

DNB Occasional Studies
Vol.11/No.4 (2013)

The irrationality of payment behaviour

DNB
Occasional Studies

Frank van der Horst and Ester Matthijsen

Central bank and prudential supervisor of financial institutions

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P.O. Box 98
1000 AB Amsterdam
The Netherlands
Internet: www.dnb.nl

Occasional Studies

Vol.II/No.4 (2013)

Frank van der Horst and Ester Matthijsen

The irrationality of payment behaviour

Conclusions based on literature and
direct observations in a virtual-reality
and a neuroscientific study

'It is not reason which is the guide of life, but custom.'

David Hume

Scottish philosopher and historian 1711-1776

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Abstract

Despite the efforts that commercial banks have made to promote the use of debit cards and the introduction of new payment methods, the migration from cash to electronic payment methods is not proceeding as quickly as sometimes expected. Why do people pay by cash on one occasion and by bank card on another? How conscious is people's decision-making? How rational are their reasons for choosing one method over another? For policy makers at a central bank it is relevant to have insight into the psychological aspects and effects of payment method choice, because it provides a pointer to the roles that payment methods will play in the future. Also these insights are helpful if an authority wants to encourage the usage of a specific means of payment.

DNB has therefore been investigating the psychological aspects of payment method choice. The research had three components: a literature study, a virtual-reality study and a neuroscientific study. The latter two components were innovative continuations of existing studies, which usually assume a 'rational decision-maker', are quantitative in nature and are questionnaire-based. The virtual-reality study involved the direct observation of (virtual) behaviour, while the neuroscientific research involved the direct observation of brain activity, translated into emotions and automatic behaviour.

The literature study found that, in the vast majority of cases, people do not make conscious, planned decisions; most decisions are the product of automatism and emotion.

The choice of payment method appears to have implications not only for purchase value, but also the purchase type. Transparent payment methods, such as cash, make payment more 'painful' and are associated with lower purchase values and lower levels of impulse buying than less transparent payment methods, such as debit card.

A virtual-reality study for DNB by the Free University of Amsterdam has revealed that there is little scope for manipulating payment decisions; people choose which payment method to use mainly at the checkout and on the basis of habit. People like having cash with them, even if they have no short-term plans to use it.

The neuroscientific study showed that, on balance, paying by cash triggers more positive emotions than paying by debit card. Both debit cards and cash activate automatic behaviour, regardless of whether the subject is making the payment or merely observing it. This automaticity is stronger for cash. Also, in the research, paying by cash was more strongly associated with positive emotions than paying by debit card. More positive emotions on balance and more habitual behaviour for cash are consistent with the fact that most purchases are paid for with cash. However, it remains unclear why, on balance, more positive emotions were measured in connection with cash payments, when such payments are, in theory, more 'painful'.

Older people are more inclined than young people to prefer one particular payment method, whether cash or debit card. Older people who report paying for most things by cash tend to have a stronger emotional preference for cash payments, which is also likely to trigger habitual behaviour. Older people who report paying for most things by debit card have only a slight emotional preference for using their cards and do so primarily out of habit. In young people, such differences in the perceptions of the two payment methods are less pronounced.

One of a central bank's functions is to increase the efficiency of the payment transactions. At present, the focus tends to be on reducing the social costs. One could discuss the need for authorities to take also into account the following when encouraging the usage of a specific means of payment:

- The choice of consumers for a particular means of payment is depending on a variety of implicit respectable motives;
- The transparency of a payment method influences spending behaviour.

Changing payment behaviour is not easy. It is an evolutionary process, especially because payment behaviour is to a large extent habitual. The neuroscientific research indicated that behavioural change is most likely to be realised by measures aimed at particular target groups bearing in mind that the choice for a payment method is not (completely) rational.

I Introduction

Dutch people are more likely to pay cash at the checkout than to pay with a bank card. In 2012, for example, 59% of all purchases were paid for in cash¹. The year before, the percentage was a little higher (62%); the use of cash is gradually declining and the number of debit card transactions is increasing. However, the expectation had been that the migration would proceed more quickly. That expectation was based partly on the fact that, in recent years, the commercial banks and others have run publicity campaigns in the Netherlands to encourage people to use their cards more often and for smaller transactions. In parallel, the acceptance of card transactions at the checkout has increased. It is therefore a valid question to ask why most checkout payments are still made in cash and, more generally, what psychological factors play a role in payment method selection.

Do consumers make rational decisions at the checkout or do unconscious factors such as habitual behaviour play a greater role? If the latter is the case, how difficult is it to change firmly established payment habits? Can understanding of such matters ultimately help the central bank and policy makers to perform their roles and realise their objectives? Where cash payments are concerned, answers to such questions are hard to find, because most research assumes that consumers are rational decision-makers, and because the research tends to be more quantitative than qualitative and based on questionnaires rather than the observation of behaviour. This Occasional Study is intended not only to provide an overview of literature in this field, but also to place the findings of the various relevant studies in context.

In addition, DNB initiated two studies, which were carried out in the period from the start of 2012 to March 2013, with the aim of directly measuring the psychological aspects of consumers' payment behaviour. The research methods chosen by DNB were innovative, in the sense that they were not based on questionnaires, as most studies in this field have done. The two studies were as follows:

1. A virtual-reality study, intended to investigate the manipulability of the choice between paying with a bank card and paying by cash. How do certain variables influence payment method choice and what is their impact?

2. A neuroscientific study of the differences in emotional perception between bank card transactions and cash transactions. The research involved three component studies, which addressed the following questions:
 - a. To what extent is paying by one method, as opposed to the other, the outcome of a habitual process in the brain of the consumer?
 - b. Do older people and young people differ in their (unconscious) payment method preferences?
 - c. Does carry cash with you (when one is not particularly intending to use it) generate positive emotions by allaying the fear to end up in a situation where not all payment methods are accepted? Or do the positive emotions stem from the inherent pleasure of being in physical possession of money?

The structure of this report is as follows. Section 2 describes the existing literature that is relevant to answer the question of how people make decisions. Section 3 focuses on literature relating to the effects of payment method choice. Section 4 explains why DNB chose to investigate the relevant issues using unusual research methods. Sections 5 and 6 describe the design and findings of the two studies initiated by DNB. Sections 7 and 8 round off the report with our conclusions and discussion points.

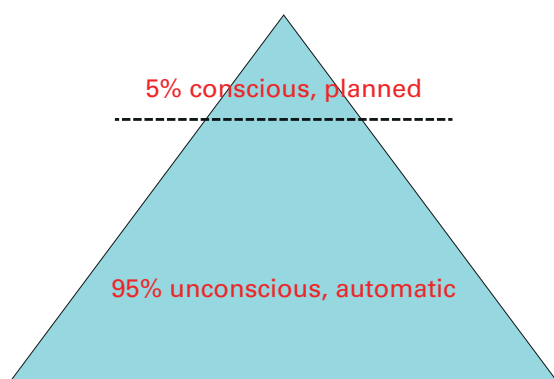
2 Literature study: how people make decisions

The hypothesis for this Occasional Study is that people's decision to use a payment method to complete a transaction is often made automatically. To what extent do people make decisions 'on automatic pilot' and how rational are their choices? Do we decide on the basis of emotions? In short: how do people usually make decisions?

People generally like to believe that they consider rationally before acting. Such beliefs bring a reassuring sense of being in control of one's own actions. In reality, however, human behaviour is influenced by a variety of mental, physical and environmental variables, which we are not usually aware of on a conscious level.

Most researchers support the estimate that only 5% of our behaviour is conscious and planned, while at least 95% is unconscious (figure 1)². Decisions are mostly made based on automatism, emotion, memory, intuition, environmental cues, and what we have been taught.

Figure 1 Relationship between conscious and unconscious behaviour



Source: Bargh (2009)

2.1 Habit

Habitual behaviour is an unconscious process that plays a very important role in the way we make choices. Doing something for the first time requires planning and concentration and involves the conscious appraisal of options. However, if in similar situations a person repeatedly makes the same choice, the person's decision-making becomes automatic; the behaviour becomes habitual. A characteristic of automatic behaviour – things such as washing one's hair or putting on one's coat – is that the ease or success of the activity is not adversely influenced by the simultaneous performance of another activity.

Automatic behaviour is very useful, because paying conscious attention to every activity would take a great deal of effort. Van den Brandhof³ explains it thus:

'Our brains seek routine and control. If we had to consider every possible combination of garments each morning before getting dressed, we would have a problem. According to Edward de Bono, it would take us 76 years to dress, assuming that we possess eleven items of clothing and spend one minute considering each combination.'

Automatic behaviour is characterised by efficiency, unconscious, unintentional and non-controlled behaviour. It is the product of practice and repetition.

How does one determine whether an event requires attention? The brain filters incoming stimuli, directing some to the conscious mind and some to the subconscious. Broadly speaking: a one-off stimulus is treated as important, but repeated stimuli are normally treated as unimportant. This process is called habituation, and may be seen on an electroencephalogram (EEG) of the brain. When we are exposed to a certain sound, the auditory cortex (the part of the brain that processes sound stimuli) 'lights up'. However, if we are exposed to that same sound at fixed intervals, the brain gradually exhibits less and less activity⁴. After a while, there is barely any discernible response to the sound. There is no general decline in our state of alertness, though: we simply become accustomed to that one particular stimulus.

Our ability to operate 'on automatic pilot' means that we don't have to pay conscious attention to all our day-to-day activities. However, the things that we do unconsciously are not necessarily the right things. Mechanically dipping into the biscuit barrel while working or watching TV is an unconscious and potentially undesirable activity. An automatic form of behaviour may also be undesirable for the community as a whole, as is the case with paying by means of a less efficient method or with undesired effects.

Changing habits is difficult and requires precision: *'Habits are like a comfortable bed; easy to get into, but hard to get out of.'*⁵ There is no ready-made method for changing habitual behaviour⁶.

Nevertheless, it is known that change is easier to bring about by intervening at times when people are making new assessments. If behaviour then becomes conscious, people can be encouraged to reassess their actions. In such situations, it is important to make the old habit less attractive and the alternatives more attractive. So, for example, information made available when someone is ready to reconsider a form of behaviour may influence that person's willingness to change.

A study by Kosse and Jansen (2012)⁷ found evidence to suggest that payment behaviour is partly habitual. First-generation immigrants from more cash-oriented countries are likely to continue paying by cash when they come to the Netherlands. By contrast, the payment behaviour of second-generation immigrants is more or less the same as that of people whose forebears were Dutch.

A 2012 report on research into stimuli by CentERdata and Tilburg University⁸ also indicated that interpersonal differences in payment decision-making were to a large extent the product of habit. In a theoretical model, differences in payment decision-making may be explained by three factors: 1) perceptions of debit card and cash payments (personal 'cost' and social norms), 2) cash withdrawal behaviour (wallet/purse-filling) and 3) habits and automatisms. Data gathered from questionnaire responses indicated that roughly half of the interpersonal differences in payment decision-making were attributable to automatisms and habits. The choice of payment method is not usually a conscious decision; one is not greatly engaged by the process. By way of illustration, an 89-year-old woman was quoted in an article on cashless supermarkets as saying, 'Yes, I know my PIN and I can use my bank card, but I never do. I've always paid cash.'⁹

If people do indeed choose how to pay largely on an unconscious and habitual basis, is it appropriate for a central bank to encourage people to change their habits? And is it actually possible for a central bank to bring about such behaviour change? After all, according to research by Lally et al¹⁰, picking up a simple and desirable daily habit, such as drinking a glass of water at breakfast, takes an average of about 66 days (with a range of 18 to 254 days). The time required to change a habit depends on how difficult the activity in question is and on the individual's level of commitment. In Lally's research, for example, the subjects wanted to effect the relevant habit change. Intentions prove to be a poor predictor of behaviour, especially where a habit has already been formed.

People differ in their ability to change their habits. Whether a person is acting deliberately or on automatic pilot can be determined by observation. The findings of a 2012 study by Amsterdam University¹¹ indicate that the analysis of magnetic

resonance imager (MRI) scans can shed light on a person's ability to modify his or her behaviour. In the study, the subjects were taught to perform a particular activity in response to a stimulus, by rewarding them for successfully performing the relevant task. However, as soon as the subject mastered the task, the 'rules of the game' changed: doing something that had previously been rewarded was punished instead. MRI scans showed that the strength of certain neural pathways determined how good the subjects were at changing their behaviour. The active neural pathways in subjects who continued to respond automatically to the stimuli, even when it was no longer in their interests to do so, were not the same as those that were active in subjects who were able to adapt their behaviour to the new circumstances.

The research referred to above suggests that habits can be broken by providing appropriate stimuli. Stimuli may in principle be given before, during or (in the form of feedback) after a payment transaction. Generally speaking, however, it appears that stimuli at the point of payment are most effective, because people don't usually decide how to pay until they actually need to do so. Retrospective stimuli appear to have little effect: feedback cannot be acted upon until the next time a payment decision is made, by which time the significance of the message has faded in the recipient's mind.

The effect of newspaper articles about skimming/payment card fraud on the use of the debit card has been investigated and the findings reported in a DNB Working Paper¹². The conclusion was that – depending on a number of variables, including position in the paper – newspaper articles could influence debit card usage habits, but that the subjects returned to their habitual behaviours after an average of just one day.

2.2 Unconscious influences on behaviour

It is apparent, then, that people often make decisions on automatic pilot. Such habitual behaviour is a very efficient way of using brain capacity. But does it lead to rational decision-making? Are people able to correctly process all the available information, and thus to arrive at the decision that best serves their interests? 'Rational choice theory' is well-established in both economics and social science. The essence of the theory is that a decision-maker chooses the course of action that has the greatest subjectively perceived benefit¹³. In recent decades, however, questions have been raised concerning various assumptions underpinning rational choice theory¹⁴. The assumptions in question and the criticism of them are summarised below.

One assumption of rational choice theory is that people are motivated primarily by self-interest. However, decision-making is also influenced by considerations such as fairness and honesty. An example of such influence is given in the following

subsection: in an ‘ultimatum game’, a decision-maker has to strike a balance between rational and emotional considerations in the context of a financial transaction. In the virtual-reality study, one of the manipulating factors was the sympathy that a customer feels for the party who needs to be paid. The study sought to establish the extent to which such sympathy influences payment behaviour.

Another criticism of the rational choice theory is that people don’t in reality always seek the best possible outcome, as the theory assumes. Good is often good enough. Nor does everyone seek to fully inform themselves before making a decision. The majority (60%) of Dutch people have not switched health insurers since the new care system was introduced in 2006³⁵. Some of those people must consequently be losing out financially, because data published by the Authority for Consumers & Markets indicates that the average person can save as much as 1000 euros or more a year by looking more critically at their insurance and mortgage. Yet the sheer range of choice is too bewildering for many, who choose the first option that they regard as good enough.

People have a limited capacity for rational discounting of the future. Asked whether they would prefer to have 100 euro now or 110 euros next week, most people choose to take 100 euros now. At the current rate of inflation, that does not appear to be a logical choice. However, people asked to choose between 100 euros a year from now and 110 euros in a year and a week, people invariably choose the 110 euros. A week that’s a year away is apparently insignificant, but we prefer immediate payment to deferred payment.

Conventional wisdom, and another assumption of the rational choice theory, is that emotion has no part to play in good decision-making. However, emotions are vital to the decision-making process, as explained in the following subsection.

If we consider the future of cash, we find that there are both rational and emotional reasons for paying by cash now and in the future:

Rational reasons:

- It is not always possible to pay electronically everywhere.
- Using cash makes it easier to remain within budget.
- Cash is the fastest way to settle retail transactions.
- A substantial proportion of the world’s population has no bank account.

Emotional reasons:

- Cash is the physical manifestation of value.
- Cash is perceived to be a safe haven at times of crisis.
- People trust cash: it has proved itself to be relatively secure against forgery and fraud.

- Privacy: the desire for privacy is rational on the part of people who wish to hide funds from the authorities, but has an emotional basis as well, insofar as many people don't like the idea that their payment behaviour can be monitored.

2.3 Triune brain

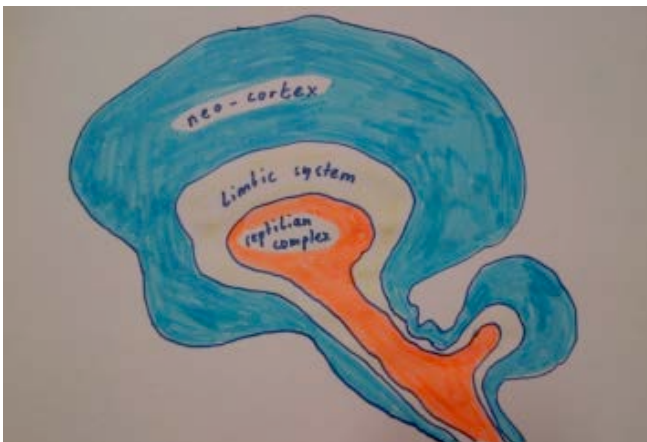
To aid understanding of the relationship between rational thought and emotion, the evolution of the brain is considered in this subsection.

According to the triune brain model developed by neurologist Paul MacLean,¹⁶ a person's skull contains not one, but three brains. Each brain is a separate evolutionary layer, formed around the more primitive layers. The three brains – the reptilian brain, the mammal brain and the human brain – evolved in successive phases of human development. In the course of an individual's maturation, his or her brain develops in accordance with the same evolutionary pattern. Thus, the neocortex – referred to below as the human brain – is not fully developed until roughly the twenty-fifth year of life. Each of the three brains is linked to the other two, but each appears to function as an independent system with its own capabilities.

2.3.1 Reptilian brain

In evolutionary terms, the reptilian brain is the oldest part of the brain. According to MacLean, this brain is about 500 million years old. The reptilian brain consists

Figure 2 The triune brain



Drawing by the author, after Paul D. MacLean (1992). *The Triune Brain in Evolution*. New York – Plenum Press.

of the brain stem, the between brain and the olfactory bulb. The reptilian brain controls physical responses, such as heart rhythm, breathing and balance. It is extremely powerful, almost insuperable. If you burn your hand, you can't help snatch it away from the heat source; if you look towards a light, your pupils inevitably contract; if you try to hold your breath, you can only manage it for a short time. The reptilian complex is instinctive and serves exclusively to facilitate survival. The reptilian brain is permanently active, even when one is in deep sleep.

2.3.2 *Mammal brain*

The mammal brain or limbic system ('limbus' means 'edge'; the system is located around the midbrain) is the brain's inner layer. It is primarily the site of feelings and emotions, particularly emotions linked to survival, through feeding, fighting, flight and reproduction.¹⁷

The mammal brain responds to stimuli from the environment. If the mammal sees green grass, it goes to graze; if it sees green grass and a lion, it runs away. The chemical process that drives the decision to run away is what we call anxiety¹⁸. The mammal brain evolved approximately 200 million years ago.

2.3.3 *Human brain*

The human brain or neocortex makes up more than two thirds of the volume of the human brain. It is somewhat squashed up and folded in on itself, in order to fit into the available space, making it look a little like a shelled walnut. The human brain is the seat of our consciousness, and the part of our brain that handles planning, language, invention and abstract thinking. The cortex is divided into two halves or hemispheres. The left hemisphere controls the right-hand side of the body and the right hemisphere the left-hand side of the body. The right hemisphere is mainly responsible for spatial awareness, abstraction, musicality and art, while the left hemisphere is more linear, rational and verbal.

The human brain evolved about 500 thousand years ago, making it the newest part of the brain. Despite its greater size, the human brain is less powerful than the mammal brain. If there is a conflict between the mammal and human brains, the mammal brain will normally prevail. Only determined efforts to activate the neocortex offer any prospect of overriding the more primitive yet dominant brain.

An example of conflict between the mammal brain and the human brain is provided by a financial game designed by Werner Güth of Humboldt University in Berlin. The game is what is known as an 'ultimatum game'. A researcher makes a certain sum of money available to two subjects. Subject 1 is invited to propose how the sum should be divided between the two of them. Subject 2 may accept or reject the proposal. If the proposal is accepted, the money is shared out as suggested; if the proposal is rejected, neither subject gets anything. Only one proposal may be made; negotiation is not allowed.

In principle subject 1 may suggest taking 99% him/herself, and giving 1% to subject 2. If the latter turns down the proposal, he/she will get nothing, as will subject 1. A purely rational analysis by subject 2 will lead to the conclusion that acceptance is the most advantageous course of action, because a little is better than nothing. However, subject 2 is liable to be affronted by the unfairness of the proposal, in which case tension will arise between the subject's rational and emotional thought processes. If the latter prevail, the subject will reject the proposal.

Many first subjects who play Güth's game feel inclined to propose a 50:50 split, but some dare to ask more for themselves. However, more than half of the second subjects reject an offer of less than 30%. The response of those subjects goes against the expectation that rational self-interest will shape decision-making regarding transactions with other people. In practice, it seems, many decision-makers also consider the implications for the other person.

Generally speaking, neuroscientific research into the ultimatum game indicates that our financial decisions are the outcome of two-way communication between cognitive and emotional mechanisms¹⁹. Neurons gather information about 'the views' of cognitive and emotional networks, and weigh them up in order to arrive at a decision. If the calculated neural discrepancy is great enough (i.e. if one option is clearly better than another), a decision is taken. The decisions made by subjects in ultimatum games and the results of brain scans appear to indicate that the neural emotional response to unfairness outweighs the rational (utilitarian) self-interest response. In other words, the human brain and the mammal brain may be in agreement or in disagreement, but the ultimate decision is normally made by the mammal brain.

The mammal brain is not only more powerful than the human brain, but also much faster. It's not often that you meet a bear, but if ever you do, you may be confident that your most primitive brain will immediately prepare your body for action: your heart rate will increase, your eyes will open wide, adrenaline will be released and sugars will be transported to your muscles. You will already be running before your human brain can think, 'Help, a bear!' Your most primitive brain knows things before you know them yourself. The latter view of the way we function is not new: in the early twentieth century, William James and Carl Lange proposed the counterintuitive theory that physical responses are not the cause, but the result of certain emotions. That theory is often illustrated by reference to old sayings suggesting, for example, that crying makes you sad or that running away makes you scared. Neuroscientific research now enables us to investigate cause and effect more closely.

According to Lamme,²⁰ it is now generally accepted that conscious perception is subject to a delay of somewhere between 0.2 and 0.3 seconds. That is much longer than the time required for the stimulation of the senses to lead to the activation of

the muscles – a process known as the formation of a cortical reflex arc. Conscious perception is a latecomer to the party: by the time it arrives, the action is already in full swing. Lamme therefore refers to the neocortex as a ‘babble box’, a sort of commentator that merely keeps attempting to make logical interventions.

3 Literature study: pain of paying

As we have seen, in by far the majority of cases, decision-making is unconscious; people do not always make rational decisions. The way we make financial decisions is no different. That is apparent from, for example, the psychological concept of ‘pain of paying’, introduced by Zellermyer in 1996²¹. Zellermyer defined pain of paying as ‘direct and immediate displeasure or pain from the act of making a payment.’ Such pain isn’t physical, but ‘psychological or hedonistic discomfort associated with making a payment’. Pain of paying may reduce the pleasure of making a purchase, or the prospect of it may persuade us not to make the purchase at all.

There is a positive correlation between pain of paying and the amount spent on a purchase. More surprisingly, research indicates that the payment method used influences the level of pain of paying experienced.

In a series of studies, Chatterjee and Rose (2012)²² demonstrated that different payment methods were associated with different consumer perceptions of prospective purchases. Consumers who were ‘primed’ to use credit cards (i.e. by asking them to think of a few other words associated with their credit card) focused more on the product features, whereas those who were primed to use cash were more inclined to consider the cost of the products.

The relationship between payment method and pain of paying is considered in subsection 3.1, while the implications of pain of paying for consumption are covered in subsection 3.2.

3.1 Correlation between payment pain and payment method transparency

The degree of the pain of paying correlates to the transparency of the payment method. The more transparent the payment method, the greater the pain of paying and the less the payer is willing to spend. According to Soman,²³ the transparency of a payment method is determined by three factors: 1) the salience of the payment form, 2) the salience of the amount paid and 3) the relative timing of transaction and money outflow.

3.1.1 *Salience of the payment form*

Cash is the payment method that makes it most clear that one is spending ‘real’ money. Notes and coins are tangible and visible in the payer’s wallet or purse. When one pays by cash, one sees the money leave one’s possession. Research involving 2300 adult German subjects by the Deutsche Bundesbank in 2011²⁴ demonstrated that consumers make use of the fact that cash allows one to see at a glance not only what one has available to spend, but also how much one has already spent. Consumers who want close control over their disposable liquid assets therefore make more purchases in cash, use non-cash payment methods less, withdraw less and retain larger cash balances than other consumers. Consumers who use cash a lot do use bank cards for some transactions. However, the threshold transaction value for using a card is higher amongst such consumers than amongst other consumers. The researchers therefore concluded that it was unlikely that cash would become less important for certain groups of users, particularly those who were short of funds and those who found it hard to process (abstract) information.

3.1.2 *Salience of the amount*

Payment methods also differ in terms of the extent to which the amount paid is consciously perceived by the payer. Cash payment makes the consumer more aware of the amount than other payment methods. Coins and banknotes prominently state their value and the relevant amount has to be counted out and handed over; the payer then has to pay attention to how much change is received. When paying by debit card, one pays less attention to the amount when checking out. According to the authors of the book *Psychologeld* (2011),²⁵ the card user is more focused on entering the correct PIN (code) and making sure that no one else can see it.

3.1.3 *Coupling*

Prelec and Loewenstein²⁶ introduced the concept of ‘coupling’: the link between consumption and payment in the mind of the payer. Direct coupling, as when paying cash or with debit card, is the most transparent. Retrospective payment, as with a credit card, and pre-payment, as with a prepaid card/stored value card or gift voucher, are both much less transparent.

On the basis of interviews, Soman placed the various payment methods in order of transparency by reference to the three factors described above. The most transparent payment method in the list is cash and the least transparent methods are prepaid cards/stored value cards (e.g. electronic wallets and gift vouchers) and direct debit.

3.2 **Influence of pain of paying on consumption**

3.2.1 *Pain of paying and purchase value*

The payment method therefore influences the pain of paying, but how do different levels of payment pain affect consumption? The relationship has been thoroughly

Table 1 Levels of transparency of various payment methods

| Payment mechanism | Saliency of form | Saliency of amount | Relative timing of money outflow and purchase | Transparency |
|--|------------------|--------------------|---|--------------|
| Cash | Very high | High | Concurrent | High |
| Cheque | Medium | High | Payment after purchase | Medium |
| Credit card | | | Payment significantly after purchase | |
| | Medium | Medium | | Low |
| Debit card | Medium | Medium | Concurrent | Low |
| Stored value card | Low | Low | Payment before purchase | Very low |
| Autopay (direct debit from bank account) | Very low | Very low | Concurrent | Very low |

investigated. Pain of paying can diminish the pleasure of purchasing and influences what the buyer is willing to spend on a purchase. If you experience less pain of paying, you spend more without noticing it.

Those findings were made in 2001 by Prelec and Simester²⁷, who observed that, in an auction for tickets to watch the Boston Celtics basketball team, students from Boston were willing to pay more than twice as much when they had to pay by credit card (little pain of paying) as when they had to pay by cash (more pain of paying). The difference was not attributable to how much cash the students just

Figure 3 Celtics tickets.



Source: Sports fan 4

so happened to have with them, because they did not have to settle up until the following day.

It was also found that students buying books in a university bookshop by credit card estimated the value of the purchase to be lower than when payment was made by cash. Loewenstein (professor of economics and psychology to Carnegie Mellon University) accordingly concluded that credit cards mitigated pain of paying.²⁸

There is less pain of paying when settlement is made after the transaction (as with a credit card) and less still when payment is made prior to the transaction, as with an electronic wallet or a gift voucher. With prepaid transactions, the 'bookkeeper in the payer's head' has long since written off the money, making the payer willing to spend more. This effect is, of course, well known to casino proprietors, who use prepaid chips to disconnect payment from the act of placing a bet. Gamblers are then willing to wager more than if they have to place hard cash on the table.

In 2002, Dan Ariely²⁹ established that consumption was influenced more by the salience of the payment (as associated with the coupling of payment and purchase) than by the cost. Ariely gave 163 students 45 minutes to read information on four different websites. Three websites had various pages of appealing content (news, scientific information, cartoons), but the students had to pay to view it. The fourth website had free but unappealing content (so unappealing that, in a pilot study, subjects were found to prefer listening to screaming than to reading the content in question). At the outset, each student was given 10 dollars to pay for website content. Each student was also randomly assigned one of five different payment methods: (1) prepayment, in the form of money loaded on an electronic wallet (2) retrospective payment, in the form of settlement at the end of the session (3) simultaneous payment, at the time of opening each web page (4) subscription, allowing unrestricted access to the content and (5) subscription, requiring certain additional activities to access the content.

Subjects who had to pay as each page was opened spent significantly less than the other subjects, and were much more likely to look at the free, unappealing information. The most was spent by the two groups of subscribers, followed by the pre-payers and then the retrospective payers.

3.2.2 *Pain of paying and purchase type*

As explained above, the payer is more conscious of a cash payment than a card payment. That influences not only how much the payer is prepared to spend, but also the type of purchase the payer is inclined to make. Electronic payment allows more scope for impulse buying.

In a field study,³⁰ the shopping done by a thousand single-person households over a period of six months was analysed. It was found that people who paid by credit or debit card were more impulsive and more inclined to buy unhealthy food than those who paid with cash. The research observations were interpreted as supporting the hypothesis that, being less painful, paying by card diminished the payer's impulse control. The fact that the same effect was observed in both debit card users and credit card users (even though the debit card users were charged immediately) was seen by the researchers as indicating that the lower level of pain was attributable not to the deferral of settlement, but to the abstract and emotionless nature of the transaction – in other words, to what was referred to in subsection 3.1 as the salience of the payment form.

The effects were replicated in three empirical follow-up studies. In one of the studies, the researchers looked at the influence of the payment method on the number of 'unhealthy' products in the subjects' shopping baskets. The findings supported the hypothesis that card transactions were associated with larger purchases and the consumption of unhealthy foods.

A study of behaviour in a university canteen found that bank card payers bought more unhealthy products than cash payers. Students paying by card bought 10% more calories; they were three times as likely to buy brownies and twice as likely to buy soft drinks as students who paid cash.

The studies referred to above are known as 'pay cash, eat less trash' studies.

Figure 4 Brownie images.



Source: Your.dictionary.com

The payer's consciousness of the amount paid also affects other impulses. Dan Ariely³¹ performed a study, in which six one-dollar bottles of cola were placed in a number of shared refrigerators in student accommodation units. All the bottles were taken within 72 hours. In several other refrigerators, he left not bottles of cola, but six one-dollar bills. The dollars remained untouched for 72 hours, after which Ariely removed them himself. Ariely interpreted his observations, and the findings of several other similar studies, as evidence for his hypothesis that the more remote 'real money' became, the more lightly people took the idea of cheating. The same principle applies to false accounting and, for example, to submitting fraudulent tax returns.

To sum up, the research presented in this section indicates that transparent payment methods, such as cash, are associated with greater pain of paying, lower purchase values and less impulse buying than less transparent payment methods, such as debit cards.

4 Innovative research methods

DNB has sought to add to the existing research and the portfolio of available research methods by carrying out a neuroscientific study and a virtual-reality study into unconscious payment method preferences. As indicated earlier, most of the research conducted to date assumes a rational decision-maker, is quantitative and is based on the use of questionnaires.

As indicated in the previous sections of this report, people do not always make decisions rationally. DNB's neuroscientific study of purchase decision-making therefore focused primarily on the emotions and neural networks, rather than on rational processes. Using functional magnetic resonance imaging (fMRI) technology, DNB commissioned research into how the (evolutionarily primitive) brain responds to the emotional choice between cash and card. The direct observation of behaviour, rather than the indirect investigation of behaviour via the medium of questionnaires, was also considered to be important. In this section, the added value of the innovative direct observation-based research methods over quantitative questionnaire-based research is considered.

4.1 Direct observation

Researchers often seek to establish when and under what circumstances people use different methods of payment by conducting questionnaires or performing counts at the checkout. Such research is useful for determining the personal characteristics associated with particular forms of payment behaviour, but sheds less light on people's motives. As previously discussed, the expectation is that the motivation for payment decisions is largely unconscious. That begs the question: how can one establish what that motivation is?

Clearly, if a person's motives are unconscious, there is little to be gained by asking about them in a questionnaire. A person will often behave a certain way for unconscious reasons, then find a logical explanation for his/her behaviour. The explanation is usually based on common sense, mainly so that the person can believe it him/herself. We shall return to this subject later, but for the moment one example is instructive. In his book *De vrije wil bestaat niet (There is no such thing as free will)*,³² Lamme cites a study by Nisbett and Wilson, which addressed the following

question: ‘To what extent are people aware of and able to report on the true causes of their behaviour?’ To answer that question, the researchers invited passers-by in a shopping centre to choose the best of four pairs of tights. Afterwards, the passers-by were asked to explain their choices. In fact, the tights were identical, but that was not apparent to the subjects. The subjects were allowed to examine the tights in any way they liked, including feeling them and smelling them. Because the garments were in fact identical, one would expect rational choice to lead each product getting 25% of the votes. That was not the case, however. The tights on the right-hand end of the line-up were identified as the best nearly four times as often as the tights on the left. The observed effect was attributed to the garment’s position in the line-up: the participants moved along the line from left to right, so that the tights on the right were examined last. In psychology, the observed effect is known as the ‘recency effect’: the thing that a person has viewed most recently automatically has that person’s emotional preference and is most readily recalled. The participants were not conscious of that influence on their decision-making, and consequently attributed their choices to one pair of tights being more stretchy than the others, or being of better quality. Such experiments indicate that we are less aware of what actually motivates us than we think.

Questionnaires have the added disadvantage that there is always a time lag between the behaviour that the researcher is interested in and the subject answering questions about it. There is, of course, no such time lag when behaviour is directly observed. Devising just the right questions can also be difficult. Questions need to be formulated in concrete terms and to yield as few answer tendencies as possible. It is well established, for example, that research subjects are inclined to give the answer that they believe the researcher wants, or that is expected of them by society. It has also been repeatedly demonstrated that positive or concurring options or

Figure 5 Which nylons are best?



expressions of satisfaction are more likely than the opposite answers. People prefer to say 'Yes', 'Satisfied' and 'True' than to say 'No', 'Dissatisfied' and 'False'³³.

No such drawbacks exist with direct observational studies.

In the first study (the virtual-reality study), the (virtual) behaviour of subjects making payments was observed, and the scope for manipulating payment method choice was investigated.

In the second study (the neuroscientific study), the researchers observed which neural networks were active when a subject made a payment decision. What emotions can be directly registered when a person pays in cash or by debit card? Is it possible to discern whether the subject's decision-making involves automatic or newly learned behaviour?

5 Virtual-reality study

5.1 Virtual-reality study design

Hypothesis

It is expected that payment method choice is a form of habitual behaviour, and therefore cannot easily be manipulated.

Sample

Participants were recruited by CentERdata out of a representative panel. Total participation was 1,465, consisting of 800 males between ages 16 and 87 (average: 53.6) and 665 females between 16 and 90 (average: 49.3).

Participants were sent a survey, one week after they had finished the virtual-reality game. 1,280 persons (701 males, 579 females) answered the survey.

Scheme

DNB commissioned Martijn Meeter and Daniel de Schreij of the Cognition Department at the VU University Amsterdam to investigate the manipulability of payment method choice. There are numerous variables that may influence payment method choice, but the researchers concentrated on a small selection for practical reasons. The research involved an online game, in which everyday life was simulated. As indicated before, the direct observation of real-life behaviour is preferable, but that would have been impractical because of the large number of variables at play. One would have to observe an unworkable number of subjects in real life in order to support statistically valid conclusions. Even with the chosen study design, involving nearly 1,300 subjects sitting at their PCs, the number of variables had to be limited.

An introductory text explained to the subjects that they were going to participate in a game, in which they were asked to choose between various healthy and less healthy options. Subjects were not told that the intention was to observe their transactional behaviour, and there was no emphasis on payment decisions in the instructions.

Before starting, subjects were given the opportunity to draw up to 70 euros in cash and to bring their preferred means of electronic payment (debit card, credit

card). An on-screen pop-up then asked them to go to a virtual supermarket for their shopping and to a virtual restaurant for a meal. Once ‘inside’, they were able to select supermarket products from photographs or restaurant items from a menu. They were then asked how they would like to pay: by cash, debit card or credit card (the options offered were confined to those that the subjects had chosen to take with them).

Each subject therefore made four choices regarding each means of payment:

| | |
|--|---|
| 1. Beforehand: whether to take it to the supermarket | 2. Beforehand: whether to take it to the restaurant |
| 3. Whether to use it in the supermarket | 4. Whether to use it in the restaurant |

Requiring subjects to make more choices was not considered desirable, because it is unlikely that the choice would be mutually independent. The order of the two scenarios – first the restaurant and then supermarket, or vice versa – was determined randomly for each subject.

During the course of the game, a number of variables were manipulated with a view to establishing which factors led to the subject choosing to use a given payment method. The manipulations were concealed in the scenarios introductory text, or integrated into the structure of the game. Since the value of each variable was fixed for the individual subject, the subjects were unaware of the manipulations. The possible motives and the manipulations are described in the following subsection.

The investigated variables were manipulated either by giving the subjects particular instructions before they began the game, or by modifying the scenarios that were presented to the subjects during the game. One variable featured both in the instructions and in the game. All variables were manipulated in the context of both scenarios (the restaurant and the supermarket). The variables used in the research were selected on the basis of literature research. It was very important that not too many variables were introduced, in order to ensure that the manipulations did not interfere with each other and to prevent the need for an impracticable number of subjects.

Variables adjusted in the introductory instructions

- *Environment*: Some of the subjects were told that, in order to reach their destination, they would need to walk through a rough neighbourhood; no such warning was given to the other subjects. This variable was intended to manipulate the subjects’ sense of physical security and possibly influence their inclination to carry cash.

- *Warning about skimming:* Some of the subjects were warned about the need to be alert to the danger of ‘skimming’; no such warning was given to the other subjects. This variable was intended to manipulate the subjects’ confidence in the payment method and possibly influence their inclination to carry and use a debit card.
- *Budget:* Some of the subjects were told that they had to manage on a small budget and therefore needed to be careful not to spend too much. The others were told that they had an ample budget and could afford to treat themselves. This variable was intended to manipulate the subjects’ consciousness of how much they were spending. Its inclusion reflected the fact that it was reported in the literature that people who have to be careful about their spending are more likely to pay cash, because cash provides a better oversight of spending or a greater sense of control.

Variables adjusted during the game

- *Healthiness of the food:* Some of the subjects were asked to buy fruit from the supermarket and the others to buy snacks (crisps or chocolate). In the restaurant, some were asked to buy healthy food and the others to buy junk food. This variable was introduced to investigate whether there was any correlation between the healthiness of the food purchased and the chosen payment method. It was thought possible that there might be an unconscious bias towards the use of certain payment methods to pay for, respectively, healthy and unhealthy products, e.g. because cashless payment facilitates unhealthy impulse buying or because people think more about what they are buying when they pay cash.
- *Sympathy for the person taking the payment:* When they went to pay, some subjects were met by a friendly-looking checkout operator/waiter who made eye contact, while the others encountered an unfriendly-looking person who avoided eye contact. This variable was included to investigate whether the subjects’ payment behaviour was influenced by their sympathy for the checkout operator/waiter, and their assumptions about what payment method that person would prefer.
- *Promotion/payment method cost:* This variable had four values:
 - a. No sign
 - b. Sign saying ‘We accept bank cards for small transactions’ (encouragement of card use)
 - c. Sign saying ‘We accept cash for small transactions’ (encouragement of cash use)
 - d. Sign saying ‘10-cent surcharge for bank card transaction’.

This variable was included to investigate whether the promotion of a particular payment method or the imposition of a charge for using a particular payment method (in this case only bank card use) influenced the subject's choice of payment method.

- *Prominence of the payment terminal*: When they went to pay, some subjects were presented with a scene in which no payment terminal was visible, while the others saw a scene with a prominent terminal. This variable was included to investigate whether the visibility of a payment terminal influenced subjects' inclination to pay by card.
- *Price 'roundness'*: Some subjects were offered products with 'round-number' prices, while the others needed to pay 'awkward' amounts. The intention was to see whether subjects were more likely to use a card when the amount to pay was not a whole number of euros, in order to avoid a complicated change transaction and/or the inconvenience of carrying a lot of change.

Figure 6 Payment screen in the supermarket scenario



Variables adjusted both in the instructions in during the game

- *Time pressure:* Some of the subjects were told that they had a relatively short time to eat out or do their shopping, because they needed to get back for an important engagement. To maintain awareness of the need to hurry, an on-screen clock remained visible to these subjects while the game was in progress. With each step in the game, the clock moved closer to 2pm (the deadline). The other subjects were not told to hurry or shown a clock. This variable was included to manipulate the subjects' sense of (time) pressure and possibly influence their choice of payment method, if one method was perceived 'quicker' than the other.

A week after taking part in the game, the subjects were asked to complete a short questionnaire about their preference for cash or electronic payment methods in real life. A total of 1,280 people ultimately both played the game and completed the questionnaire.

5.2 Results of the virtual-reality study

5.2.1 Carrying and paying

Subjects' decisions about carrying and using the various means of payment are summarised in table 2. By far the majority of subjects chose to take both cash and (a) bank card(s), both to the supermarket (65%) and to the restaurant (70%). Very few subjects took only cash (6% and 5%, respectively) and relatively few took only

Table 2 Decisions to carry and use the various means of payment

| | Carrying | Supermarket | Use |
|--------------------------|----------|-------------|------|
| Only cash | 6% | Cash | 47% |
| Only debit card (and CC) | 29% | Debit card | 53% |
| Both | 65% | | |
| Total | 100% | Total | 100% |

| | Carrying | Restaurant | Use |
|--------------------------|----------|-------------|------|
| Only cash | 5% | Cash | 43% |
| Only debit card (and CC) | 25% | Credit card | 3% |
| Both | 70% | Debit card | 53% |
| Total | 100% | Total | 100% |

a bank card (29% and 29%, respectively). Apparently, most people wanted to keep both payment options open for as long as possible. In that respect, the observed behaviour was consistent with a 2012 study by CentERdata and Tilburg University³⁴, which found that people often automatically took both a bank card and cash when going out. Approximately 40% of the questionnaire respondents in that study reported that there were circumstances in which they deliberately left either cash or their bank card at home. Cash was typically dispensed with for practical reasons (a card on its own being easier to carry), while subjects were inclined not to bother with their cards mainly if they were not planning to make any large purchases.

In the virtual-reality study, there was a roughly equal split between subjects choosing to pay cash and choosing to pay by card, although card use was marginally more popular. In reality, there is a more marked preference for cash when paying at a checkout, as indicated in the introduction to this report.

5.2.2 *Directional predictors for the explanation of dependent variables*

Not all the investigated variables were found to significantly influence payment method choice. Table 3 lists only those variables that actually appear to help explain payment method choice. In the table, purple shading indicates a significant influence on the decision in favour of cash/debit card. In other words, the relevant variables help to explain the model. A minus sign in a cell indicates a negative correlation, and a plus sign a positive correlation. Annex 1 presents the outcome of the logistic regression analysis in more detail.

People on tight budgets proved more likely to carry cash, for example. That finding is consistent with the research by the Deutsche Bundesbank, referred to above, which concluded that people use cash partly to help them maintain an overview of their spending.

It is also understandable that people are disinclined to carry cash when walking to their destination in the dark, regardless of whether that destination is a supermarket or a restaurant.

In line with earlier quantitative research,³⁵ our study found a correlation between income and attitude to cash. The lower a person's income, the more likely he or she is to carry and use cash, either at a supermarket or in a restaurant.

The overall size of the transaction is also linked to payment method choice: the larger the amount to be paid, the more likely it is that the payer will choose to use a card. Again, that finding is consistent with earlier quantitative research.

Another predictable finding is that charging for card use leads to more people paying cash.

Table 3 Directional predictors for the explanation of dependent variables

| | Supermarket: cash carried | Supermarket: cash used | Restaurant: cash carried | Restaurant: cash used |
|---------------------------------|------------------------------|---------------------------|-----------------------------|--------------------------|
| Budget | - | | - | |
| Walk in the dark | - | | - | |
| Gross income | - | - | - | - |
| Education | - | - | | |
| Amount payable | | - | - | - |
| Card surcharge | | + | | + |
| Age | | + | | |
| Promotion of card use | | | | - |
| Skimming warning | | | - | |
| Restaurant first | | | | + |
| Household includes child | | | + | |
| In charge of household finances | | - | | |
| AH versus Aldi | | - | | |

More surprisingly, warning people about skimming appears to lead to fewer of them taking cash to a restaurant. According to CentERdata and Tilburg University,³⁷ Dutch people who are nervous about card fraud or street robbery are less inclined to pay by card. We have no satisfactory explanation for the discrepancy between the latter finding and our results, except to speculate that the warning about skimming may have made people consider the area unsafe and therefore disinclined to carry much cash.

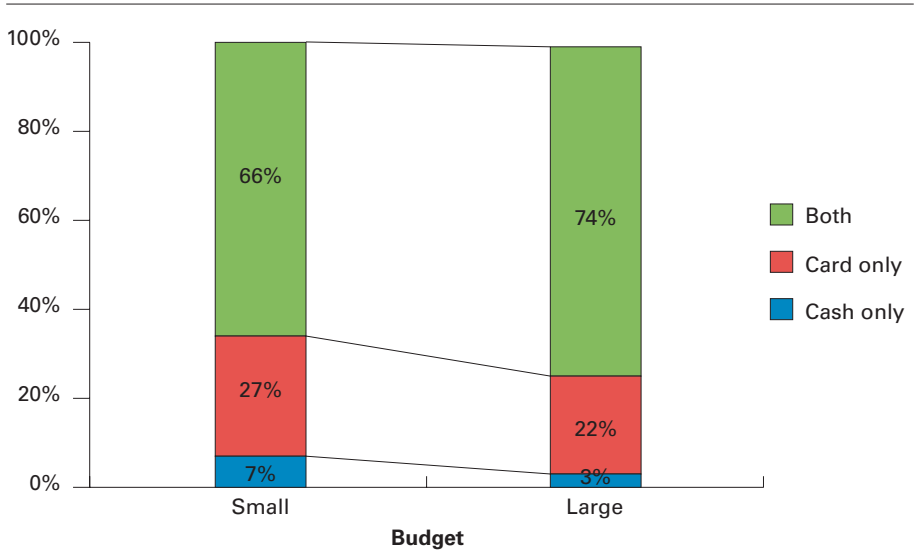
5.2.3 Consideration of two key variables

Two of the variables that influence payment choice – budget and cost – are considered in a little more detail below. In this context, credit cards and debit cards are grouped together, because credit cards are used so little that separation of the findings yields little additional information.

5.2.4 Budget

Subjects with small budgets were more likely to decide to take one particular means of payment with them to a restaurant than those with larger budgets (see figure 7); budgetary pressure was particularly likely to lead to people taking only cash (although the absolute numbers involved remained small). No such effect was observed in relation to supermarket shopping, and the effect on the payment method ultimately used was overshadowed by the effect of the amount to be paid.

Figure 7 Choice of means of payment carried when going out to eat, as influenced by budget size



5.2.5 Promotion or card use surcharges

If people are charged to use cards, they are more likely to pay cash than when no surcharge is applied. Conversely, when card use is actively promoted, the likelihood of people choosing to pay by card increases. Such effects were observed in both scenarios (figures 8 and 9) and, contrary to expectation, were unaltered by the apparent friendliness of the checkout operator or waiter.

5.2.6 Relationship between questionnaire and game

Figure 10 consists of two graphs that illustrate the validation of the research. After a week, the game players were asked about their real-life payment preferences. As figure 10 shows, the vast majority of people who said that they nearly always paid cash in real life also chose to carry and use cash in the game.

More than half (nearly 60%) of the subjects who reported (nearly) always paying by card also chose to carry cash in the game, but only actually paid cash in 20% of cases. People apparently like having cash with them, probably ‘just in case’.

Figure 8 Payment method used for eating out, as influenced by card use surcharges and by active card use promotion (in the form of signage)

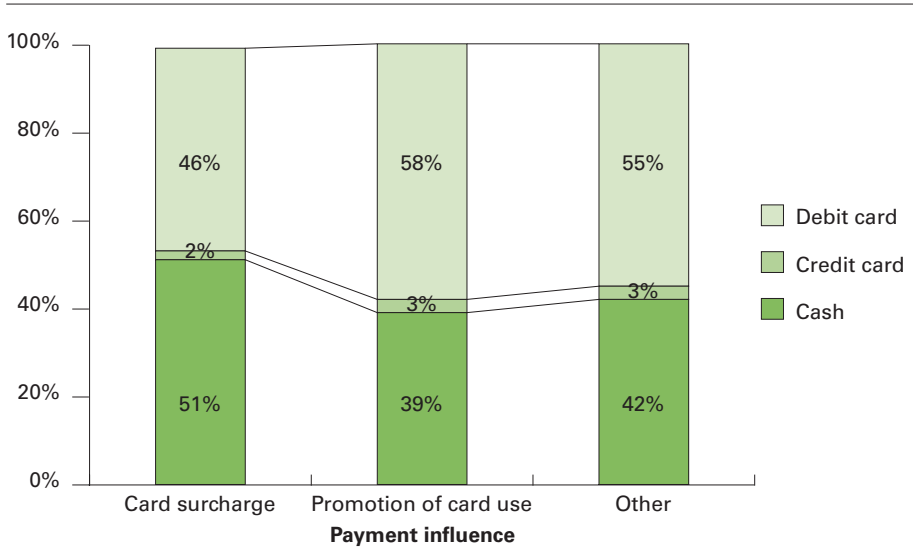


Figure 9 Payment method used for shopping, as influenced by card use surcharges and by active card use promotion (in the form of signage)

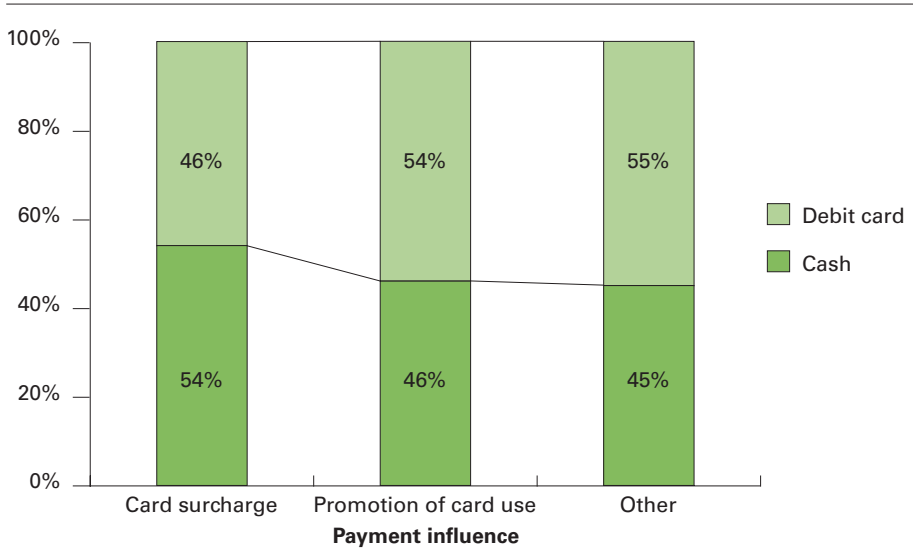
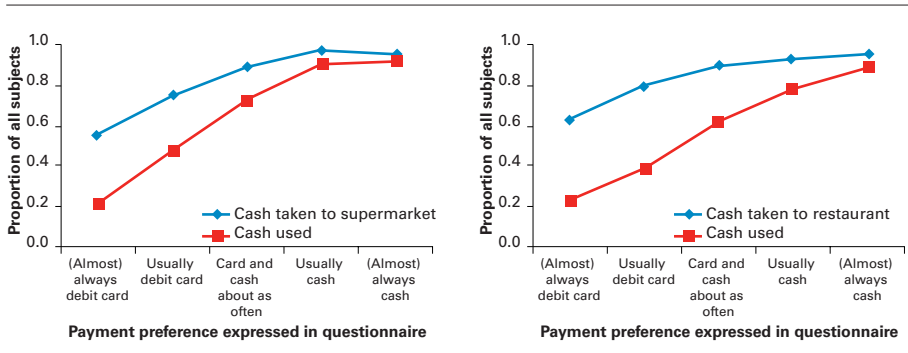


Figure 10 Relationship between questionnaire and game



5.3 Summary of results

The conclusions of the virtual-reality study may be summarised as follows:

- Subjects' (virtual) behaviour is to a large extent determined by habit. Attempts at behavioural manipulation have limited effect (between 15 and 20%).
- A number of variables, such as budget size and income level, influenced behaviour as expected. Other variables, such as price roundness and food type, did not have the expected influence. The 'skimming warning' variable actually had the opposite effect to that expected.
- The promotion of card use and charging for card use did affect behaviour. That implies that the subjects noticed the manipulations. Other manipulations, such as the apparent friendliness of the person taking the money may have simply been too subtle to produce the expected effect.
- Subjects' behaviour in the game was representative of their real-life-behaviour.

6 Neuroscientific study

6.1 fMRI research

In recent years, great advances have been made in neuroscientific research. We can quite literally look inside someone's head while he or she makes a decision or processes information. The techniques involved do, of course, have their limitations. For example, Professor Richard Birke³⁷ points out that brain scans are expensive and do not produce images of our emotions, but of magnetic responses, which require considerable extrapolation and interpretation.

To perform a neurological scan, one needs a functional magnetic resonance imager (fMRI). This is a very large magnet designed for non-invasive viewing of the brain. An fMRI measures changes in the oxygen levels in the more active parts of the brain. A stimulus, such as an image, film or question, activates part of the brain, whose oxygen use consequently increases relative to adjacent parts of the brain. An fMRI scan is a 3D image showing where and when oxygen-rich blood is present in the brain and therefore which parts of the brain are most active at the time of the scan.

Figure 11 fMRI-scanner



In 2006 and 2007, George Loewenstein and his team published two studies concerned with the way people make purchasing decisions and what emotions are involved when making such decisions ('Tightwads and Spendthrifts' and 'Neuroeconomics: How Neuroscience Can Inform Economics')³⁸. The studies were based on the analysis of brain scans, and demonstrated that the parts of the brain that were active during the decision-making were the areas that are responsible for both pleasure and pain. By examining the relevant brain structures, it was possible to predict what choices people would make, before they were themselves conscious of having arrived at a decision.

Neurensics is a research agency that uses the technique mainly to advise companies on the suitability of their advertising. Neurensics claims to be able to identify a so-called 'buy button' in the brain. According to Neurensics, if the 'approach emotions' lust and desire are highly activated and the 'avoidance emotion' anxiety is not, purchasing behaviour is 70% predictable.

The neural tests focus mainly on certain parts of the brain:

- The insula (associated with the anticipation of loss and excessive prices; the insula light up when a person pays a price that he or she considers too high, and shut down if the person thinks he/she has a bargain. Getting a bargain mitigates payment pain.³⁹).
- The amygdala (two almond-shaped centres within the limbic system, which are activated by anxiety or aggression).
- The nucleus accumbens (the reward centre, associated with product preference).

Neurensics, to which Professor Victor Lamme of the University of Amsterdam is affiliated, undertook a neuroscientific study for DNB into the emotional perceptions associated with making payments using various methods. DNB first wished to establish, by means of a pilot study, whether the emotional perceptions associated with making payments by cash differed from those associated with making payments by card, because emotions play an important role in determining behaviour. The small-scale study yielded some interesting results, but just as many follow-up questions, a number of which were addressed by a larger subsequent study.

6.2 Pilot study

6.2.1 *Hypothesis pilot*

Emotions that can be identified by a fMRI-scan in people's brain differ during a cash payment transaction and a debit card payment transaction.

The theory of 'the pain of paying' can be confirmed.

6.2.2 *Sample pilot*

Participants were 26 Dutch consumers aged between 25-45 years old (13 men and 13 women).

6.2.3 *Scheme pilot*

The methodology of the pilot study was as follows. Every individual's brain processes are different, so it was necessary to perform calibration tests on the subjects before testing their responses to the research stimuli. The subjects were therefore shown loving or erotic images to trigger their 'approach emotions', or images of mutilation or the open jaws of fierce dogs, from which people have been programmed to flee by countless years of evolution. Using the MRI scanner, it was then possible to determine whether each 3mm x 3mm part of the brain – each 'voxel' – responded positively or negatively to the images. The patterns of voxel activity thus established formed the basis for comparative analysis of the subject's responses to the research stimuli.

Following calibration, the activity occurring in a subject's brain in response to the research stimulus can be recorded. In the context of Neurensics' commercial activities, the stimulus is often a new advert, but in the case of the DNB study, it was making a payment by cash or with a debit card. To deliver the stimulus, three videos were made, each featuring a young woman making a cash or debit card payment in a particular situation (supermarket, filling station and market). The three situations were selected to allow the influence of the situation to be excluded, after subsequent averaging. The videos were shown to the subjects at random, as they lay in the fMRI scanner, and the location, duration and intensity of the resulting activity patterns were recorded. On the basis of correlation with the responses to the calibration images, the brain structures were then given names (emotions). The following thirteen were identified:

- Positive or approach emotions: desire, lust, expectation and trust.
- Negative or avoidance emotions: danger, disgust, anger and fear.
- Personal appeal: value, involvement, familiarity.
- General impact: novelty, attention.

It is possible to use this method for the analysis of purchase decisions, because the subject watching the video exhibits essentially the same brain activity as if he/she were making the purchase. That is due to the fact that people possess so-called mirror neurons, which 'fire' not only when we perform a deliberate act, but also when we watch someone else perform that act. Observation immediately triggers the same feelings we would have if we were doing the observed thing ourselves. Mirror neurons are located in the premotor cortex and were discovered in the nineties through research with macaque monkeys. It was found that the same neural networks were activated in the monkeys when they watched another monkey eat a banana as when they ate one themselves. It was subsequently established that the

Figure 12 Young woman who makes payments using cash or debit card



same happens in humans. When a person who watches someone do something, the activity in the watcher's brain is nearly the same as when he or she does that thing personally⁴⁰. The mirroring is clearest when the watcher can imagine him/herself in the actor's shoes and feels empathy for the actor.

6.2.4 *Results pilot*

The study population of 25 to 45-year-olds were found to experience more positive emotions (on balance) when watching debit card transactions than when watching cash transactions. This resulted in a significantly higher brain quotient (BQ) for debit cards than for cash. The BQ is an expression of the balance between positive and negative emotions, which is vital for predicting consumer behaviour.

In contrast to the main study results presented below, the pilot study results indicate that people should be more inclined to pay by card than with cash, and therefore liable to spend more money when using a card. This observation is consistent with the findings reported in the literature on pain of paying discussed in section 3. One would therefore expect greater use of debit cards than is indicated by the estimates of real-life usage. The researchers suggested that the discrepancy between the

anticipated usage levels and actual usage levels is attributable to habitual behaviour and its influence on payment decision-making. That prompted the question: could the ‘intervention’ of habit be observed on the fMRI scan? Another question promoted by the pilot study was whether the study population was representative of the population as a whole, given that the subjects were aged 25 to 45. The age of the subjects was thought significant because the estimates of actual usage suggest this people in the relevant age group are more likely to use cards than older people⁴¹. The desire for answers to those questions prompted a follow-up study (the ‘main study’).

6.3 Main study

6.3.1 Research questions

The research that followed the pilot study was designed to address three questions:

1. To what extent is paying in cash or by card guided by habit, or by unconscious emotions or other determinants?
2. To what extent do different age groups differ in their payment method preferences and to what extent are any differences in emotional preference or in behavioural automation an inherent consequence of aging or merely a generational phenomenon?
3. What motivates the desire to carry cash even when one is not intending to use it?

To investigate these questions, subjects were introduced to various virtual situations, in which there was uncertainty regarding the payment methods to be used.

6.3.2 Sample

In addition to subjects in the pilot study age group (25 to 40-year-olds), the main study involved a group of older subjects (55 to 70-year-olds). In each group, distinction was made between people with a lot of experience of card use and people with little experience, thus creating four distinct groups:

| | 25 to 40-year-olds | 55 to 70-year-olds |
|---------------------------------------|--------------------------|------------------------|
| Little debit card experience | 'Young cash users' (n=8) | 'Old cash users' (n=9) |
| A lot of debit card experience | 'Young card users' (n=9) | 'Old card users' (n=9) |

6.3.3 Design of the main study

A ‘mapper’ was developed specially for the study, to determine whether something was a habit. To that end, the brain patterns associated with automatic motor behaviour in each subject were ascertained. That was done by first asking the subjects to perform two motor tasks (pressing four buttons in a particular fixed order) before entering the scanner; the tasks had to be performed repeatedly until the subject could perform them blind. The subject was then placed in the scanner and the

brain activity observed during performance of the routine tasks was compared with that observed during the performance of new, previously unlearned tasks. In this way, the researchers were able to map the areas of the subject's brain activated by automatic behaviour. That in turn allowed the level of automatic motor activity associated with any subsequent task to be measured on the basis of the correlation with between the brain activity pattern for the relevant task and the subject's automatic behaviour reference map.

Brain activity was triggered by the following:

1. Subjects were shown videos depicting a young woman (for the 25 to 40-year-olds) or an older man (for the 55 to 70-year-olds) paying for something, either with cash or with a bank card, in three different situations.
2. Subjects were asked to play a game, in which they were given virtual cash only, a virtual debit card only, or both means of payment. They then had to make purchases at shops that accepted only cash, only cards or both cash and cards (figure 13). In some cases, the subject was told about the shop's payment policy immediately, while in other cases the information was not made available until a few seconds after getting to the shop. The delay was introduced to create payment uncertainty, which was considered important in relation to the motives for always wanting to carry cash (as observed in the virtual-reality study). When the subject came to pay, he or she could do one of three things: 1) pay using

Figure 13 Information screen for active participants



his/her preferred payment method, where possible; 2) pay cash or by card, that being the only means of payment he/she was carrying; or 3) abort the transaction without paying, because he/she was not carrying the only means of payment accepted by the shop.

6.3.4 Results of the main study

Emotional differences between the whole groups

When the subjects watch videos of cash transactions, on balance they experience more positive emotions than when they watch videos of card transactions. The spider's web graph as presented in figure 14 shows that card use has a stronger effect on the attention systems and on the indicators of the activity's novelty or surprise level. The value perception of a card transaction is somewhat lower than that of a cash transaction, but trust in the transaction is higher. Familiarity with cash is greater and, because coins and banknotes prominently state their value, both the perceived (transaction) value and the expectation level associated with cash are higher.

The emotional and motor responses of all subjects collectively are illustrated in the graphs in figure 15 and 16. Distinction is made between active payment (in the game) and passive payment (watching video clips). The results show a consistent pattern.

Figure 14 Web graph with values on 13 brain structures

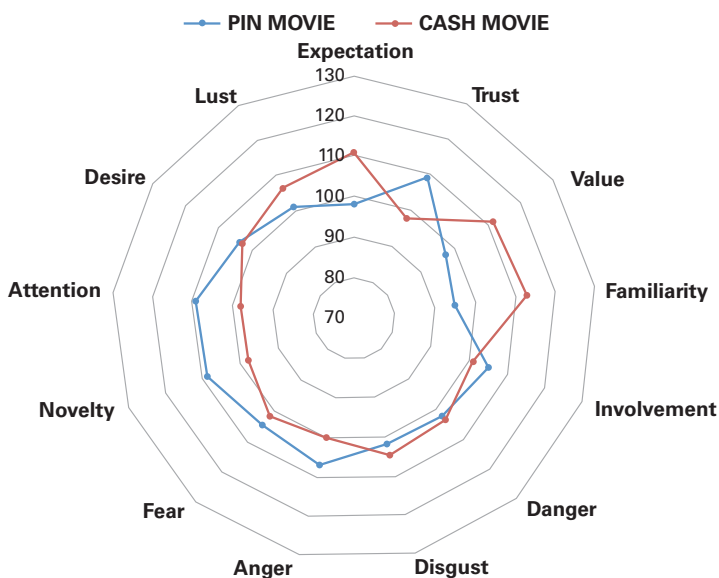
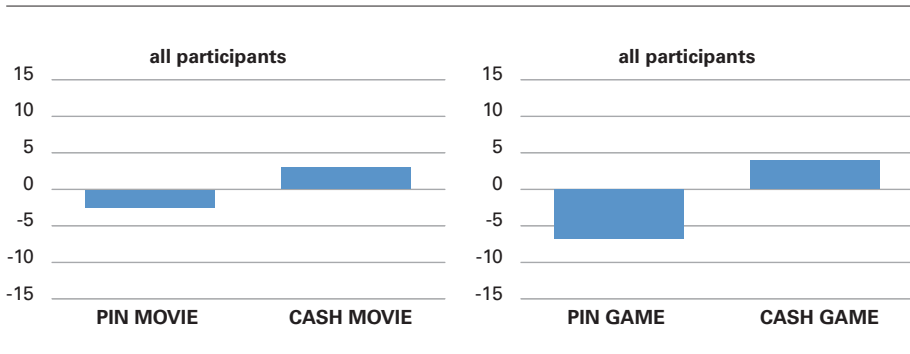


Figure 15 Positive - negative balance on emotions



Weighing the positive responses (lust, desire, trust, value) against the negative responses (fear, anger, disgust, danger) yields a positive-negative balance. As the graph shows, cash payments yield a positive balance, while card transactions yield a negative balance, regardless of whether the subject makes the payments or merely watches a video of the payments.

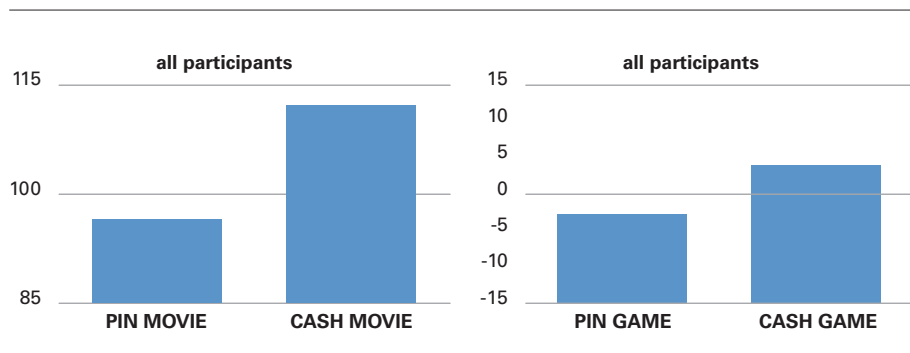
The latter finding is out of step with the pilot study, in which card transactions yielded a more favourable balance. In the main study, the subjects were told at the outset that the study was concerned with payment behaviour. Because subjects were given instructions and asked to practise relevant game tasks, thus making the payments more relevant to them, the experimental manipulation may have shifted the emotional preference exhibited during passive viewing from debit cards to cash: when we ourselves have to pay, we also perceive cash payments that we view more positively than debit card transactions that we view.

Motor activity differences between the whole groups

The motor activity associated with observing and performing cash or card payments was compared with the activity observed when subjects undertook familiar, internalised activities. The motor activity index for card payments was less than 100, indicating that paying by card was more of a novel motor behaviour than a learned, automatic behaviour.

Stronger automatic behavioural responses were triggered when the subjects watched or made cash payments than when they watched or made card payments; using cash may therefore be regarded as a more habitual activity than using a card. That would seem logical, since formation of the neural networks associated with cash payment is likely to have begun in childhood, when the subjects first started spending their pocket money. The degree of habitualness is less pronounced when the subjects make payment themselves than when they observe payments being made.

Figure 16 Automaticity



Age effects

No general generation effect was observed. Not all older people have a strong emotional or motor preference for paying in cash or by card as can be seen in figures 17 and 18.

Older cash users tend to be more *emotionally* engaged by cash, while older card users are more emotionally neutral, and more inclined to operate on automatic pilot. However, the strength of the emotional preference for cash seen in older cash users may be due to the subjects merely happening to have a strong innate emotional leaning towards cash. Possibly the prolonged experience that older people have with their preferred payment method makes them habitually and emotionally inclined towards that payment method.

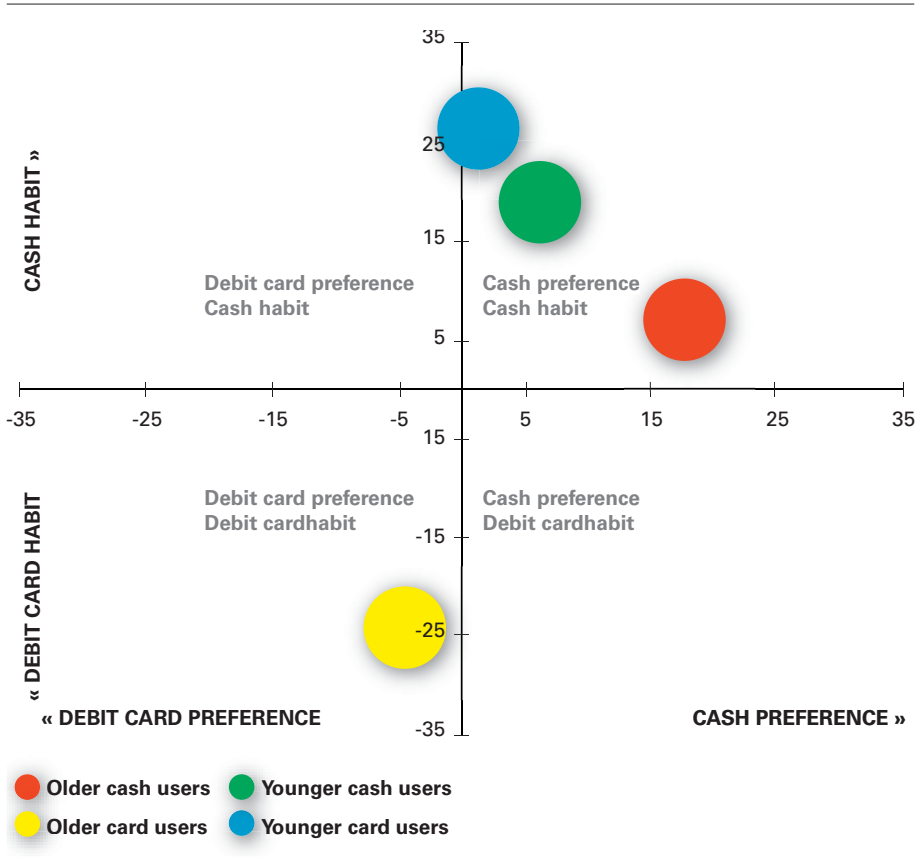
Young cash users also have a stronger emotional bond with cash. Young card users are emotionally more neutral in their payment method preference. Because the differences in emotional response observed in young subjects are relatively small, it is doubtful that they will ultimately become as marked as those observed in the older subjects. As people who are more familiar with debit cards get older, this group may contract. If that were to happen, one could legitimately say that a generation effect was at work.

Young people have a stronger motor response to cash than to card use; stronger, even, than that seen in older cash users. Young card users, who are known to make fewer cash payments, appear to have an unconscious wish to spend cash if they have it with them. That is striking, because subjects in the young card user group are people who have indicated that, in reality, they pay mainly by card. Perhaps the subjects in question have a more conscious approach to using cash. They may try to avoid carrying cash and, when they do carry it, they may suppress the urge to spend it, so as to retain enough for when they really need it.

Cash as a backup

All groups display economic rationalism, except for the older cash users (figure 18). In this context, economic rationalism implies preferring to have both cash and a card to having only one or the other (more available payment options being advantageous). The fact that older cash users do not display economic rationalism may be a response to 'option stress'. Older people who usually pay cash may prefer not to have to make payment method decisions. They would rather carry only a debit card, than carry both card and cash and have to choose between them.

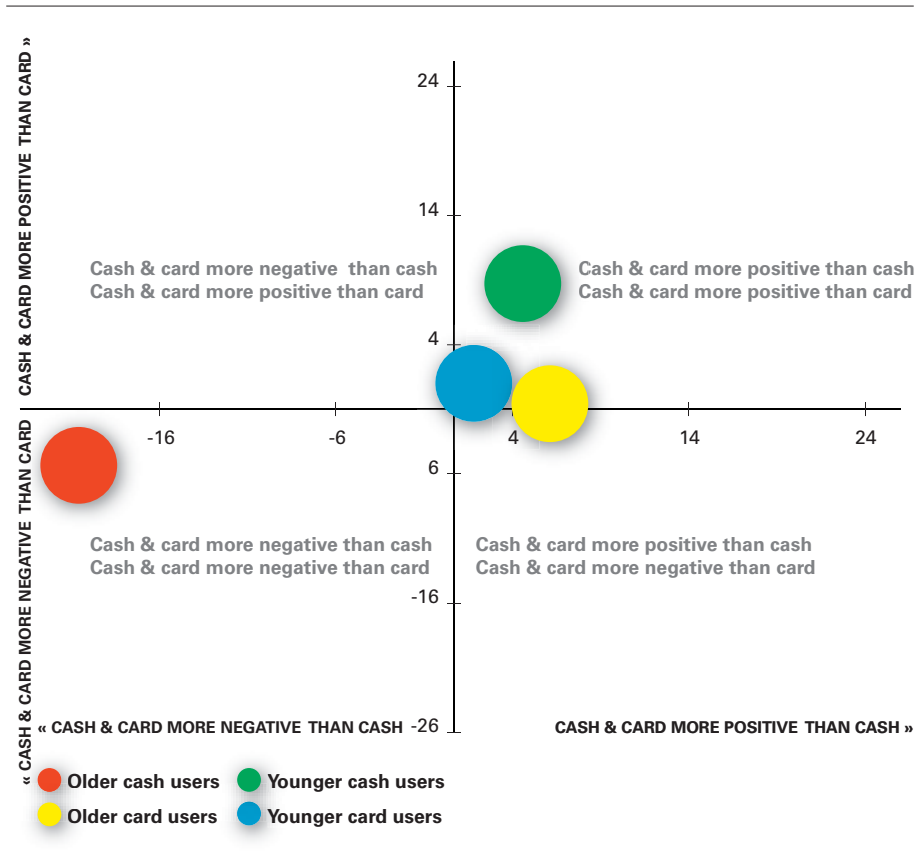
Figure 17 Payment method preference and habit



The responses of the various subject groups may be summarised as follows:

| | |
|------------------|---|
| Young cash users | - On balance, response to cash payments is positive |
| | - Paying cash is habitual |
| | - Fear and disgust only for debit cards |
| Young card users | - Emotionally more neutral |
| | - Paying cash is habitual |
| Old cash users | - On balance, response to cash payments is positive |
| | - Paying cash is habitual |
| | - Option stress associated with debit cards & cash |
| Old card users | - On balance, response to card payments is positive |
| | - Paying by card is habitual |

Figure 18 Preference of carrying payment methods



Influencing behaviour

Behaviour is best influenced by addressing each target group separately. For example, the research has shown that young people are more susceptible to mirroring and therefore more easily influenced by advertising videos that include payment activity. Older people do not internalise behaviours learned by social exposure; they must use a card personally before the behaviour is internalised. Persuading them to use cards is likely to require a more explicit appeal. Communication may be expected to have more effect if the simplicity and agreeableness of the activity are emphasised.

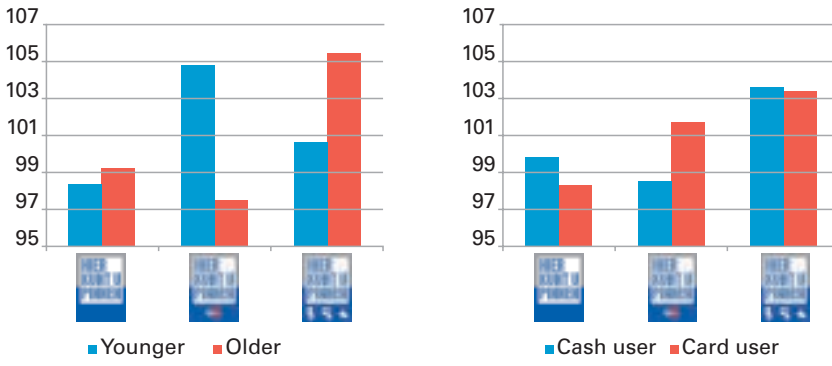
Three information posters were tested to determine their ability to activate subjects' openness to motor action: 1) a poster with the basic message only, 2) a poster also showing the European Maestro logo and 3) a poster also showing three icons that guide the viewer through the payment process without inducing motor stress and that emphasise the convenience of card payment.

Young people respond strongly to the Maestro logo, whereas older people do not. Older people respond strongly to the icons depicting the payment activity. The Maestro logo is a visible appeal to the experience that frequent debit card users have. Regardless of experience, the icons depicting the payment process have the strongest activating effect.

Figure 19 Three variants of a poster indicating that debit cards are welcome



Figure 20



7 Conclusions

Payment method choice is unconscious

The main conclusion to be drawn from the literature and the two studies commissioned by DNB is that paying in cash or by card is not the outcome of a conscious choice, but is largely habitual and therefore difficult to influence. Even manipulations such as budgetary constraint, the need to walk in the dark or a surcharge for card use can explain no more than 20% of the variation in the use of cash.

People usually act before they know why. The more primitive part of our brains, which mainly processes our emotions, is more powerful and faster than the part of our brain that evolved more recently, which we use for things such as reflection and planning. Decision-making is more of an emotional process than a cognitive process. DNB therefore commissioned a study in which neuroscientific tests were used to investigate emotional preferences for using cards or cash. The approach had not previously been used to study payment behaviour, and provides new insights based on the direct measurements of brain activity. It is important to bear in mind, however, that brain scans do not provide images of our emotions, but of magnetic responses, which require considerable extrapolation and interpretation.

Cash is associated with more positive emotions and automatic behaviour

On balance, paying by cash triggers more positive emotions than paying by debit card. The observed emotional engagement is consistent with the finding of the virtual-reality study that people like to have cash with them, even if they are not intending to spend it in the near future. Both debit cards and cash activate automatic behaviour, regardless of whether the subject is making the payment or merely observing it. The inherent preference for cash and the automatic behavioural response associated with watching or simulating cash payments, may well explain why the majority of checkout transactions in the Netherlands are made in cash.

Payment method choice influences both purchase values and purchase types

The decision to use a particular payment method is followed by the process of making the payment. According to the literature, that process appears to affect both what people are willing to pay and what they are willing to buy. Cash transactions are more transparent than electronic transactions. The money has to be counted

out and handed over; the payer then has to pay attention to how much change is received, and coins and banknotes prominently state their value. That transparency results in greater ‘pain of paying’, which in turn deters large purchases and impulse buying. It remains unclear, however, why in the neuroscientific study making cash payments was associated with more positive emotions, when in theory such payments induce more payment pain.

Age-related differences in payment preferences and habits

An emotional and motor preference for cash payments over debit card payments was observed in all groups of subjects in the neuroscientific study, except for older people who report paying mainly by debit card. Age-related differences were observed both in preferences and in automatism. Young people – even those who claim to pay mainly by debit card in real life – appear to have a stronger unconscious automatic inclination to pay cash. That inclination must therefore be suppressed by members of the group.

Older people differ in their emotional payment method preferences and habits. Older people who reported paying mainly in cash were found to have a strong emotional preference for cash, and to exhibit stronger habitual behaviour responses to cash. Older people who said that they usually paid by card had a (slight) emotional preference for cards and probably use cards mainly out of habit. In young people, the differences in perceptions of the payment methods are less pronounced.

Is it reasonable to believe that payment habits will change with the cycle of the generations? Will the age groups that currently prefer electronic payment methods continue to use them as they grow older and displace today’s older people, who tend to prefer paying cash? The results of the neuroscientific study do not provide a clear answer: there is no generalised generational effect involving the use of cash or debit cards.

People of both age groups who usually pay by debit card like to carry cash as well as their cards. Young subjects who say that they often pay cash also appear to enjoy having a card in addition to cash. Older people who usually pay cash appear to enjoy having two means of payment less.

8 Discussion

If a central bank's functions is to ensure the smooth flow of payment traffic and it has a role in ensuring that payment transactions are secure, reliable and efficient, further insight into the use of different payment methods is very valuable.

One of a central bank's functions is to increase the efficiency of the payment transactions. At present, the focus tends to be on reducing the social costs. Based on this study one could discuss the need for authorities to take also into account the following when encouraging the usage of a specific means of payment:

- The choice of consumers for a particular means of payment is depending on a variety of implicit respectable motives;
- The transparency of a payment method influences spending behaviour.

Changing payment behaviour is not easy. It is an evolutionary process, especially because payment behaviour is to a large extent habitual. The neuroscientific research indicated that behavioural change is most likely to be realised by measures aimed at particular target groups bearing in mind that the choice for a payment method is not (completely) rational.

Annex I Logistic regression virtual-reality study

Logistic regression is a type of regression analysis used for predicting the chance that a categorical dependent variable happens, using several independent variables. This virtual-reality study contains four dependent variables:

- To take cash to the supermarket
- To take cash to the restaurant
- To use cash in the supermarket
- To use cash in the restaurant.

The table presents the predictors for each of the four dependent variables that cannot be missed to make the best prediction possible for the dependent variable. The 'Wald' statistic, analogous to the t-test in linear regression, is used to assess the significance of coefficients. The Wald statistic is the ratio of the square of the regression coefficient to the square of the standard error of the coefficient and is asymptotically distributed as a chi-square distribution.

The number of stars is an indication for the effect of the individual variable (*= $p < 0,05$, **= $p < 0,01$, ***= $p < 0,001$).

The size of the effect is reflected by the 'B'-parameter, but 'exp(B)' gives a better interpretation. This value shows the powers of changing the odds when a predictor is increased by one step. As an example we use the first and seventh line in the table. 'Constant' reflects the odds if all predictors have value '0'. In that case, according to the seventh line, the odds that a participant takes cash to the restaurant is '4.16 is to 1', which means that there is four times as much chance to take cash to the restaurant than not to take cash. If the predictor 'budget' changes from high to low (coded as 1), the chance that cash is taken to the restaurant increases with 1.38 (exp(B)). This means that the chance goes from 1.38* 4.16= '4.7 is to 1'. If the budget is low, the chance to take cash is almost five times as high as not to take it.

As can be seen from the table the predictor 'gross income' works for all four dependent variables. The higher the gross income, the smaller the chance for carrying or paying with cash, either in the restaurant or in the supermarket. Some predictors, like the prominence of the payment terminal, time pressure, price roundness or gender appear to have no influence at all.

| Dependent variable | Predictors | B | Wald | Exp(B) |
|---------------------------|--------------------------|--------|----------|--------|
| Restaurant: cash carried | Budget | 0.325 | 5.27* | 1.38 |
| | Skim warning | -0.672 | 7.1** | 0.511 |
| | Walk in the dark | -0.839 | 13.32*** | 0.432 |
| | Amount payable | -0.012 | 3.57 | 0.988 |
| | Gross income | -0.047 | 3.67 | 0.945 |
| | Household includes child | 0.791 | 5.3* | 2.2 |
| | Constant | 1.4 | 39.39 | 4.16 |
| Restaurant: cash used | Card surcharge | 0.372 | 3.01 | 1.45 |
| | Promotion of card use | -3.94 | 2.82 | 0.675 |
| | Restaurant first | 0.301 | 5.35* | 1.35 |
| | Amount payable | -0.067 | 124.9*** | 0.935 |
| | Gross income | -0.118 | 14.38*** | 0.889 |
| | Constant | 1.11 | 26.64 | 3.05 |
| Supermarket: cash carried | Walk in the dark | -0.5 | 5.36* | 0.607 |
| | Education | -0.101 | 5.64* | 0.904 |
| | Gross income | -0.052 | 4.12* | 0.949 |
| | Budget | -0.206 | 2.7 | 0.814 |
| | Constant | 1.8 | 59.19 | 6.06 |
| Supermarket: cash used | Card surcharge | 0.361 | 3.37 | 1.43 |
| | Age | 0.01 | 6.33* | 1.01 |
| | Amount payable | -0.162 | 28.6*** | 0.851 |
| | Gross income | -0.118 | 14.38*** | 0.889 |
| | In charge of hh finances | -0.326 | 6.8** | 0.722 |
| | AH versus Aldi | -0.156 | 4.0* | 0.789 |
| | Education | -0.121 | 8.86** | 0.886 |
| | Constant | 1.24 | 13.37 | 3.46 |

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