# Intentional Systems, Intentional Stance, and Explanations of Intentional Behavior

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## Abstract

This paper is a limited overview of a preliminary research task carried out for the National Security Agency (NSA) having to do with developing a basic understanding of the notions and concepts of intent, intentionality, and intentional behavior. These notions clearly have significant implications for intelligence analysis and especially predictive intelligence; modern-day "asymmetric threats" and "operations other than war" make the understanding and exploitation of these notions yet more urgent. The projects' eventual goal is to develop and conduct research-oriented experiments with a prototype automated intent-estimating aid based on fused SIGINT-type data, as a path toward developing deeper knowledge about these concepts. This research effort is in support of NSA's "WARGODDESS" program which is developing a SIGINT-Fusion capability for operational use. As will be seen from the paper, this first study effort started with a review of the quite-basic research literature in the philosophical, cognitive, and legal arenas, with the purpose of evolving possibly new but minimally consistent and synthesized understanding of these basic concepts. It will also be seen that such understanding will not come easily and will require a serious continuing research program if optimal progress is to be made.

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## *1 Introduction*

The estimation of the intent of an adversary is clearly a desirable goal in combative environments, as it may provide a mechanism for warning of force units and for replanning of tactical activities. It is especially important in the modern era of “asymmetric threats” and “operations other than war”, which involve a broad repertoire of mission types having a very broad range of risk implications. The intent estimation process is spoken of in the defense research literature as if it is a part of conventional intelligence data analysis, although contact with some intelligence agencies reveals that, at best, this is an implicit part of intelligence analysis if it exists at all (Golden98). Typical current approaches to intent estimation (sometimes known as course-of-action estimation) are based on either extrapolations of recent behavior or on leader-profiling techniques. While these methods have had a degree of success in highly structured environments, they are inadequate in the face of the non-linear, combinatoric aspects of the modern, diverse threats mentioned above. Discussions on this topic with staff from NSA in relation to the evolving WARGODDESS automated SIGINT fusion program and its desire to estimate intent from such fused data led to the suggestion that a coordinated research program, beginning with an inquiry about the first principles underlying the notion of intent, be initiated. This paper describes some of the results of that first effort; the subsequent goals of this project are to define, design, and conduct experiments with a prototype automated intent-estimating analysis aid.

Interestingly, the past three decades have seen an explosion of analysis and research on intentions and intentionality, although serious assessment of this work does not seem to have been carried out for DoD purposes. A number of factors have contributed to this rapid growth:

- The exhaustion of both behaviorist and Freudian movements in psychology.
- Empirical advances in biology and the neurosciences.
- The advent of digital and optical computing as a paradigm and tool for research.
- The "naturalization" of logic, language, and mathematics.

Moreover, interest in intentionality or "intentional systems" has transcended the traditional boundaries of philosophy, linguistics, psychology, sociology, biology, and ethology. Studies on intentionality draw upon an ever-expanding universe of theoretical and empirical research ranging from abstract logic systems to field studies on chimpanzees.

This paper identifies some of the main trends in the study of intentionality at the dawn of the twenty-first century, but focuses on only one of them due to page constraints, and due to the author’s views on how best to proceed beyond this initial work. The interested reader is referred to the complete, two-part report written for this project (Deutsch and Llinas, 99). From our literature review, it appears that there are four diverse approaches to the explanation of intentional behavior. These include:

- "Folk psychology"
- Theory of Mind
- Communication Theory
- Intentional Action Studies

While all four approaches depart from the -- more or less -- same starting point, they operationalize the concepts of intentionality in different ways and for radically different purposes.

## *2 Fundamentals*

### 2.1 Intentionality and Intentions

According to John Searle (Searle69,79,83)

> Intentionality is that property of many mental states and events by which they are directed at or about or of objects and states in the world.

Intentionality should not be confused with "intention". Intentional states are directed; they are about something, not simply about intending to act. Intention -- in the sense of intending to act -- is merely one of many types of intentional states. Beliefs, desires, fears, hopes, doubts, suspicions, etc. are some of the many kinds of mental states that can be called intentional. What distinguishes intentional from other kinds of mental states is their content -- intentional states are “about something.” In this view, only some mental states can be characterized as Intentional states which have content, an "aboutness".

> While the boundaries between intentional and non-intentional states are obviously fuzzy and subject to fierce debate in the philosophical, psychological, and ethological literature, the directedness of intentional states can be interpreted or represented with "that" or "of".

Intentional states have content and a psychological mode or direction -- e.g., believe, desire, hope, etc. Representations -- pictorial, linguistic, symbolic, etc. -- are clearly intentional in nature, but not all intentional states can be represented by means of images, language, or symbols.

Intentionality should not be confused with consciousness. According to Searle,

> Intentionality is not the same as consciousness. Many conscious states are not Intentional, e.g., a sudden sense of elation; and many Intentional states are not conscious, e,g., I have beliefs (“about” something) that I am not thinking about at present and I may never have thought of. [2]

Many beliefs and desires survive and thrive beneath the surface of conscious awareness and we consciously experience many sensations that cannot be called intentional.

Finally, what are the scope and domain of intentionality? **Table 1** summarizes Searle's views on five key "forms" of intentionality.

**Table 1. Summary of Searle's Forms of Intentionality**

| | **Nature of Intentional Component** | **Presentation or Representation** | **Direction of Fit** |
|---|---|---|---|
| **Believing** | belief | representation | mind-to-world |
| **Desiring** | desire | representation | world-to-mind |
| **Remembering** | memory | representation | mind-to-world |

| | | | |
|---|---|---|---|
| **Seeing (Perception)** | visual experience | presentation | mind-to-world |
| **Intentional Action** | intention in action | presentation | world-to-mind |
| **Prior Intention** | prior intention | representation | world-to-mind |

These five "forms" could be taken to define the core scope of intentional states. While most authors would agree on the centrality of beliefs and desires in the understanding of intentionality, the intentional basis of memory and perception is more controversial and the literature on the intentionality of action is large, growing, and fraught with disagreement over fundamentals.

The domain of intentionality refers to the class of objects – persons, animals, systems, etc. – that display or be treated as displaying – intentionality. Obviously, debates over the intentionality of non-human systems – higher-order animals on the one hand and complex computer programs on the other – are endemic and irreducible in many respects. Nevertheless, the domain of research and application is inexorably growing as researchers are developing and using increasingly sophisticated means to test for intentionality in animate systems and build intentional states into inanimate systems (an interesting point when considering future concepts of warfare).

### 2.2 Intentional Stance and Intentional Systems

While philosophical excursions on the nature of intentionality and the relationship between intentionality and mind date back to the nineteenth century and Brentano, it was Daniel Dennett (Dennett69,78,87) who popularized the concept of intentionality and freed it from the narrow bounds of philosophical discussion. Dennett's writings are accessible to a broad audience and were primarily responsible for the rebirth of interest in intentionality and intentional systems.

Dennett's principal contribution was to move the focus of debate from the "essence" of intentionality to the benefits of using intentional terms to explain and predict the behavior of people, animals, and systems of any kind. Dennett's approach was instrumental -- intentional terms are useful in predicting the behavior of all kinds of systems regardless of the intrinsic intentionality of the system itself.

Dennett distinguishes three broad "stances" or strategies for explaining and predicting the behavior of a system: physical, design, and intentional.

1. **Physical Stance**. The observer determines the physical constitution of a given system and its physical interactions with its environment and then uses the appropriate laws of physics to predict the outcome for any input. The physical stance is generally useful for predicting the behavior of fairly simple systems with limited numbers of elements and states. For complex systems, the utility of the physical stance declines rapidly. However, the physical stance is most useful in explaining breakdowns or malfunctions in both mechanical and human systems.

2. **Design Stance**. The observer "ignores the actual (possibly messy) details of the physical constitution of an object, and, on the assumption that it has a certain design, predicts that it will behave as it is designed to behave under various circumstances." "The essential feature of the design stance is that we make predictions solely from knowledge or assumptions about the system's functional design, irrespective of the physical constitution or condition of the innards or the particular object." "Different varieties of design stance predictions can be discerned, but all

of them are alike in relying on the notion of *function*, ...That is, the design of a system breaks it up into larger or smaller functional parts, and design-stance predictions are generated by assuming that each functional part will function properly." The design stance informs explanations of computer systems and human brains alike – one can identify the various modules and their respective functions and even track their activities in progress, but one does not need or seek to know the actual configuration of states for any given operation at any given time. Design-stance predictions are limited, however, to the designed behavior of a system in its normal or designed environment. Changes in the environment, attempts to perform undesigned functions, or unanticipated interactions of designed functions will typically produce system breakdowns -- failures often best explained by means of the physical stance.

3. **Intentional Stance**. When the design of a system is exceedingly complex or inaccessible to the observer, one can adopt the intentional stance. "One predicts behavior in such a case by ascribing to the system the possession of certain information and supposing it to be directed by certain goals, and then by working out the most reasonable or appropriate action on the basis of these ascriptions and suppositions." "Whenever one can successfully adopt the intentional stance toward an object, I call that object an *intentional system*. The success of the stand is of course a matter settled pragmatically, without reference to whether the object *really* has beliefs , intentions, and so forth." Thus, complex computer systems like Deep Blue can be considered intentional systems in Dennett's sense, because their behavior can be successfully predicted by ascribing beliefs and desires. "When should we expect the tactic of adopting the intentional stance to pay off? Whenever we have reason to suppose the assumption of optimal design is warranted, and doubt the practicality of prediction from the design or physical stance."

By placing the burden on the observer, Dennett ducks the ontological issues of what really constitutes an intentional system. Intentionality is in the eye of the beholder.

**2.3 Orders of Intentionality**

Dennett further elaborates on his concept of intentional systems by distinguishing between different orders of intentional systems

1. ***Zero-order*** intentionality – simple stimulus-response behavior or reflex reaction without intentional content.

2. A ***first-order*** intentional system has beliefs and desires (etc.) but no beliefs and desires *about* beliefs and desires.

3. A ***second-order*** intentional system is more sophisticated; it has beliefs and desires (and no doubt other intentional states) about beliefs and desires (and other intentional states) – both those of others and its own.

4. A ***third-order*** intentional system is one that is capable of such states as

   Tom wants Mary to believe that Tom believes he is successful.

5. A ***fourth-order*** system might want you to think it understood you to be requesting that it leave.

This progression may go on forever, at least in principle. Indeed, in intelligence contexts, high orders of intentionality are involved when opponents are attempting to psych-out or manipulate each other. In most social contexts, however, five or six orders of intentionality are the most that human participants can effectively manage.

However, orders of intentionality become a critical issue in evaluating the complexity or intelligence of a given system.

> [T]hese orders ascend what is intuitively a scale of intelligence; higher-order attributions strike us as much more sophisticated, much more human, requiring more intelligence. [H. P.] Grice (Grice89) and other philosophers (see especially [Jonathan] Bennett(Bennett76)) have developed the view that genuine communication, speech acts in the strong human sense of the word, depend on at least three orders of intentionality in both speaker and audience. . .

Thus, orders of intentionality provides a framework for measuring the intelligence of an intentional system and attributing the presence or absence of truly human-like communication in animals. Notions of orders of intentionality are important to define, discern and understand in military problem settings, where adversaries are working toward psyching each other out.

### 2.4 Dennett's Legacy

However, this strategy liberates the analysis of intentionality from the prison of philosophy and challenges scientists in a wide variety of disciplines to come up with empirical standards and tests for intentionality. Intentionality has different standards, tests, and applications for primatologists, psychologists, neurobiologists, and jurists. Dennett's writings constituted an open challenge for specialists in all fields to operationalize intentionality to serve their own agendas.

Because of the page limitations for this paper, we focus on the Theory of Mind approach toward understanding intentional behavior in what follows; the other research areas mentioned above are covered in detail in our university report, available upon request (DeutschLlinas99).

## *3 Theory of Mind*

Although the literature on the 'Theory of Mind" deals with the same fundamental issues as Folk Psychology, it has a distinct genealogy and research focus. The term Theory of Mind was coined by David Premack and Guy Woodruff in 1979 as a product of research on chimpanzees. Their primary concern was whether on not chimpanzees could – like humans – attribute states of mind to others and use this information to predict the behavior of others. When and how does behavior reading become mind reading.

> When, then would it become valid to say that a non-verbal creature was reading behaviour in a way which made it of real interest to say they were mind-reading? [Whiten in (Carruthers92)]

Unlike the folk psychological analysis of verbal humans, primatologists and child development psychologists cannot rely on language to distinguish behavior reading from mind reading. Hence, research on the Theory of Mind has focused on two types of intentional systems – primates and children under the age of 5 – that populate the border regions of linguistic competence. Some of the most interesting insights into the Theory of Mind have resulted from research on autism.

> In a series of publications since 1985, Alan Leslie, Simon Baron-Cohen (see eg (Baron-Cohen93)) and others have argued that autism should be identified with *mind-blindness* – that is, with damage to an innate theory of mind module, leading to an inability to understand the mental states of other people. [Carruthers in (Carruthers92)]

While the mindblindness explanation of autism has not been universally accepted, it has generated some of the most productive, empirical hypotheses on the mechanics of mindreading.

In *Mindblindness*, Simon Baron-Cohen proposes four mechanisms that underlie the human – and non-human – capacity to read the minds of others. Like Fodor, Baron-Cohen understands these four mechanisms to be real – that is, to be instantiated in the wetware of the brain itself. Figure 1 reproduces Baron-Cohen's model of the mindreading modules in the brain.

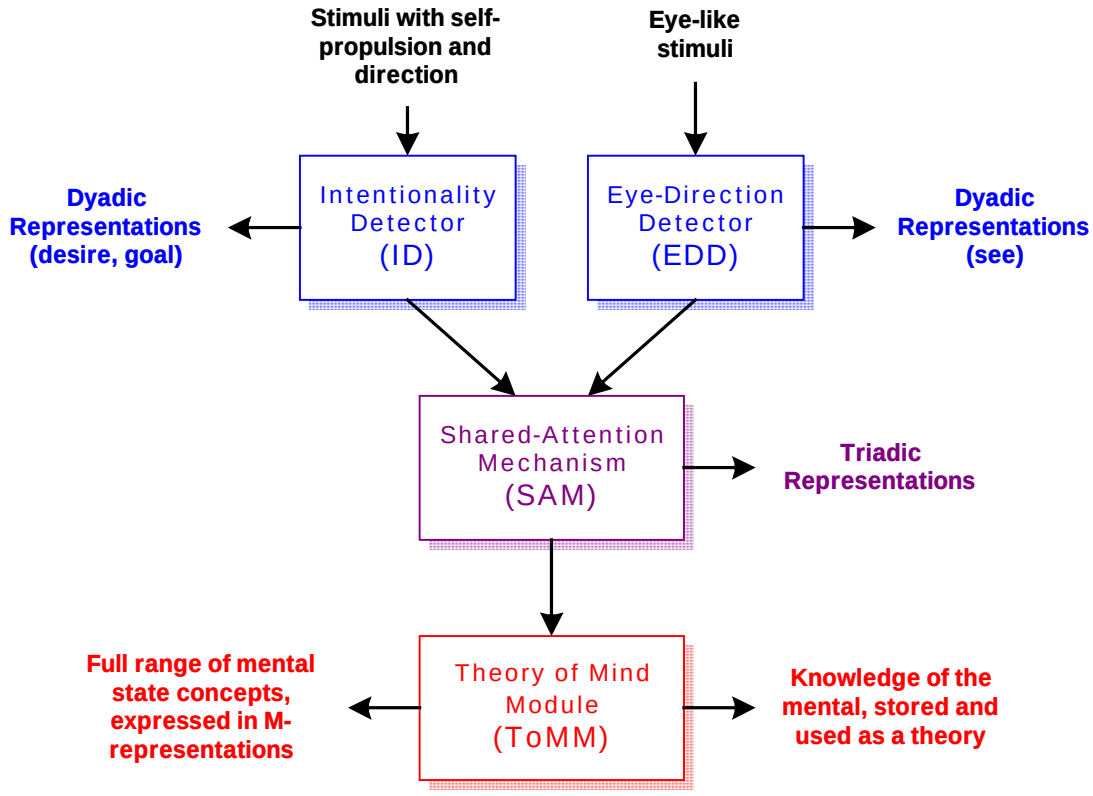


**Figure 1. The Mindreading System**

### 3.1 The Intentionality Detector (ID)

According to Baron-Cohen,

> ID is a perceptual device that interprets motion stimuli in terms of the primitive volitional mental states of goal and desire. I see these as primitive mental states in that they are the basic ones that are needed in order to be able to make sense of the universal movements of all animals: approach and avoidance. . . .

> ID, then is really very basic. It works through the senses (vision, touch, and audition), and it value lies in its generality of application: it will interpret almost anything with self-propelled motion, or anything that makes a non-random sound, as a query agent with goals and desires. [32-34]

The capacity to distinguish the self-propelled motion of animate agents from random or environmentally determined motion appears to be hardwired into the brain. Experimental research on the human tendency to anthropromorphize the behavior of geometric shapes dates back to the 1940s. Animals of all kinds have the same perceptual bias.

### 3.2 The Eye-Direction Detector (EDD)

According to Baron-Cohen, EDD is a specialized feature of the visual system.

> EDD has three basic functions: it detects the presence of eyes or eye-like stimuli, it computes whether eyes are directed toward it or toward something else, and it infers from its on case that if another organism's eyes are directed at something then that organism sees that thing. This last function is important because it allows the infant to attribute a perceptual state to another organism. [37-38]

Empirical research demonstrates the presence and primacy of eye detection and gaze control at a vary early age.

> There is clear evidence of physiological arousal produced by mutual eye contact . . . an infant's control over its visual system is precociously mature, enabling the infant to make or break eye contact and thus regulate the degree of eye contact and the amount of physiological arousal that the infant can cope with at a time. [42]

Although EDD involves second-order intentionality like ID, EDD is different from ID in the kind of mental states it attributes to others.

> ID interprets stimuli in terms of the volitional mental states of desire and goal; EDD interprets stimuli in terms of what an agent sees.

### 3.3 The Shared-Attention Mechanism (SAM)

The limitations of ID and EDD are obvious.

> [T]hese mechanism do not allow you to represent that you and someone else (whom we have been calling the Agent) are both attending to the same object or event. And yet that is exactly what one would need in order to be able to communicate about a shared reality and to feel that you and the other person are focusing on and thinking about the same thing. Without this crucial next step, your universe would be, in one sense, an "autistic" one. You would have sensations, and you would have images of people doing things and even wanting and seeing things, but you would have no way of knowing that what you and another person were seeing or thinking about was the very same thing. [44]

The Shared-Attention Mechanism performs this function.

> The key thing to emphasize is SAM can build triadic representations specifying shared attention, only if it receives information about another agent's perceptual state. It then computes shared

> attention by comparing another agent's perceptual state with the self's current perceptual state. It is like a comparator, fusing dyadic representations about the self' current perceptual state into a triadic representation. [46]

In Dennett's terms, SAM involves a special case of third-order intentionality, that is:

> Tom sees that Mary sees the ball *too*.

SAM also interacts with ID and EDD.

> SAM has a second function: to "talk" to the other two mindreading mechanisms. . .Here I propose that SAM can make ID's output (e.g., [Agent-has-goal-to-pick up the rock]) available to EDD. This allows EDD to read eye direction in terms of an agent's goals or desires. [48]

When the goal of an agent's action is ambiguous, "the first place young children (and indeed adults) look for information to disambiguate the goal is the person's eyes." [49] For most children with autism, this function of SAM does not appear to work normally.

> In most children with autism, SAM does not appear to be working through any modality – vision, touch, or audition. By and large, they bring an object over to someone, or point an object out, or lead someone to an object and place the person's hand on it, only when they want the person to operate that object or to get it from or for them. This is not shared attention in any sense; these behaviors are primarily instrumental, and do not indicate a desire to share interest with another person for its own sake. [69]

**3.4 The Theory-of-Mind Mechanism (ToMM)**

According to Baron-Cohen, a fourth module is needed to complete the story.

> ToMM is a system for inferring a full range of mental states from behavior – that is, for employing a "theory of mind" . . .The first thing that is still needed is a way of representing the set of epistemic mental states (which include pretending, thinking, knowing, believing, imagining, dreaming, guessing, and deceiving). The second is a way of tying together all these mental-state concepts (the volitional, the perceptual, and the epistemic) into a coherent understanding of how mental states and actions are related. [51]

These epistemic states correspond to the propositional attitudes that form the basis of Fodor's (and Dennett's) folk psychology.

> Leslie calls these M-Representations, and he argues that they are crucial to the ability to represent epistemic mental states. This is because the attitude is directed toward a proposition, and the proposition can be false while the whole M-Representation is true. . . So ToMM allow the *referential opacity* that is a key property of epistemic mental states.[52]

The basic test of a full ToMM is the notion of "false belief" – the ability to understand that others can believe in propositions – "The King of France is bald" – that are empirically false. But in this model, ID is very primitive -- while ToMM is key, we are not as much interested in states of mind as we are of intentions.

### 3.5 Mind Reading and the Economics of Interpretation

Andrew Whiten has offered a simple explanation for the survival value of mindreading. Simple behavior reading establishes a complicated network of links or relationships between stimuli, on one side, and responses, on the other. Each stimulus can produce a range of responses and each response, in turn, could be produced by a variety of stimuli. Therefore, efficient behavior reading would involve a complex calculus of cause and effect compounded by the statistical probabilities or strengths of these relationships.

> The suggestion is that recognising a state of mind in another follows this general pattern: for the folk mind-reader, attributing a mental state is in important respects the same as recognition of intervening variables by the professional psychologist. Any specific state, such as B knowing a certain thing, may be recognised by A on the basis of a number of different observable conditions which can cause this knowledge: and once the knowledge is attributed, that state itself could lead to a multitude of outcomes predictable according to circumstance. Thus, recognition of such states in others can be a powerful way of representing and predicting their behavior patterns, economic of neural resources. [Whiten in (Carruthers92)]

Attributing mental states to others is simply a better, more efficient use of scarce brain power. In effect, this evolutionary rationale for mindreading provides empirical support for Dennett's instrumentalist approach to folk psychology.

## *4. A More Practical View*

Another less esoteric and more practical approach to the task of "mindreading" is to shift the problem from discovering intentions to predicting the behavior of the "Other". Of course, that is the real task for US Government analysts. This predictability issue can best be considered from the standpoint of,

- How Is Behavior and Mentation Naturally Structured?

Ethological, sociobiological and anthropological studies have revealed basic and universal ways behavior and thinking are organized, constrained and structured. This is as process, not content. Humankind is not built into its environment via instinct. People must make meaning. This creation of meaning syncretically harmonizes data, belief and emotion into a design that serves the worldview of its maker. This design cannot be likened to a physics problem or an engineering technology. It is NON-LINEAR. It is SYMBOLIC.

People – whether your next-door neighbor or your enemy – are not logicians or statisticians. People make meaning and interpret "The World" in the service of their own familiar. Moreover, in the face of uncertainty and incomplete information, people do not wait for rosetta stones to answer the questions, "What's happening?" and "What am I going to do?" They just do it. And they do it in a way that the nature of mind dictates.

The mind is a:

1. pattern-maker
2. symbol-maker
3. narrative-maker

4. metaphor-maker, and

5. myth-maker.

The human will find patterns (even when there are none), will put symbolic meaning on that pattern in the service of his- or her story about "I" and "The World," will over-include "near fits" to this story, will over-exclude near non-fits, will fill in gaps (or deem them not important), will assume consistency, will let connotation completely override denotation; all in order to come to a bottom line (what's going on?) ASAP. In other words, each of us transforms the world into our world. And when we create our world we all work extraordinarily hard to fit what comes next into what is already conceived.

From this point of view, the task of US Government analysts seeking to predict the action of The Other is first to discover the symbolic associations that make, from the target person's subjectivity, data points into patterns and patterns into stories and stories into metaphors from which they extrapolate into future scenarios. Here, 'the usual' is seen as actively bringing things in line with your self-story; and 'the unusual' is interpreted as an expression of the underlying structure eminent in 'the usual.' All behavior is considered functional, mutually-supportive and non-contradictory from viewpoint of the target person's subjectivity.

Under this framework that addresses the notion of predicting the enemy, the primary analytic focus is on developing a picture of the adversary's story to itself about itself and about the U.S. – generally, contextually and situationally. Once the nature of PLOT of this symbolic and functional story of the Other's subjectivity is found, strategies can be formulated and tested to influence that narrative. From this perspective, what is observable and what is important to observe of The Other (in order to understand him) is determined by viewing him as an emotionally-based "maker of meaning."

## *5. Conclusions*

The uses of intentionality and intention as explanatory terms cover a vast range of territory. Folk psychology, theory of mind, communication theory, and action theory identify four overlapping areas of research, each with its own evolutionary history and objectives. What, if anything, unites these disparate fields of endeavor? While we haven't discussed all the methods herein, we nevertheless present Figure 2 which shows a highly simplified view of the four approaches displayed on a two-dimensional grid of consciousness on the vertical axis and content on the horizontal axis.

As Figure 2 shows, the relationships between intentionality, consciousness, and content are complex. Intentional states may be conscious or unconscious, language-based or non-language based (e.g., via images). Similarly, not all conscious activity is intentional (e.g., the state of exhilaration) while some linguistic utterances may not be intended, even though intentional. The differences between the four streams of literature can be better understood as different strategies used for different purposes.

- Folk Psychology – the instrumental explanation of rational action
- Theory of Mind – the cognitive/neurophysiological explanation of the origins of and limits to intentional action
- Communication Theory – the linguistic explanation of coordinated activity
- Action Theory – the cognitive or neuropsychological explanation of individual intentional acts

What all four approaches share is the explicit use of intentionality and intention as explanatory devices. While the utility of these concepts may seem obvious today, it should not be forgotten that little more than three decades ago talk of intentionality and intention was widely dismissed as prescientific or unscientific twaddle.

Looking to the future of this project, we are planning to research, in the next phase, the emerging concepts and cultural typologies as a necessary precursor to subsequent human-in-the-loop experiments and associated modeling and software development for an intent-aiding prototype, and operationally-relevant experiments.

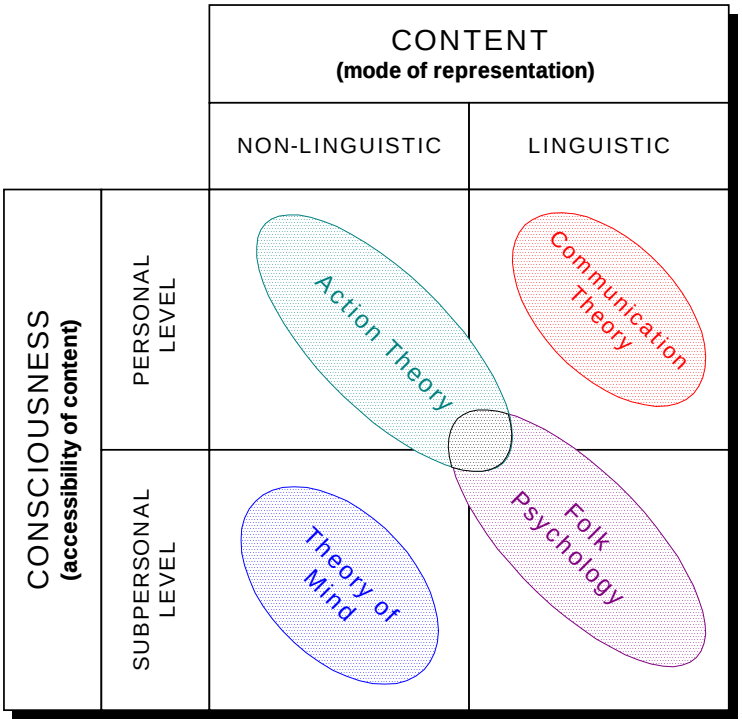


**Figure 2. Dimensions of Intentionality**


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