (e.g., wanting to advance in a career) to the wicked (e.g., wanting to hurt one's spouse). Not only do humans mentally time travel, they also wonder counterfactually what it would be like to do something different than whatever it is they are doing now. Playing out an intentional course of action in the mind's eye can be useful. It can help one realize, for example, that the long-term consequences of hitting one's boss would outweigh any ensuing short-term satisfaction. Inhibition at this early stage of intention affords a reasoned decision about which intentions become actionable and which should stay in the realm of fantasy. This requires considerable inhibitory control from the frontal cortex.

Patients with damage to orbitofrontal cortex (OFC) lack this inhibitory control. To these patients, having the thought to act and acting on that thought are largely synonymous. No lesion is as damaging to social behavior. The personality changes of OFC patients have been described by many writers. Perhaps the earliest account was by Dr. John Harlow in 1868. Harlow was the doctor who attended to Phineas Gage after Mr. Gage was involved in an accident that sent a metal tamping iron of the size of a walking stick through one eye and out of the top of his head. The accident did not kill him but decimated his OFC, giving scientists the first window into the function of this brain region. The accident did not compromise Phineas Gage's memory, sensory perception or language, leading to early reports that he survived mentally unscathed. However, Gage's friends noticed that his personality had changed radically. His lesion resulted in massively disinhibited behavior, allowing instinctual urges and transient impulses to become realized in action. The Country and Western song that thanks God for 'unanswered prayers' should add 'unrealized intentions.' The ability to quell 'bad' or inappropriate intentions is as beneficial to social relationships as realizing 'good' and appropriate intentions.

Summary

Intentions are good predictors of behavior most of the time. While simple intentions and actions have been decoupled within the context of carefully controlled experiments, they are strongly correlated. Further, it is unclear how this decoupling in the lab generalizes to the way we think about intention in everyday life.

Whether or not intentions are perfectly causal to our actions, they are consistently correlated with our own and others' behavior, and thus, are useful markers of what we might do next. Therefore, it is no wonder that a nuanced understanding of intention receives a prioritized, protracted development. The intuition that intentions cause behavior is an extremely useful heuristic in most circumstances. In sum, a thorough understanding of intention requires two things: (1) an appreciation of the general rule that conscious intention predicts behavior, and the concomitant pragmatic and legal uses of that rule and (2) a recognition of the empirical and neurological examples that show that this relationship is far from simple.

See also: Attribution.

Further Reading

Desmurget M, Reilly KT, Richard N, Szathmari A, Mottolese C, and Sirigu A (2009) Movement intention after parietal cortex stimulation in humans. *Science* 324: 811–813.

Fried I, Katz A, McCarthy G, et al. (1991) Functional organization of human supplementary motor cortex studied by electrical stimulation. *Journal of Neuroscience* 11: 3656–3666.

Haggard P (2008) Human volition: Towards a neuroscience of will. *Nature Reviews Neuroscience* 9: 934–946.

Hume D (1888) In: Selby-Bigge LA (ed.) *A Treatise on Human Nature*. London: Oxford University Press (Original work published 1739).

Libet B (1985) Unconscious cerebral initiative and the role conscious will in voluntary action. *Behavioral and Brain Sciences* 8: 529–642.

Malle BF, Moses LJ, and Baldwin DA (2001) *Intentions and intentionality: Foundations of social cognition*. Cambridge: MIT.

Ramachandran VS and Blakeslee S (1999) *Phantoms in the Brain*. New York: Harper Collins.

Soon CS, Brass M, Heinze HJ, and Haynes JD (2008) Unconscious determinants of free decisions in the human brain. *Nature Neuroscience* 11: 543–545.

Suddendorf T and Corballis MC (2007) The evolution of foresight: What is mental time travel and is it unique to humans? *Behavioral and Brain Sciences* 30: 299–313.

Wegner D (1994) *White Bears and Other Unwanted Thoughts: Suppression, Obsession and the Psychology of Mental Control*. New York: Guilford.

Wegner D (2002) *The Illusion of Conscious Will*. Cambridge: MIT.

Wellman H and Woolley J (1990) From simple desires to ordinary beliefs: The early development of everyday psychology. *Cognition* 35: 245–275.