# Non-Conscious Goal Pursuit, Working Memory, and the Effortful Control of Behavior

Ran R. Hassin[1]

Henk Aarts[2]

Baruch Eitam[1]

Ruud Custers[2]

And

Tali Kleiman[1]

[1] – Psychology Department, The Hebrew University (Israel)
[2] – Psychology Department, Utrecht University (The Netherlands)

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Correspondence should be sent to ran.hassin@huji.ac.il.

> We haven't really solved the problem of consciousness until that executive is itself broken down into subcomponents that are themselves clearly just unconscious underlaborers which themselves work (compete, interfere, dawdle,…) without supervision (Dennett, 2001, p. 228)

A significant proportion of human behavior is determined by non-conscious goal pursuits. This assertion is easily derived from two well-established and highly consensual observations about human nature. First, much of human behavior is purposeful, or goal directed. Our goals range from very trivial (e.g., to make a cup of coffee) and a little less so (e.g., to get to work), through more complex (e.g., to write an interesting chapter) to extremely difficult ones (e.g., to be a good parent). It is not completely unlikely that goals direct behavior at virtually every moment of our lives. Second, our consciousness is very – but very – limited in its processing resources. Memorize simple cooking instructions, count the number of knives you put on the table, or just think a simple thought – and your conscious capacity drops substantially. In fact, even reading THIS trivial sentence is likely to consume much of your conscious processing resources. This grave limitation on conscious processing suggests that a big chunk of the mental processes related to goal-pursuits have to occur outside of conscious awareness. Considered in tandem, then, these two observations imply that much of our behavior is determined by non-conscious goal pursuit, and hence that the dynamics of non-conscious goal(s) pursuit are important determinants of the psychology of action.

We begin this chapter by discussing the existing literature on automatic, non-conscious goal pursuit. We then present the adaptiveness paradox: On the one hand, we argue, in order to be effective non-conscious goal pursuit must be adaptive. On the other hand, non-conscious, automatic processes are widely believed to rely on existing networks of associations, and are hence thought to be inflexible. We then propose three new hypotheses. These help to resolve the paradox because at their core lies the contention that working memory (WM) is involved in non-conscious goal pursuit. Given the nature of WM, we argue, its involvement in non-conscious goal pursuits allows them to be flexible.

We review a series of studies that support our predictions. The studies focus on one particular type of automatic processes – non-conscious goal pursuit. The resolution that we offer to the adaptiveness paradox – i.e., the involvement of WM in automatic processes – is more general, though. Thus, we also review exciting advances in neighboring literatures. We conclude by examining the implications of the proposed framework to our understanding of the functions of the frontal lobes.

## Introduction and Background

Traditionally, goal pursuit was considered to be a conscious and effortful process, one that requires (conscious) intention and can be stopped at (conscious) will. In other words, goal pursuit was considered to be a controlled process (cf. Ajzen, 1991; Bandura, 1986; Deci & Ryan, 1985; Locke & Latham, 1990). The intuition that underlies the traditional view is very appealing: Anyone who has ever attempted to pursue non-trivial goals would probably agree that goal pursuit often seems to be an effortful, conscious process.

This state of affairs has recently changed. Following Bargh's original idea (Bargh, 1990) and first empirical findings (Chartrand & Bargh, 1996), the last decade has witnessed a boost of empirical demonstrations of non-conscious goal pursuit (e.g., Aarts & Hassin, 2005; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Troetschel, 2001; Fishbach, Friedman, & Kruglanski, 2003; Fitzsimons & Bargh, 2003; Hassin & Bargh, 2004; Kruglanski et al., 2002; G. B. Moskowitz, Gollwitzer, Wasel, & Schaal, 1999; J. Y. Shah, 2003). In light of this research it seems safe to conclude that we now have solid empirical support for the idea that goals can be activated and pursued non-consciously and unintentionally (for recent reviews see Ferguson, Hassin, & Bargh, in press; Kruglanski & Kopetz, this volume).

Two definitional notes are in order before we continue. First, we define ‘goal’ as a desired state (e.g., behavior, outcome) that the individual believes (consciously or non-consciously) she knows how to produce. Hence, a mental representation of a goal is a mental representation of a desired state (cf. Aarts & Hassin, 2005; Austin & Vancouver, 1996; Kruglanski, 1996; shallice & Burgess, 1998). While this formulation applies to goals in general – from low level motor goals (e.g., to lift a finger; cf. Prinz et. al, this volume) to high-level personal goals (e.g., to win someone’s affection) – our work focuses on, and applies to, the latter.

Second, throughout this chapter we use the notion of habit. We use ‘habit’ in a lay way, to denote a routinized set of actions (broadly defined to include thought, emotion, motivation and behavior) that may occur non-consciously and unintentionally, specifically in the contexts in which these routines frequently occur.

## Mechanisms for Non-conscious Pursuit of Habitual Goals

So how are goals pursued non-consciously? Most of the work on non-conscious goal pursuit examined the pursuit of habitual goals in what might be thought of as relatively habitual contexts. Goal pursuit in these cases seems to depend on associative networks that include contexts, goals that are regularly pursued in these contexts, and means that one usually uses to attain these goals (see Chapter by Wood, this volume). These networks are shaped by one’s history, and they allow for goal pursuit via spreading of activation (see Förster et al, this volume). Thus, for example, the context of meeting an attractive colleague may instigate the goal of intimacy, which may bring about a certain way of talking that has proved in the past to be an effective means for attaining this goal. This chain of events (i.e., a context activates a goal that activates certain means) may occur outside of awareness, without a conscious decision, and sometimes even despite one's conscious intentions.

The nature of the representations that take part in these processes is yet to be determined. While earlier work – which is echoed in the above paragraph – suggests that these are a-modal, abstract, and semantic (Bargh, 1990; Kruglanski et al., 2002), recent work leans towards more modal, concrete and embodied representations (Bargh, 2006).

The lion's share of work on non-conscious goal pursuit has been conducted by two research groups – that of Bargh and his colleagues and that of Kruglanski, Shah and their colleagues (cf. Bargh, 1990; Bargh et al., 2001; Kruglanski & Kopetz, this volume; Kruglanski et al., 2002). It is mainly due to their work that we may confidently conclude that goal activation and pursuit may indeed occur non-consciously and unintentionally.

## Going Beyond Habits

The worlds we live in – be it the physical, the mental, or the social – are dynamic to their core. This characteristic suggests that even when we engage in habitual procedures we may (frequently) confront novel circumstances.[1] Take courting as an example. On the one hand, courting obviously involves habitual procedures – from tone of speech, through body gestures, to preferred topics of conversation. Yet, it seems quite obvious that in order for it to be effective, courting needs to be tailored to the specific courtee and the specific situation. So while one may habitually use humor during courtship, the specifics vary – from person to person and from context to context – and the possible variation seems to be large. So large, in fact, that a finite set of previously used humor strategies would not seem to suffice for future goal pursuits.

This simple example suggests that in order to be effective even habitual courting procedures should enable us to confront novel circumstances and produce novel sets of behaviors. More generally, it illustrates the idea that habitual goal pursuits should allow for quick, “on-line” adaptation to novel circumstances (otherwise there will be no second date).

At this point it may seem as if we are arguing that habits – and habitual goal pursuits in particular – are always underspecified. In other words, it may seem as if we are arguing that habits can never orchestrate behavior without further, context specific, refinement. Note, that while this strong claim may indeed be true, it is not necessary for the argument we are making here. For the current purposes the milder claim – under certain circumstances some habits are underspecified – suffices. Given the dynamic nature of the world it seems to us that there is little doubt, if any, regarding the veracity of the latter claim.

So how do we go beyond pre-existing routines in non-conscious goal pursuit? The traditional answer would be that we do not: Non-conscious goal pursuit, like every other automatic process, is limited to circumstances in which pre-existing routines could be successfully applied. If they cannot be successfully applied, then non-conscious goal pursuit is bound to fail and conscious processes would be called to the fore.

While tempting, this suggestion is psychologically improbable. Given the scarcity of conscious mental resources on the one hand, and the dynamic nature of the worlds we inhabit on the other, it seems that we should be able to go beyond existing routines, that is – reveal quick flexibility – even during non-conscious goal pursuit.

## The Adaptiveness Paradox

To explore the possibility that non-conscious goal pursuit may be flexible, Hassin and Bargh (2006) examined the effect of goal priming on performance in the Wisconsin Card Sorting Test (WCST). The WCST was originally developed to assess abstract reasoning and the ability to shift cognitive strategies in response to changing environmental contingencies (Berg, 1948; Heaton, Chelune, Talley, Kay, & Curtiss, 1993). In this test, participants are asked to sort cards to one of four piles. Unbeknownst to the participants (at least at first), the cards can be sorted according to one of three rules: color, shape, or number. Participants are given feedback about the accuracy of each sorting (‘right’ versus ‘wrong’), but never about the sorting rule itself. The crucial feature of the WCST is that after 10 consecutive correct sortings the sorting rule changes without a warning. Participants have to adapt to this new environment until it, too, changes (after ten correct sortings). This goes on until two decks of cards are sorted.

The WCST is particularly suitable for examining flexibility because it (intentionally) captures the essence of flexible adaptation to changing environments (e.g., Berg, 1948; Demakis, 2003). The logic is simple: Physical and social environments suggest behavioral rules that, if followed, lead to better survival. Environmental changes often entail changes in these rules, and in these cases better survival may depend upon rapid adaptation to the new rules. The structure of the WCST reflects this logic: The rule that governs sorting changes without a prior warning, and participants have to look for a new rule and then follow it – without recourse to the previous one. Flexibility is measured here as the inverse of perseveration or, more concretely, by the number of perseverative errors. Thus, for example, if the sorting rule has just changed from color to number, color-congruent sortings would count as perseverative errors.

In this set of studies, participants were either primed with a goal, or not, and they then went on to do the WCST. In the first two studies, participants who were primed with an achievement goal revealed more flexibility than control participants. Crucially, a thorough debriefing revealed that participants were unaware of the fact that they had been primed with a goal. Similarly, their goal commitment did not differ from that of control participants. In a third study, we directly primed the goal of becoming flexible, and found similar effects: Primed participants more easily adapted to changes in their environment.

In conclusion, then, data from these three studies suggest that non-conscious goal pursuit results in increased cognitive flexibility as it is measured by the WCST. In other words, if one treats one’s current sorting rule as one’s (admittedly, new) habit, then these studies show that primed goals enhance our capacity for overcoming habits, exactly when this adaptability is needed: Immediately after a crucial change in the environment.

This, then, may be thought of as the adaptiveness paradox: Automatic, non-conscious processes are held to be inflexible, in the sense that they are limited to pre-existing routines that are associated with them. We have argued, however, that in order to be truly beneficial non-conscious goal pursuit should allow for rapid flexibility. And as we have just seen, automatic, non-conscious goal pursuits reveal exactly this kind of flexibility. In the following sections we will attempt to resolve this paradox by suggesting a mechanism that allows for rapid flexibility in non-conscious goal pursuit.

*BEYOND NETWORKS OF GOALS AND MEANS*

The results briefly described above reveal that non-conscious goal pursuit is not confined to routinized processes. To account for results of this sort, and for non-habitual non-conscious processes more generally, we propose the following principles:

(1) Whenever a goal is activated beyond a threshold it enters a working memory (WM), and some capacity is allocated to it.[2] This capacity may be thought of in terms of mental resources, processing time of a central processor (see Pashler, 1998) or, more generally, any component essential for processing of which there are limited quantities at any given point in time (cf. Navon, 1984).

(2) Assuming that the goal is allocated sufficient capacity, then if only one applicable network of goals, means and relevant knowledge (henceforth: schema) for goal pursuit is readily accessible, the goal would be pursued in the situation via this schema. In most cases this is likely to be the habitual schema, but noise or (temporary) biases may bring about the selection of other schemas.

If, however, more than one existing schema is readily accessible then schema selection is guided by principles reminiscent of those suggested by Norman and Shallice in their pioneering work on contention scheduling in action control (Norman & Shallice, 1986; Shallice & Burgess, 1993). (A more thorough discussion of these principles is presented in the last section of this chapter).

Finally, if no existing schema is readily accessible, or in cases where schema selection proves to be difficult, the goal is maintained (cf. Goschke & Kuhl, 1993; Marsh, Hicks, & Bink, 1998; Zeigarnik, 1938), waiting for further developments. These may include, among other processes, the construction of a new schema; the selection of a schema that is justified by a change in the circumstances, or the haphazard selection of schema for reasons that will be currently summarized as 'noise'. Alternatively, the goal may simply decay.

(3) Once a schema (old or new) has been selected, goal pursuit is launched and progress monitoring begins via a feedback loop.

Before we go on we wish to elaborate on three points. First, as we described above, models of non-conscious goal pursuit focused on habitual goal pursuit, that is – goals that are consistently pursued in certain contexts via habitual means (Bargh, 1990; Kruglanski, 1996). As far as the pursuit of habitual goals under habitual circumstances is concerned, our hypotheses are similar to those of these models: Principle 2 stipulates that activation of a goal of this kind is likely to lead to goal pursuit via its habitual schema.

Even under these circumstances, though, our predictions diverge from those of previous models. To mention a few of these differences: The current framework explicitly allows for a selection of non-habitual courses of action; it stipulates involvement of working memory in non-conscious goal pursuit, and it allows (but does not require) non-conscious monitoring and feedback processing. These differences may allow for more flexible and adaptive goal pursuits.

Secondly, the proposed principles apply to goal pursuits that are automatic in the following senses. First, conscious intention is not a prerequisite of any of the processes described above (e.g. goal priming may unintentionally lead to allocation of capacity to this goal). Second, conscious awareness is not a prerequisite for these processes too (e.g., one does not have to be aware of the primed goal or its operation). Thirdly, some aspects of these processes may be ballistic (e.g., one may not be able to stop the monitoring process or one may fail to stop goal pursuit itself). Ex hypothesis, however, some of these processes are effortful, that is – they require mental resources. In our view, this does not render the processes described herein “controlled” or “not-automatic” (for similar views see Bargh, 1989, 1994; Hassin, 2005a; Kahneman & Treisman, 1984; Wegner & Bargh, 1998).

Thirdly, our account assumes that working memory can operate outside of conscious awareness. While this may be a controversial supposition (e.g., Baars & Franklin, 2003; Baddeley, 1993; Cowan, 1999; O’Reilly, Braver, & Cohen, 1999), some of us have recently argued for it, marshalling both behavioral and fMRI evidence (Hassin, 2005b; Hassin, Bargh, Engell, & McCulluch, 2007).

## Working Memory

Given WM’s hypothesized role in non-conscious goal pursuit, we turn now to a brief review of relevant aspects of the working memory literature. Working memory has long attracted the attention of psychologists and neuroscientists who are interested in how people acquire knowledge, reason, solve problems, make decisions, achieve cognitive control, and, of special interest for the current concerns, pursue goals (Baddeley & Logie, 1999; Dudai, 2004; P. Shah & Miyake, 1999). A review of models of WM – its components, functions, and brain instantiations – is beyond the scope of the current chapter (but see Miyake & Shah, 1999). However, as an inspection of these models and the tasks used to examine them reveals, there is a consensus regarding the functions of WM that is matched by a general agreement regarding its characteristics (e.g., Daneman & Carpenter, 1980; O’Reilly et al., 1999; Smith & Jonides, 1999, see Hassin, 2005 #209; Turner & Engle, 1989). These include: (1) active maintenance of ordered information for relatively short periods of time; (2) context-relevant updating of information, and (3) *goal-relevant* computations involving active representations and rapid biasing of task relevant cognitions and behaviors, *in the service of currently held goals* (Hassin, 2005b; O'Reilly et al., 1999). The latter functions include attending and inhibiting, scheduling, monitoring and planning (cf., Smith & Jonides, 1999).

The cognitive literature assumes that working memory is central for goal pursuit and then goes on to examine the operation and interaction of its components. To the best of our knowledge, however, it did not experimentally investigate WM's role in goal pursuit by introducing various goals and examining their effects (but see Duncan, 1995; Duncan, Emslie, & Williams, 1996, for a discussion of goal neglect). Evidence from related literatures in neuropsychology, however, suggests that damage to brain tissues related to working memory result in specific impairments to goal pursuit (cf. Baddeley, Della Salla, Papagno, & Spinnler, 1997; Damasio, 1994; Luria, 1966; Norman & Shallice, 1986; Shallice, 1982).

Alan Baddeley, one of the forefathers of the concept of WM, and of one of the most influential models of WM (Baddeley & Hitch, 1974), has recently added a new component to his WM model – the episodic buffer (Baddeley, 2000, 2003). This new buffer serves as an interface between a range of systems, including long term memory, and as such it "provides not only a mechanism for modelling the environment, but also for creating new cognitive representations, which in turn might facilitate problem solving" (Baddeley, 2000, p. 421). A component of this kind seems to be exactly what successful goal pursuit requires: It allows episodic representations of the environment, interaction with long term memory, and the construction of new cognitive representations.

To sum up, WM is a multi-component cognitive structure with storage capacity and executive functions. It allows for flexible, context-sensitive representations of the environment, as well as for the creation of new cognitive representations. These, and other WM functions, are instrumental for goal pursuit, and hence impairment in brain structures that are related to WM are associated with decreased capacity for goal pursuit.

## *TESTING THE PROPOSED PRINCIPLES*

### Set I: Effort

We have recently completed an empirical examination of the first principle. (Hassin, Aarts, Eitam, & Custers, 2005). To examine whether primed goals enter WM and are then assigned some capacity, participants in these studies had been primed with a goal, and they then engaged in a working memory task that was clearly novel to them.

Consider, first, a participant who is primed with a goal that may be applied (cf. Aarts, Gollwitzer, & Hassin, 2004; E. T. Higgins, 1996) to a WM task, and who then goes on to engage in such a task. According to the first principle, upon priming (and given that a threshold is passed) the goal enters WM and some of its capacity is allocated to it. Then, when the task is introduced, it, too, is allocated resources. Non-primed (control) participants, on the other hand, only enjoy resources that are assigned to the task, which means that they should fare worse than participants in the experimental condition.[3]

Consider, next, a participant who is primed with a goal that is inapplicable to a laboratory WM task (e.g., going out), and then goes on to engage in such a task. Again, the first two assumptions entail that the goal enters WM, and that a proportion of its available resources are allocated to it. Since, ex hypothesis, the goal is inapplicable to the task, this allocated capacity cannot be used for the task.[4]

These, then, were our two hypotheses: Priming of an applicable goal should result in improved performance on a following WM task, and priming of an inapplicable goal should bring about reduced performance.

Results from five studies supported these predictions. In the first study, participants had either been primed with an applicable goal (achievement) or not, and they then engaged in one of the best known WM tasks, the OSPAN (Turner & Engle, 1989). The OSPAN is a dual task that consists of correctly solving equations while memorizing lists of words. The results showed that the control and the experimental conditions achieved the same WM span, but participants in the priming condition achieved it in a significantly shorter time. These findings suggest that the dual task performance of primed participants was better than that of the control group, and thus that they devoted more resources to the experimental tasks.

To further examine the effect of goal priming on WM capacity we ran another study, in which we used the automated versions of the OSPAN and the conceptually-similar reading span (RSPAN). In this experiment, achievement priming led to a significant increase in WM's capacity both on the OSPAN and on the RSPAN. In the third study priming of an applicable goal was followed by a WM inhibition paradigm developed by Jonides and colleagues (Jonides, Smith, Marshuetz, Koeppe, & Reuter-Lorenz, 1998, Study 2). The results of this study showed that primed participants were significantly better at inhibiting prepotent responses – an effortful, resource-demanding behavior. Together, the results from these studies support the first hypothesis developed above.

Next, two studies examined the effect of priming of non-applicable goals (e.g., to have fun) on performance in the inhibition paradigm mentioned above. Supporting the second hypothesis, both studies documented decrease in performance following priming. That is, participants who had been primed with an inapplicable goal were significantly worse than their control counterparts at inhibiting prepotent responses. Together, the evidence from these five studies strongly supports the first principle.

Related findings were recently reported by Shah and Kruglanski (2002), who showed that priming of a goal that participants perceived as applicable to their task led them to invest more time, and to do better on it (the two variables were strongly correlated). Taken together, then, these results mean that priming of an applicable goal led participants to invest more resources in the experimental task.

Yet, there is a qualitative difference between these findings and the ones we discussed above: We showed that goal priming leads to an increase/decrease of resources invested in a task **per unit of time**, that is – we documented changes in the online availability of resources. Shah and Kruglanski (2002; cf. Bargh et. al, 2001), however, examined the **total amount** of resources invested in a task, which may also be a function of the time spent in the task (and hence do not necessarily reflect the online availability of resources)**.**

In a sense, then, their findings and ours are complimentary: It may well be the case that task, personality, and motivational factors determine which alternative we follow – whether we increase resource spending per unit of time (i.e., increase WM's capacity), increase the total quantity of resources spent on the task, both, or none.

## Set II: Conflict

Very minor modifications to the principles presented above allow the proposed framework to handle the non-conscious interaction of multiple goals. Simply, instead of describing the activation of one goal (and its later assignment to WM), they may describe the activation of multiple goals, and their allocation to WM. These modifications do not require and changes in the nature of the proposed framework.

Note, then, that when two goals are in conflict, hence rendering relevant decisions more difficult, the goals are maintained until further developments help resolve or downplay the conflict. Thus, this principle makes a very simple prediction regarding non-conscious goal conflict: It should lead to longer decision times.

In a study that was designed to examine this prediction we looked at participants' behavior in a commons resource dilemma (cf. Bargh et al., 2001). In this task participants played fishermen, and they had been led to believe that they would be playing against another participant. On each "season" (i.e., trial) participants "caught" a certain number of fish, and their task was to decide how many fish they would throw back to the lake (and how many they would keep to themselves).

The conflict, like in every commons resource dilemma, is this: On the one hand, participants' competitive urges (and, ex hypothesis, survival needs) lead them to keep to themselves as many fish as they can. In other words, participants' personal goal is to compete. On the other hand, if both fishermen behave too egotistically then the fish population would be wiped out, thus causing a societal disaster. In other words, the high-level goal in this game is to cooperate. These two goals are, of course, in direct conflict – given a scale (of how many fish to return to the lake) they "pull" the response to opposite directions. Furthermore, given that this conflict is between a higher-level and a lower-level goal, we deem it is a self-control conflict.

Prior to engaging in this commons resource dilemma, half of our participants were primed with a co-operation goal. Given the structure and nature of the task, we expected that this priming would result in increased conflict, that is – in more difficult decisions.  Hence, by assumption 3c, priming should lead to increased decision times. And indeed, these were the results we obtained. First, replicating Bargh el al.'s (2001) results, participants who were primed with a cooperation goal cooperated more than control participants. In other words, they returned more fish to the lake. Crucially, primed participants' decision times were significantly longer than those of control participants, supporting the proposed principles.

During the game there were a few occasions in which a message appeared on the screen, warning participants that the fish population is at risk. Interestingly, decision times following the warnings were longer for both groups, probably reflecting, amongst other things, an increase in the conscious conflict between the personal goal of competing and the higher goal of cooperating. Note, that even in these trials, the decision times of participants in the primed condition were longer than those of the control condition, implying that conscious conflict and non-conscious conflict may operate at the same time (cf., the additive effects of conscious and non-conscious goals in Bargh et. al, 2001).

A second study in this series examined another implication of the proposed principles. Note that these principles imply that, at least under certain circumstances, noise should affect decisions under goal conflict more than decisions when there is no goal conflict. The rationale is simple. Goal conflict is likely to result in close call decisions. These, by their very nature, increase the probability that small differences – noise included – would tip the scales.

In this study participants engaged in 120 trials of the common resource dilemma described above. Prior to each trial participants engaged in another task, in which they were asked to decide whether a number that appeared on the screen was odd or even. These numbers were meant to serve as irrelevant anchors (cf. Tversky & Kahneman, 1974). Crucially, on some trials the numbers were relatively big (9,10,11), whereas on others they were relatively small (1,2,3). Since, from participants' point of view, the two tasks were completely unrelated, these numerical anchors could be viewed as noise.

Recall that according to the prediction we developed above, goal conflict may result in an increased effect of noise on decisions. Hence, the proposed principles predict that non-conscious goal conflict should enhance the use of anchors in this paradigm. And indeed, these were the results we obtained: Primed participants returned more fish to the lake in the high anchor trials than in the low anchor trials, while no such effect was found for the control group. Here, like in the first study in this set, a thorough debriefing revealed no differences between the groups in goal commitment, or awareness of a conflict.

## Set III: Monitoring

Although we have not yet started to systematically address the last principle, a set of recent studies provides preliminary support for the idea that non-conscious goal pursuit involves monitoring, discrepancy detection, and cognitive processes related to discrepancy reduction.

Generally speaking, previous research failed to examine the question of monitoring during non-conscious goal pursuit for one of two reasons. First, studies that manipulated discrepancy (Fein & Spencer, 1997; Koole, Smeets, van Knippenberg, & Dijksterhuis, 1999; Moskowitz, 2002)usually manipulated it explicitly, hence leading to conscious awareness of the goal itself. Secondly, studies that manipulated goal accessibility usually did so in contexts in which goal discrepancy is inherent, that is – environments in which one's relevant goal is yet to be achieved (see Custers & Aarts, 2005). This possible confound makes it hard to determine whether the resulting behavior resulted from ‘simple’ goal priming, or whether it involved a reaction to detected discrepancy.

Recently we conducted a line of experiments that examined how goal accessibility and discrepancy detection lead to the activation of means for goal achievement (Custers & Aarts, 2005). The goal that we used in these studies was that of looking well-groomed, a goal which typically needs to be maintained over time and – according to pilot testing – was highly desirable to our participants. Accessibility was either measured as an individual difference (Study 1), or manipulated (Study 2). Discrepancy was manipulated via descriptions of either discrepant (e.g., “The shoes you put on look dirty”) or control (e.g., “The shoes you put on have laces”) situations.

To test the effect of discrepancy detection, we employed a probe-recognition paradigm (Hassin, Aarts, & Ferguson, 2005; McKoon & Ratcliff, 1986; Uleman, Hon, Roman, & Moskowitz, 1996). In this paradigm sentences that appear on the screen are immediately followed by probe words. Participants’ task is to indicate, as quickly as possible, whether the probe appeared in the preceding sentence or not. Probes that are rendered more accessible during the reading of a sentence – without actually appearing in it – should lead to longer RTs (vs. control words). This is the case because while the correct response to these probes is negative, their heightened accessibility suggests a positive response.

In our studies, the scenarios were either goal-discrepant (e.g., “The shirt you button up looks wrinkled”), or control (e.g., “The shirt you button up is blue”). Both types of sentences were followed by a probe word that represented an action that may reduce discrepancy (e.g., “ironing”). And thus, if discrepancy detection leads to the automatic activation of appropriate means for goal achievement, probes that appear after goal discrepant scenarios should take longer to react to than probes that appear after control sentences.

The first study looked at individual differences between people who are chronic well-groomers, and people who are not. The results showed that, for chronic well-groomers, RTs for probes that were preceded by a goal-discrepant scenario were longer than for those that were preceded by a control scenario. This effect was not present for people who did not frequently pursue the goal. These results suggest that perceived discrepancy may automatically facilitate access to discrepancy-reducing actions. Importantly, the differences between chronics and nonchronics suggest that this effect of discrepancy requires an active goal – but not necessarily a conscious one.

In a subsequent experiment, we experimentally manipulated the goal by way of subliminal priming. Thus, just before the onset of the goal-discrepant sentences two (Dutch) synonyms for "well-groomed" were flashed several times for 20 ms in the fixation point (cf. Wigboldus, Dijksterhuis, & Knippenberg, 2003). The results indicated that subliminal priming had the same effect as the chronic goal – it facilitated access to representations of instrumental actions (cf. Bargh, Lombardi, & Higgins, 1988; E. T. Higgins, Bargh, & Lombardi, 1985).

Together, these studies suggest that people can automatically react to goal-discrepant situations with the spontaneous activation of means for goal achievement. Note that this spontaneous activation of means only occurs if the goal is accessible. Furthermore, this effect occurs even when the goal is non-consciously primed. This pattern suggests that enhanced accessibility of goals – whether conscious or not – leads people to monitor their environment for discrepancies. These findings, then, lend support to the idea that non-conscious goal pursuit may involve monitoring.

Summary

To sum up, three new sets of studies support our predictions regarding non-conscious goal pursuit. The first set showed that priming of applicable goals led to improved performance on resource-demanding WM tasks, and therefore for an improvement in WM capacity. Priming of inapplicable goals, however, led to decreased performance on these tasks. The second set of studies demonstrated that non-conscious goal conflict leads to increase in decision times. Furthermore, the second study in this set showed that non-conscious goal conflict increases the effect of irrelevant information on decisions. Lastly, the studies described in the previous section suggest that non-conscious goal pursuit may lead to monitoring and discrepancy detection.

*NON-CONSCIOUS THOUGHT*

At the outset of this chapter we argued that the idea that WM, and executive functions more generally, are involved in non-conscious goal pursuit, endow the latter the flexibility that is oftentimes a prerequisite for their effectiveness. We also argued that the basic notion of executive involvement in non-conscious processes may shed new light on neighboring literatures on complex non-conscious high-level cognitive processes. In this section we explore one such example, that of non-conscious thought. In the following section we discuss another example, the literature on controlled behavior and the frontal lobes.

Recently, Ap Dijksterhuis and his colleagues presented and tested a theory of unconscious thought (UTT Dijksterhuis, 2004; Dijksterhuis, Bos, Nordgren, & van Baaren, 2006; Dijksterhuis & Nordgren, 2006). UTT holds that unconscious thought is an effortless (that is, occurs without conscious attention) yet time-consuming process, whose capacity to integrate and weigh information – even in high level processes such as judgments and decision making – is much larger than that of conscious thought.

The paradigm developed by Dijksterhuis to examine unconscious thought (2004) is the following. Participants are first presented with decision-related information, and then pursue one of three routes. In the immediate decision condition, participants make their decision immediately after they were exposed to the information. In the conscious thought condition, participants are asked to think about their decision for a certain amount of time, and they then indicate their choice. Participants in the third and crucial group – the unconscious thought condition – are given the same amount of time as participants in the conscious thought condition, but instead of thinking about their choice they engage in an effortful task that does not allow for much conscious thought.

The general finding in this paradigm is that in complex decisions participants in the unconscious thought condition fare better than participants in the conscious thought condition. In other words, unconscious thought processes seem to be better at using multiple units of information to form a decision.

UTT's postulation that unconscious thought processes are effortless suggest that they do not involve WM-like executive functions. On the other hand, UTT's postulation that unconscious thought is time consuming does suggest a limited-resource process, if only in the sense of having to process information serially (otherwise, why would the process be time consuming?). Given that limited resources are usually associated with controlled processes (in social psychology), and with WM and executive processes (in the cognitive sciences more generally), it seems that unconscious thought may help itself to non-consciously using (non-conscious) executive processes.

This is, admittedly, a speculative account of some of the possible cognitive mechanisms that underlie non-conscious thought. It opens, however, exciting routes for an improved understanding of executive processes on the one hand, and non-conscious thought on the other.

## *NON-CONSCIOUS GOAL PURUSUIT AND THE FRONTAL LOBES*

In the previous sections we discussed the proposed principles in the context of the social psychological literature on automatic goal pursuit, and the cognitive literature regarding working memory. In the current section we would like to discuss them in the context of the work of Shallice and his colleagues on action control and frontal lobe patients.

### The Norman-Shallice Model

Norman and Shallice's (Norman & Shallice, 1986; Shallice, 1982, 2002) work suggests that two complementary processes operate in the selection and control of action. One, contention scheduling, handles well-learned sequences of behaviors, whereas the other – the supervisory attentional system, or SAS – allows for conscious, willful control of behavior. While the model does not explicitly focus on goal pursuit, this seems to be mainly a terminological issue. A closer examination reveals that its founders hold the belief that their model of action control is intimately associated with goal pursuit (Cooper & Shallice, 2000; Shallice, 1972; shallice & Burgess, 1998).

Norman and Shallice (1986) assumed that well-learned, routine, action sequences are represented in schemas, and that these schemas may be activated by appropriate cues (either internal or external). When only one schema is activated, this schema controls behavior. When multiple schemas are activated, a selection process – which they termed contention scheduling – selects the one with the highest level of activation (the activation level of a schema is determined by the cues and context, as well as by processes of lateral activation and inhibition). In cases where schema selection is difficult or conflictual (e.g., when one attempts to overcome temptations), or in cases where no schema is available to control behavior (especially in novel tasks, or those that involve planning), the SAS comes into play. The SAS provides **attentional**, **conscious** control over behavior by changing the activation levels of different schemas, thus creating novel and adaptive sequences of behaviors.

This conceptualization of the division of labor between Contention Scheduling and the SAS is reminiscent of the class of models that we nowadays refer to as dual process models (Chaiken & Trope, 1999)(Strack & Neuman, this volume). There is one route of action control which is, grossly speaking, automatic (non-conscious, effortless, unintentional and ballistic), and it accounts for routinized behaviors. The other route of action control is controlled (it requires attention and conscious intention), and it accounts for non-routinized behavior. Note that, in the Norman-Shallice model, the latter route is implemented by way of modulation: the SAS modulates activation and inhibition levels – it does not have a more direct way of affecting behavior.

Evidence supporting this model comes mainly from neuropsychology. Assuming that the SAS is a frontal component, whereas contention scheduling is not, these researchers hypothesized a dissociation between performance on routine (automatic) tasks and on non-routine ones. Specifically, they hypothesized that frontal patients – who, ex hypothesis, should have difficulties with the SAS – should show decreased performance on non-habitual tasks, but not on habitual ones. Patterns of this sort had been previously reported in the literature (e.g., Luria, 1966), and novel studies with frontal patients corroborate the hypothesis (e.g., Shallice, 1982; Shallice & Burgess, 1993).

While some of this model's principles are similar to the ones we propose here (see, especially, assumptions 3a and 3b), there are numerous differences between the two frameworks. Among these are the treatment of abstract goals; the role of resources in non-conscious goal pursuit; the role of WM in non-conscious goal pursuit; the non-conscious coping with goal conflict, etc. In the next section we focus on one difference that we deem as important – the role of the supervisory attentional system.

## Non-conscious goal pursuit and the SAS

Note that the current principles have no SAS-equivalent; they contains no necessarily-conscious, effortful executive processes per-se. If we follow the logic of Norman and Shallice's (1986) model, then, our principles should only apply to routine, automatic behaviors. In fact, this logic is not unique to the Norman-Shallice model. Quite to the contrary – the equation 'no executive = only automatic' seems to reflect the general perception of automatic and controlled processes in experimental psychology.

Yet, we emphasized that the current principles apply not only routinized goal pursuits, but also goal pursuits in novel, non-routinized, circumstances. Furthermore, we contended that they also encompass conflictual situations. These hypotheses were confirmed in two separate sets of studies. The studies that examined the effects of goal priming on cognitive flexibility, or adaptation to novel environments (see Section II  above), supported the former assertion; the studies that examined non-conscious goal conflict supported the latter.

So how do automatic goal pursuits get along without the necessarily-conscious, effortful executive processes per-se? Some of the feats of the SAS, we argue, may be achieved through non-conscious resource allocation. This allocation is bound to affect goals' activation levels – thus achieving one of the most central aspects of SAS.[5] It is important to note here that we do not suggest that SAS – or, more generally, conscious, effortful executive processes – are superfluous in the determination of human action. We do propose, however, that they are neither necessary in novel situations, nor in conflictual ones.

## Non-conscious goal pursuit and the Frontal-Lobe Syndrome

Recall, that the work of Shallice and his colleagues (Norman & Shallice, 1986; Shallice, 1982; Shallice & Burgess, 1993) established a dissociation between routine and non-routine action: Frontal-lobe  patients seem to be impaired on the latter, but not on the former. At present we don't know whether the non-conscious resource allocating process is implemented by a frontal component of the brain or not. Either way, its existence allows us to makes novel predictions, and in the following paragraphs we explore some of them.

First, assume that the non-conscious resource allocation processes described in this chapter are not based in the frontal lobes, or that they are frontal but subserved by neural networks that are not involved in conscious, effortful executive processes (after all, the frontal lobes make for a big portion of our brain.)  In this case we could make the prediction that patients with frontal syndrome should have some preserved ability to pursue goals in novel and conflictual situations. These patients, furthermore, should be affected by goal priming, maybe even more so than control participants, whose behavior may be concurrently controlled by conscious, effortful executive processes.

Lastly, patients with damage to this specific area may suffer from deficiencies in non-conscious – but not conscious – goal pursuit.

The second possibility is that these functions and those of more conscious, effortful executive processes are implemented by the same neural networks. In other words, the main difference between conscious and non-conscious executive processes lies in their phenomenology (how is this phenomenology implemented in the brain is beyond the scope of the current discussion). This alternative has interesting consequences too. First, it implies that frontal patients should have difficulties not only with non-routine action, but also with some types of routine actions. More specifically, they may reveal deficiencies even in (certain kinds of) habitual goal pursuits. Second, it suggests that full-blown, effortful executive processes may be non-conscious. While this suggestion seems to be in conflict with the present zeitgeist it has received some empirical and theoretical support (Hassin, 2005b; Hassin & Bargh, 2006; Hassin et al., 2007). Further evidence supporting this suggestion was recently published by Naccache et al. (2005), who studied a patient showing a dissociation between the operation of executive attention and the conscious feeling of effort.

## *CONCLUSION*

Since much of human action is goal oriented, understanding goal pursuit promises to shed much light on the psychology of action. This chapter began with a rejection of the idea that goal pursuit is necessarily conscious and effortful (Bargh, 1990), and went on to present new principles for non-conscious goal pursuit. The current framework goes beyond previous models and findings by suggesting that non-conscious goal pursuit is not limited to existing networks of contexts, goals, and means. Rather, we argued, non-conscious goal pursuit may make use of WM and executive processes. More generally, we suggest that the involvement of WM and executive functions in non-conscious, automatic processes may help us resolve what we termed the adaptiveness paradox by proposing mechanisms that allow non-conscious, automatic processes quick adaptability.

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[1] A thorough discussion of the meaning of ‘new’ or ‘novel’ is beyond the scope of the current chapter. In some sense, nothing is ever truly new, and in another nothing is ever truly known, or ‘old’. We use ‘new’ and ‘novel’ in a lay way, that builds on shared common-sense.

[2] Note, furthermore, that the current principles refer to goals that enter ‘a working memory’, and not ‘working memory’. Recall, that at any given point in time WM may be engaged in the pursuit of multiple goals. The current notation follows from our belief that it may be theoretically advantageous to treat the processes related to each goal separately.

[3] To put it more formally, assume that WM’s available resources just before priming takes place are $R_i$; that the available post-priming resources are $R_k$ (where $R_k < R_i$ due to the allocation of resources to the primed goal), and that, for simplicity’s sake, WM assigns an initial proportion P of its available resources to <u>every</u> goal that is assigned to it. In the experimental situation described above, the resources allocated to the task goal are P of $R_i$ without prior priming, and P of $R_k$ following priming. The primed goal is always assigned P of $R_i$ resources. Thus, without prior priming the task proceeds with $P*R_i$ resources. With priming, however, it enjoys $P*R_i + P*R_k$ (assuming that the upper limit of resources was not reached). Priming of applicable goals, then, should result in the investment of more resources, thus leading to improved performance on WM tasks.

[4] In the notation introduced above, the task proceeds with $P*R_i$ resources when no prior priming occurs, whereas following priming it enjoys $P_*R_k$. Since $R_k < R_i$, priming of an inapplicable goal would lead to decrease in performance (relative to a non-primed control group).

[5] In their original chapter, Norman and Shallice (1986) recognize the role of motivation in the determination of schema’s activation levels. Yet, what they mean by ‘motivation’ must be different than what we mean by ‘goal’, because for them it is a “relatively slow acting system, working primarily to bias the operation of the horizontal thread structures toward the long term goals of the organism” (p. 7)