Acting and being aware

PENDERS, Jacques <http://orcid.org/0000-0002-6049-508X>

CHAPTER #

1.1 Awareness, Action and Attention

SUBTITLE

Jacques Penders
Research Group on Mathematical Linguistics
Rovira i Virgili University
Tarragona, Spain[1]

Abstract

One often assumes that we, human beings are rational and first think and than act. This paper is an attempt to describe the mental characteristics governing the performance of regular everyday actions; and shows that no mental act has to precede our actions, instead of consciously thinking before we act, we mostly act while simultaneously overseeing our acting. The case of ball juggling is used to underpin the analysis with empirical facts.

[1] Currently Sheffield Hallam University, Sheffield UK.
+44 114 225 3738
j.penders@shu.ac.uk

1 Introduction

In this paper I make an attempt to describe the mental stance applied by a human being while performing the standard routines of everyday life. The drive behind this attempt stems from research into what is called Machine Consciousness studies. Machine Consciousness studies cover efforts to construct machines that display characteristics which one might call mental.

The notions of mind, the mental and consciousness have been studied extensively in Philosophy. For the purpose of sketching the position of my research a brief discussion of some of the central notions. Concerning the duality of body and mind the dominant presupposition of western thinking is that body and mind are distinct and that the mental realm is distinct and separate from the material world in which the body acts. Descartes' famous '*I think therefore I am*', is often taken as to imply a notion of self-consciousness. Self-consciousness is often thought to be manifested as rationality: to be able to reason about oneself. Moreover, rationality is usually associated with the verbal, resulting in associating mental processes with a language of thought. The presupposition that mental processes proceed as a language of thought tempted some philosophers to define consciousness as a 'Centre of Narrative Gravity', (Dennett 2002).

In line with such reasoning is the often-encountered assumption – which I believe is generally untrue – that a certain mental act precedes our bodily actions, or in plain language that we first think and then act. For instance Haggard et al. (2002) write: "*Normal human experience consists of a coherent stream of sensorimotor events, in which we formulate intentions to act and then move our bodies to produce a desired effect*".

Indeed, on occasions we do first think and then try to act accordingly. Being human, we like to think of ourselves as rational beings. In the history of Philosophy Immanuel Kant is probably the clearest exponent of this view. He saw a human being as a logical subject of thought (Stuart, 2005) that is bound to act in the physical world. Kant's work could be seen as a major attempt to give primacy to rationality. However, Kant did not assume that we are rational; he argued that we should be rational; in his view rationality had to be fought for.

Concerning mental processes and body control, William James (1890) clearly noted that the suggested ordering in time in which a mental act precedes our bodily actions, does not hold. He described his concept of ideomotor action summarised as: we think the act and it is done. An example of his: "*We think to drink our coffee and we find ourselves already holding the cup in our hands*". I will argue a step beyond and show that we often act before any conscious thinking can occur. My point is not to substantiate a general moral excuse for

cases where we have done things, which we afterwards regret. My point is pragmatic: we cannot act and behave as we do in ordinary life if we first have to think (let alone think over) every action.

Whereas philosophy of mind generally analyses and then tries to explain the working of the mind, machine consciousness studies aim at a constructive approach. Machine consciousness studies are considered a branch of robotics or Artificial Intelligence. Chrisley et al., (2005) describe the aim of these studies as: 1) to create artifacts that have mental characteristics typically associated with consciousness (such as awareness, self-awareness, emotion and affect, experience, phenomenal states, imagination etc.) and 2) to model these aspects of natural systems in embodied models (e.g., robots).

This definition stipulates that the mental phenomena are to be studied in an embodied creature; thus the combination of computing machinery for information processing and mechanical actuators generating physical action is brought into the focus. My aim is neither to discuss whether the aims of machine consciousness studies can ever be achieved using the means currently applied in machines and robots; nor whether are the aims of Artificial Intelligence and robotics achievable. My interest is in whether these constructive approaches produce new insights. Present-day computers provide robots with tremendous reasoning capabilities. Nevertheless, the currently applied robots are far from being able to perform actions which seem elementary to a human being, such as throwing and catching a ball. Robotics and Artificial Intelligence move into an area, which is so familiar to us that we assume it all to be obvious. The lesson to be learned is that we hardly understand how we ourselves perform our actions, and in particular how sensory inputs guide our actions.

The present paper is an attempt to identify the mental processes, which manifest themselves in regular action oriented contexts. Without being able to provide a systematic view, I will discuss a few assumptions which indicate and position the relevant mental processes. Reasoning appears not to provide the solution for building artificial creatures and I will show that rationality is not the major guide for our everyday acting; obviously, the latter does not imply that irrationality applies. Rationality requires reasoning and reasoning is a conscious process; below I show that conscious processes cannot control our everyday actions.

In this paper I will hardly touch upon the notion of consciousness. Instead, the line of reasoning is the following. Any action and generally any perceptual input is accessible to consciousness only if it has passed through or has been passed on by attention. The processing by attention takes time and causes delay, and if the control of all actions has to pass attention then certain performances

cannot be executed by a human being. Nevertheless humans do perform these. Thus, the control of our acting does not necessarily pass attention, which means that certain activities and performances are beyond the control of consciousness. Instead of first thinking and then acting, we often only oversee our actions with our conscious and rational minds. Below, I will use juggling as the primary example to investigate the flow of the mental processes and prove my point.

2 Attentional focus and Acting

In the morning of a regular day, while deliberating on how to make the best out of the day ahead, we routinely drink our coffee and make our way to work, say by car. While driving the car, we suddenly stand on the brakes as we are forced to an emergency stop. Only after having come to a standstill it becomes clear what has happened the seconds before and what has been our contribution to the event.

My interest is in the mental stance governing the behaviour before the emergency stop, and which I believe we usually take when routinely drinking coffee or driving the car. This is a stance under which actions are selected and performed (for instance grabbing the coffee cup or pushing the brakes) without the actions being in the focus of attention.

In order to explore the stance, first a few words about the notion of attention. Our mind can be in different modes of activity, with sleeping as the extreme on the less active end. When awakening from sleep, our mind has to "warm-up" in an arousal phase. Then we become generally aware enough so that we can attend: the mind is aroused and proceeds via getting aware to attention. Further onwards, when there is attention, conscious experiencing, and consciousness and reasoning may come in.

Our senses produce an overload of signals as they are continuously subject to various stimuli. Broadbent (1958) argued that the processing of semantic features (´features related to the meanings of objects´) from the senses' inputs has severe capacity limitations. And since Broadbent's work the faculty of attention is often conceived of as a filter for or a gate to consciousness, which blocks, weakens or inhibits incoming messages from the senses. Baars (1997) introduced the metaphor of attention acting as a spotlight in a theatre. When in the spotlight of attention, the mental processing becomes accessible to consciousness. The filter metaphor characterises the operations of attention as reductive while the spotlight metaphor suggests amplification; both nevertheless agree that attention is the gateway to consciousness and that it is selective.

A different but equally important aspect of attention is that it also has to do with action. “Awareness [or being aware] implies perception, a purely sensate phase of receptivity. Attention reaches. It is awareness stretched toward something. It has executive, motoric implications. We attend **to** things.” (Austin, 1998).

Attention can guide our actions; however, the question is whether all our actions are guided and controlled by attention. Appropriate applications of motor skills - that is to act appropriately - requires a proper combination of perception, action selection and action execution. The role of attention in relation to perception has been widely studied; however its role in applying motor-skills has not received as much scientific interest. The reason for this might be that motor-control, which is a prerequisite for motor-skilfulness, is very much on and below the edge of what we can consciously experience and control.

The performing arts and sports sciences deal with action and attention. Artists and sports men and women engage in what is called *deliberate practice* (Rossano, 2003) (Ericsson et al., 1993): the concentrated effort to hone and improve specific (mental and) physical skills. Literature on deliberate practice distinguishes between external attentional focus and internal attentional focus; internal attentional focus means that the performer directs attention to the movements itself, while in external attentional focus, the attention goes to the effects the movements have on the environment (Wulf and Prinz, 2001). Obviously, in both attitudes attention plays a prominent role.

The influence of internal attentional focus may be observed in, for instance, dancing or martial arts classes. In a class of beginners, the students might be quite able to follow and copy the movements of their instructors. However, when the instructor explains the consecutive moves to the very detail, several students appear not to be able to perform, even though they may have performed quite well before. The reverse also applies: when the instructor is asked about the details of a move which (s)he has never made explicit before, it is likely he or she has to perform the movement first before being able to explain. Applying internal attentional and conscious focus to motor-control hampers the performance. Extreme examples are observed with patients suffering from the syndrome called apraxia. Apraxia denotes the inability of a patient to perform a certain skilled movement. For instance when asked to demonstrate teeth brushing, the patient is unable to do so, whereas he or she is perfectly able to brush the teeth in the morning, when there is no particular emphasis on the act itself.

Attention obviously has motoric implications. Generally internal attentional focus slows down movements and external attentional focus is more proficient

(Wulf and Prinz, 2001). The examples show that internal attentional focus and conscious control of motor-skills may even lead to an inability to act.

The notion of external attentional focus is not clearly defined and allows several interpretations. In a narrow, but easy to define sense it denotes attention focusing on bringing about a single effect: directing a tennis ball, or throwing a single ball or bean bag into the air such that it can be caught. I will test this reading in the context of juggling.

When performed well, juggling is great to watch. The magic about it is that the general spectator perceives the pattern that is formed by the balls (or other objects), but neglects the movements of the juggler. For instance, in the three-ball pattern called yoyo (Dancey, 1994) the juggler only throws two balls while the third ball is kept in one hand and is carried throughout the pattern, but that does not in the least bothers the spectator. Only when the spectator is observing the scene as a whole but is neither focussing on a particular ball nor on the moves of the juggler the typical yoyo effect –of the balls appearing to be connected- is perceived. However, if one focuses on the one ball that the juggler keeps in the hand, the yoyo effect disappears.

In the literature on sports psychology it is often assumed that external attentional focus is the only alternative to internal attentional focus; refer for instance to (Wulf and Prinz, 2001). The stance of the spectator shows that a third stance, one without focus, is possible as well. In the next section I will first investigate whether external attentional focus applies for a juggler; as the answer will be negative, I will also explore whether a stance similar to that of the spectator might apply.

3 Acting and Attention Shifts

The basic pattern in five-ball juggling is the cascade; and although basic, it is quite a step beyond three-ball juggling (Dancey, 1994). It is hard to learn and requires fast acting, the complication being that between throwing and catching the same ball four other objects – three of which are already up in the air - have to be handled. When first starting, it is a problem to throw each of the five balls one after the other before the first has returned (‘flashing’ as it is called), in doing so a novice will not be able to tell which ball was first thrown, let alone be able to catch it with the proper hand. The novice juggler is trying to apply full and focussed attention, and that leads him or her astray.

Juggling requires fast series of combinations of perception, action adaptation and action. The handling of a single ball is cyclic. To estimate the time of a cycle, assume a throwing height of one meter, which is more then most patterns, including the five-ball cascade require. The law of gravity leaves less than a second of time between throwing and catching the same ball. In the interval of less than a second that this one ball is going up and down, four other objects have to be dealt with. They are flying around and have to be observed in order to be handled; figure 1 gives an overview of the five-ball cascade.

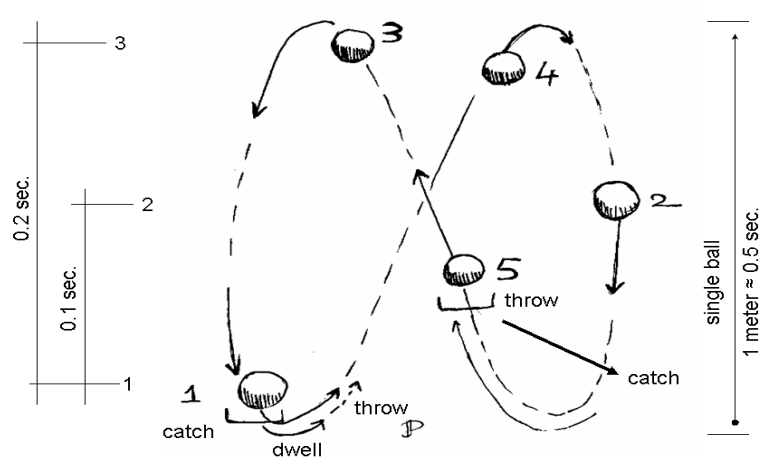

Figure 1, the main actions in a five-ball cascade.

Observations of jugglers show that the time lapse between two catches of the same hand may be as little as 0.2 seconds (refer to Polster (2003) for more details), this is indicated in figure 1 for consecutively catching balls (1) and (3). In this short interval several actions of this hand merge into each other: catching, bringing to throwing position (dwelling), throwing and preparing/waiting for the next. Since the juggling pattern is regular: in the middle of this series the other hand has to start its own series as well. In figure 1 ball (1) was the last to be caught and ball (2) is the next coming down and is to be caught about 0.1 second after ball (1) was caught. Obviously, the exact time between throwing ball (1) and catching ball (2) is less then 0.1 second; unfortunately I have no exact data.

In order for attention to be in control of the juggling actions, attention has to shift from ball to ball. Broadbent (1958) concluded that per second no more then two attention shifts can occur. Currently, psychologists distinguish between voluntary or internally (endogenously) driven attention shifts and involuntary or externally driven shifts; Broadbent only considered voluntary attention shifts (Lachter et al. 2004). Nevertheless, if attention is in control, the shifts have to be voluntarily. Recent work has found variations for voluntary attention shifts from 0.5 second to 0.15 seconds (Lachter et al. 2004). Obviously, even a fast voluntary attention shift of 0.15 second is too slow to switch from ball (1) to ball (2) since the latter is due within 0.1 second. Voluntary shifts would suffice to handle the balls due for one hand, but are too slow to interweave the actions of the second hand.

The previous section showed that internal attentional focus hampers execution of actions, and that the resulting actions are generally slower than when external attentional focus is applied. The case of five-ball juggling shows that external attentional focus, in the sense of attention focusing on bringing about a single effect fails as voluntary attention shifts require more time then the pattern allows.

4 Attention Reduced

Five-ball juggling cannot be governed by focused attention and voluntary attention shifts. Alternatively, involuntary attention shifts turn out to be much faster. Involuntary shifts require only 0.05 second (Lachter et al. 2004), which is in the order of three to ten times faster. The research into attention shifts is mainly based on experiments in which subjects are exposed to visual or audio inputs and are asked about what they perceive. However, juggling consists of an intricate combination of perception with actions such as movements of the limbs. Concerning acting, one also distinguishes between voluntary and involuntary acts. Similarly to the differences for attention shifts, voluntary acts are also slow compared to involuntary acts. The time required for the single voluntary act of pressing a button *only* when a light flashes is about 0.15 seconds (Austin, 1998). Voluntary acts are too slow to meet the constraints of juggling, thus, juggling is neither a series of voluntary actions. Involuntary acts, for example a reflexive jerk to shield the eyes from a flashing light, take only 0.025-0.05 seconds (Austin, 1998). Note that the times required for attention shifts are in the same order of magnitude as the times required for acting. The latter suggests that on occasions the body is as fast or maybe even faster than the mind.

Juggling is of course not a series of reflective jerks; the point is that humans can execute perception–action cycles at high speed. A recent assumption in cognitive neuroscience is that the mind has a layered structure with different organising levels concerning body experience. Neuroscience has found that there exist several distinct neural systems or circuitries for the perceptual control of movement (Rossano, 2003) and (Waszak et al., 2005). Raichle (1997) makes a distinction between "the neural circuitry underlying the unpractised, presumably conscious performance of a task on the one hand, and the practised presumably nonconscious performance of a task on the other hand." The response time of the latter circuitry is significantly shorter than that of the first (Raichle, 1997). More recently, Waszak et al. (2005) distinguish between actions carried out in response to exogenous stimuli or *stimulus-based* actions, and actions selected endogenously or *intention-based* actions. They note that intention-based actions are typically goal-directed, but slower than stimulus based actions.

In order to meet the time constraints, a five-ball juggler must apply a mental stance differing from internal or external attentional focus. This stance avoids intention-based actions, allowing the neural circuitry for stimulus-based actions to perform. Nevertheless, the stance must be very sensate and requires awareness; lacking an appropriate name, I call this stance: **non-focussed awareness**. And indeed, the experienced juggler does not focus on the individual balls. In his juggling book Dancey (1994) advises: "*While learning [a five-ball pattern] you are trying to* make *yourself do it, when you can do it you* watch *yourself doing it."* When acting, the juggler seems to be in a stance, which to a certain extend resembles that of a spectator.

As said before, to learn to juggle five-balls is hard; the above observations help to explain this fact. The time constraints are too tight to apply conscious controlled or voluntary actions, nevertheless it is the slower intention-based circuit that is applied to learn or correct a move.

I have shown that there simply is insufficient time for attention to interfere in five-ball juggling and that restricting attention results in faster actions. The surprising thing is that when no full attention is required for acting, the mind performs other tasks concurrently.

Three-ball juggling is less demanding than five-ball juggling. While juggling, the juggler can do other things as well, for instance speak, walk etc.; however non-focussed awareness is permanently required, when the juggler's attention drifts away and focuses elsewhere the balls drop. Car driving implies a similar requirement; the driver can perform many other things while driving but a certain level of awareness is required throughout. In daily life we perform many actions without attentional focus, car driving and juggling are two of the many possible

examples, cycling and walking are others. For instance, when walking the body performs an intricate combination of muscle activities to maintain posture.

I have avoided any attempt to define the notion of attention; therefore I cannot conclude that attention is not involved in the stance of non-focussed awareness. But referring to the spotlight metaphor, if there is attention involved, it is only a dim light. Because attention is a preliminary for consciousness this conclusion has implications for consciousness as well.

Concerning the relationship between consciousness and the body, the notion of body image plays a central role. In Yamadori's three-layer model of the mind the body image emerges at the highest level. "The lowest level is an assembly of neuronal information coming from all parts of the body; at the middle level the body schema are situated which secure the emergence of the conscious body image at the third level" (Yamadori, 1997). The body schemata are subsystems 'implementing' James' ideomotor actions, for instance grabbing the coffee cup. The suggestion is that the body image generates at the middle level and may pass on to the conscious level, thus leaving no active role for consciousness. The second level is rather independent from the conscious third level, which is confirmed by the split-brain studies and in particular very compellingly by the so-called *Anarchic hand* (Blakemore et al., 2002). The latter designates pathological behaviour in which a patient's right hand manipulates a tool properly but 'spontaneously', that is without the patient neither consciously initiating the movement nor being able to inhibit the action. The anarchic hand shows that neither attention nor consciousness is a prerequisite or a necessary condition (sine qua non) for action; neither if them is necessarily the initiator of actions. Moreover, it even shows that there exist pathological cases where consciousness is unable to inhibit actions.

Most people readily acknowledge that the internal functioning of our body is beyond our conscious control. The anarchic hand shows that even skilful behaviour might be beyond the span of control of consciousness.

Conclusions

Using the case of five-ball juggling I have made an attempt to analyse the mental stance taken by a human being when performing. I have called this a stance of *non-focussed awareness.* Unravelling this stance is interesting on its own, but it also sheds some light on the complex of mental states and stances by

which a human being monitors and controls his or her body and actions. Definitely the human body on its own is a complex system with a complex control structure, the understanding of which could function as a paradigm for robot and machine design.

The case of five-ball juggling showed that the often-supposed sequence that a mental act precedes bodily actions - or that we first think and then act - cannot hold. Juggling is not a series of voluntary actions governed consciously.

The conscious processing capacity is limited; attention is a gate to or filter for consciousness. Acting requires perception, action selection and action execution. Shifting the focus of attention is a relatively slow process. Five-ball juggling would be impossible if focused attention has to be applied. In general, attention may interfere with acting but that often results in poorer or slower execution. Restricting attention results in faster actions. The mental stance of the juggler is a very sensate stance in which there is typically little or no attentional focus. The latter implies that the performance cannot be subject to conscious control.

Besides juggling, many actions are as well initiated and performed without attentional focus; they are mostly on and below the edge of conscious experience and control. In everyday practice we usually act before consciously thinking of it. The occasions where thinking precedes acting are the exception and not routine practice. Consciousness not necessarily initiates actions, moreover in certain cases conscious control cannot inhibit actions. Consciousness only has weak control over the acting body, even though subjects have the feeling they consciously control their body. Nevertheless, we do oversee our actions with our conscious and rational minds and except for pathological cases we are able to suppress many ‘spontaneous’ actions.

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