Paper 3: Evolution of behaviour predicting the adoption of innovations

N. PALS, D.J. LANGLEY (TNO TELECOM),\textsuperscript{15}
J.R. ORTT (DELT TECHNICAL UNIVERSITY)

I. ABSTRACT

People copy each other’s behaviour. From kids playing marbles in the playground to grown ups wearing neckties. As a matter of fact it is very hard to think of behaviour that you did not copy from somebody. The recently developed theory of memetics describes how behaviour evolves whereby some behaviours become more suited to their human environment than other, competing, behaviours. This evolution can occur rapidly within a population creating hypes like particular fashions, Rubic’s cube, SMS, etc.). On the other hand some behaviour persists in a population over a long period (the necktie example). This paper describes the application of memetics to the adoption of innovations. The extent to which a product or service invites copying behaviour might very well be an excellent predictor of the market adoption of that product or service. Memetics was used to develop an instrument called SUMI (Service User Matching Instrument), which predicts the adoption of innovations. The instrument calculates the likelihood that behaviour related to the innovation will be copied by a certain target group. The development of the instrument is described in this paper as well as a number of case studies in which the instrument was applied. Initial results have been obtained in the telecommunications and in the human resources sectors. These results are very encouraging and suggest that this approach may provide good results especially where “major innovations” are concerned, which sometimes lead to completely new behavioural patterns.

II. INTRODUCTION

Predicting the adoption of an innovation in a market has always formed a scientific challenge. Scientists have pursued this challenge, by studying the subject from different disciplinary angles. Sociologists and psychologists have tried to pinpoint the unique characteristics of the first groups of consumers that adopt an innovation (the innovators and the early adopters). Based on such studies they tried to predict the likelihood that an innovation would be adopted by these groups, leading to a critical mass of users in the market. Overviews of these line of research are provided by Robertson (1971), Engel, Blackwell and Miniard (1990), Foxall and Goldsmith (1994) and Rogers (2003). Economists have studied the market conditions that foster innovation (Shumpeter, 1942; Galbraith, 1956; Schmookler 1967; Mansfield, 1968; Kamien & Schwartz, 1975). Consumer researchers measured the reaction of potential customers to product concepts and estimated future demand for the final product (Greenhalgh, 1985; Moore, 1982; Page & Rosenbaum, 1992). A number of methods of using expert opinions have been applied (Armstrong, 2001a; Rowe and Wright, 2001). For example, the Delphi technique aims at consensus between experts on the likely success of an innovation. Several methods of data-analysis and curve-fitting have been applied to predict the adoption of innovations (Armstrong, 2001a). Finally, econometric models have been utilised to predict the sales and market shares of products (Lilien, Kotler & Moerthy, 1992; Leeflang & Naert, 1978; Allen & Fildes, 2001).

\textsuperscript{15} TNO Telecom, PO Box 15000, 9700 CD Groningen, The Netherlands, n.pals@telecom.tno.nl
This paper introduces a new disciplinary angle for approaching the analysis of the adoption of innovations, drawn from the fields of biology and the behavioural sciences. It is based on a theory named memetics, which proposes a mechanism for the evolution of ideas and their associated behaviours. Memetics postulates that ideas and their associated behaviours survive in a population by being copied between people. The theory describes the conditions under which this copying of behaviour is likely to occur. We consider adoption and use of an innovation as a type of behaviour that can be copied. Insights from the theory of memetics are applied to indicate how likely certain types of people are to copy certain types of product-related behaviour. In short, we introduce copying behaviour as a new basis for making forecasts about the market adoption of products and services.

III. DESCRIPTION OF MEMETICS

Memetics is a theory, which proposes a mechanism for the evolution of ideas (Dawkins, 1976; Dennett, 1995; Blackmore, 1999). This also encompasses the behaviours and material artefacts associated with these ideas (Cloak, 1975). Examples are, “Tunes, ideas, catch-phrases, clothes fashions, ways of making pots or of building arches” (Dawkins, 1976). The theory stems, at least in part, from the field of genetics. The evolutionary geneticist, Dawkins, coined the term “meme”, pronounced to rhyme with “theme”, as a unit of cultural inheritance. Memes, it was suggested, are subject to much the same processes driving the evolution of genes. Genes determine to a large extent the physical and behavioural characteristics of organisms, which in turn affect the chances of survival of each organism in its environment. Any genes which (however unwittingly) happen to increase an organism’s chance of survival, will therefore also increase the chance of survival of the genes themselves. The genes, which now dominate the gene pools have clearly proven themselves to be successful in getting themselves passed on in this way. A similar mechanism may be responsible for the evolution of ideas and behaviours. Memetics proposes that behaviours and ideas compete with each other for attention and expression by humans. Whereas genes replicate through the process of sexual reproduction, memes replicate through imitation or copying behaviour (Dawkins, 1976; Blackmore, 1999). The dominant memes of today have clearly proven themselves to be successful at being copied. However, there are differences between the ways genes and memes replicate. Human genes are only passed on from parents to children; a relatively slow process. Memes, on the other hand, disregard biological generations and can replicate themselves rapidly within peer groups or via mass media.

Many authors over the last decade have claimed that memetics can provide an insight into which behaviours or ideas have become successful and why that is so. Plain common sense would suggest that behaviours, such as eating delicious food, become successful because they offer benefit to the person exhibiting the behaviour. One dish may be more delicious than another and therefore offer a relative advantage (c.f. Rogers, 2003) to the consumer. However, memetics would suggest that behaviours become successful because they are more suited to being copied than other (competing) behaviours. Imagine two dishes, one is delicious but has a highly complex recipe, whilst the other is slightly less delicious but has a simple recipe. Memetic thinking may point to this second dish as having the best chance of survival.
Analogous to genetics, for a meme to be successful it must have three general qualities (Dawkins, 1976):
Many copies made of it (fecundity). If many people eat a dish or learn its recipe, then that dish has a good chance of survival. If a recluse devises a delicious new dish, but refuses to tell others about it, then that dish is not likely to become widespread.
Accurate copies made of it (fidelity). If a recipe is altered each time it is passed on to a new person then, within a short space of time, the original dish will not be recognisable; it may have become revolting, very expensive or it may have been replaced by a different dish. If, on the other hand, it is impossible to digress from the original recipe in any way, then the dish cannot adapt (e.g. to changing ideas regarding cholesterol) and may become old-fashioned and obsolete.
The copies should be long-lived (longevity). If people learning a new recipe remember it and cook it for many years, then many others will come into contact with it and its chance of survival is high.

**New Principles applying Memetics to the adoption of products and services**

Based upon the general principles of memetics we have proposed a number of new principles for applying this theory to the forecasting of the market adoption of products and services (Langley et al, 2004).

1. We believe that the behavioural component of the use of products and services, including new product innovations, could also be analysed by applying the theory of memetics. If we are to do this, we will need to assess the capacity a product-related behaviour has to get itself copied in a particular population. An example of a product-related memetic process is the rapid spread, in many developed countries, of the idea of sending short text messages (SMS) from person to person regardless of location. This idea is, of course, intrinsically linked to the act of keying in and sending such messages on the physical artefact of a mobile phone.

2. We believe that a useful approach is to assess the “match” between a product-related behaviour and a person or group of people. This match describes the extent to which the people are stimulated to adopt that behaviour. In order for this to be possible, a relatively homogenous group must be used in the assessment.

3. If a meme is to be suited to a particular group of people, it must combine well with the other memes already resident in their minds (c.f. Blackmore, 1999). We take the set of currently adopted memes to be reflected in the basic personality traits of a person. Therefore, one’s make up in terms of those traits will determine (consciously or subconsciously) which new ideas or behaviours one is likely to adopt.

If we succeed in decomposing innovative concepts into a number of behavioural elements it should be possible to estimate the probability that a person with certain personality traits will copy these behavioural elements and, as a consequence, will adopt the new product. This new method should, in principle, be able to distinguish between the likely adoption of a new product by different target groups.

**IV. Instrument development**

Based on the principles described in the previous chapter, an instrument was developed which is described below (Langley et al, 2004). Basically it analyses the match between a number of product related behaviours and a number of target group characteristics. This instrument, called SUMI (Service-User Matching Instrument), calculates the
likelihood that a target group with certain traits will copy the behaviour associated with a service or product (see Figure 1).

![Figure 1. Basic model of the SUMI instrument. Target groups are described in terms of their personality traits. Products are described in terms of behaviour related to their use.](image)

The process of developing the instrument was started with a literature search looking for product related behaviour as well as personality traits that might influence the copying behaviour of an individual. This resulted in two “long lists” of characteristics, which were reduced in size during a number of discussion sessions with experts. Based on these results an “expert model” was developed in which for each possible combination of characteristic and trait, the likelihood of copying is estimated on a generic level. The process was completed with the development of software that calculates the likelihood that a specific target group will adopt the behaviour related to the use of a specific new product. The phases of the development process are now described in more detail.

1. **Product Characteristics**

A number of authors have described product characteristics which are important for the adoption of a product (e.g. Tholke et al, 1997; Heylighen, 1999; Rogers, 2003). From these sets the characteristics with a possible relation to copying behaviour were selected. If we take “complexity” and “triability” as examples (Rogers, 2003) it seems logical that a high complexity inhibits copying, while on the other hand a high tryability stimulates copying. The result of this selection was a list of 26 product characteristics affecting copying behaviour. These characteristics can be clustered into Dawkins’ (1976) categories: fecundity, fidelity, and longevity (see “Description of memetics”) whereby the most successful behaviours are those that make many (fecundity), accurate (fidelity) and long-lived (longevity) copies of themselves (Dawkins, 1976; Blackmore, 2000). Table I shows examples of these product characteristics.
Table I
Examples of SUMI product characteristics, divided into the three categories fecundity, fidelity and longevity

| Product characteristics related to Fecundity 1 | Product combines well with existing behaviour: |
| Inherent sociability: The extend to which the behaviour is social or forms part of a social event. |
| Etc. |

| Product characteristics related to Fidelity 2 | Ease of use: |
| Visibility: The extend to which the product is easy or difficult to operate |
| Etc. |

| Product characteristics related to Longevity 3 | Stability: |
| The extend to which the behaviour remains constant over time |
| The long term positive effects the behaviour has for individuals (money, time, status, appreciation) |
| Etc. |

1) Fecundity: The number of copies
2) Fidelity: The accuracy of the copies
3) Longevity: The durability of the copies

2. Target group traits
The Bige Five is a widely accepted personality model consisting of 5 personality dimensions, (Ewen, 1998; Norman 1963; Tupes & Christal, 1961). Many researchers agree on the basic influence of these dimensions, although there are a number of different labels in use, including a version based on the acronym, OCEAN, which stands for Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (Digman, 1997). A number of similar approaches have been combined to produce the

Table II
Personality traits used by SUMI

<table>
<thead>
<tr>
<th>SUMI Pairs</th>
<th>Short description of traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovative</td>
<td>Open to new experiences</td>
</tr>
<tr>
<td>Organised</td>
<td>Resistant to new experiences</td>
</tr>
<tr>
<td>Introvert</td>
<td>Very structured</td>
</tr>
<tr>
<td>Introvert</td>
<td>Not structured at all</td>
</tr>
<tr>
<td>Introvert</td>
<td>Internally oriented</td>
</tr>
<tr>
<td>Egoistic</td>
<td>Externally oriented</td>
</tr>
<tr>
<td>Conformist</td>
<td>Inclined to be selfish</td>
</tr>
<tr>
<td>Conformist</td>
<td>Inclined to sacrifice oneself</td>
</tr>
<tr>
<td>Rational</td>
<td>Inclined to chose as the majority does</td>
</tr>
<tr>
<td>Rational</td>
<td>Inclined to chose as the minority does</td>
</tr>
<tr>
<td>Driven</td>
<td>Decisions based on logic and objective criteria</td>
</tr>
<tr>
<td>Driven</td>
<td>Decisions based on subjective criteria</td>
</tr>
<tr>
<td>Driven</td>
<td>Ambitious, sets high goals</td>
</tr>
<tr>
<td>Driven</td>
<td>Unmotivated, reactive, not goal-driven</td>
</tr>
</tbody>
</table>

Abridged Big Five Dimensional Circumplex (Hofstee, et al., 1992; Johnson & Ostendorf, 1993). Some dispute the accuracy of these models which use such a broad-brush approach to something clearly so complex as human personality (e.g. Paunonen, 2001). However, for our purposes these approaches, although not perfect, do appear
applicable, having stood up to rigorous testing over a number of decades. The target
group traits used by SUMI are based on dimensions from a number of these models,
including the Big Five and the Myers-Briggs Type Indicator (Myers, 1962, Hirsh and
Kummerow, 1990). Table II gives an overview of the personality traits that are used by
SUMI.

3. Match between traits and characteristics
The match between personality traits and product characteristics is determined by the
extent to which product related behaviour fits with the personality traits of a person.
This fit determines the likelihood that the person will copy that behaviour. Table III
gives examples of the influence of product features on the chance that a person with a
certain personality trait will copy the behaviour associated with that feature. For
example the first row in the table means that if the product related behaviour is highly
“distinct from existing behaviour”, the likelihood that an “innovative” person (who is
more than average open to new experiences) will copy that behaviour is higher than for
a person who is average with respect to new experiences.

Table III
Examples of how the personality traits match with product characteristics to influence the likelihood that
the behaviour will be copied

<table>
<thead>
<tr>
<th>If a person is ….</th>
<th>And the product is/has ..</th>
<th>Then the likelihood of copying behaviour, compared to people who are neutral with respect to those traits, is relatively ..</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovative</td>
<td>High distinctiveness</td>
<td>High</td>
</tr>
<tr>
<td>Extravert</td>
<td>Inherently sociable</td>
<td>High</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>Low ease of use</td>
<td>Low</td>
</tr>
<tr>
<td>Organised</td>
<td>Low visibility</td>
<td>High</td>
</tr>
<tr>
<td>Conservative</td>
<td>Low stability</td>
<td>Low</td>
</tr>
<tr>
<td>Egoistic</td>
<td>Positive effect on individual</td>
<td>High</td>
</tr>
</tbody>
</table>

The SUMI instrument contains an “expert model”, which makes generic estimations of
all possible combinations of which Table IV gives a few examples, i.e. the effect that a
certain product characteristic has on the chance that an individual possessing certain
traits will copy the behaviour associated with the product, compared to others who are
neutral with respect to those traits. For each of the possible combinations of product
characteristics and personality traits, the following question was asked to a number of
experts: “What is, in general, the effect of characteristic x, on the chance that a person
with trait y, will copy the behaviour associated with the use of the product, compared to
others who are neutral with respect to those traits”. This expert model is generic and
can be applied to a broad range of combinations of products and target groups. To apply
the instrument to a specific product – target group combination, the specific
characteristics of both product and target group have to be assessed by people with
sufficient knowledge of the product on the one hand, and by people with sufficient
knowledge of the target group on the other hand. The characteristics are scored on Likert type scales. The expert model calculates a total “match score” for the product –
target group combination, indicating the expected adoption of the product by this target
group. The instrument also generates match scores for every individual product
characteristic (See Figure 2).
Figure 2 is an example of the detailed results of a SUMI analysis. On the horizontal axis are the 26 product characteristics. On the vertical axis are the SUMI match scores. The dotted line is a measure of the “sensitivity” of the target group for each product characteristic. The bars are the match scores for each product characteristic – target group combination. The distance between the top of a bar and the target group sensitivity line indicates that improvements to the product for that product characteristic will have a positive effect on the likely adoption of that product by the target group in question. The kind of output in Fig 2 can be used for detailed analysis. The product characteristics where target group sensitivity is high and the match is low (circled areas) represent the best possibilities for improvement.

4. The process of using SUMI
The process of a SUMI analysis consists of four steps. These steps now are illustrated, using the adoption of SMS by trendy adolescents as an example
1. The process starts with a series of interviews during which as much information as possible is gathered about the service and about the envisaged target group. People to talk with during this stage are product developers, product managers, marketing directors, marketers, etc. Emphasis is on factual information (e.g. the market segmentation methods which are used, target group descriptions, etc.).
2. During the next phase this information is translated into the characteristics and traits used by the SUMI instrument and quantified. Looking at text messaging (SMS), for example, we see high scores on visibility and low scores on ease of use. A few traits of the target group, trendy adolescents, are: innovative, spontaneous, egoistic and emotional. In most cases a number of variants of a product are analysed for three or four target groups.
3. In the next phase of the analysis the product and target group scores are fed into the instrument and the SUMI match results are calculated and analysed.
4. The process is concluded with a workshop with stakeholders, during which the results are presented and discussed. Discussion is often focused on those product characteristics where target group sensitivity is high and the match is low (circled areas) represent the best possibilities for improvement.
characteristics that are important to the target group(s) and on possibilities to improve the product if results show a poor match for those characteristics.

V. CASE STUDIES

Until now SUMI has been applied to 57 product / target group combinations for which we have information about the actual the market adoption. This information is either based on quantitative market figures or on qualitative observed success in the market. Most cases came from the telecommunications services.

Table IV shows the scores of the SUMI predictions for these 57 product / target group combinations. The SUMI match scores, which provide a relative indication of likely adoption, vary between -11 and 62. We clustered the results into three categories depending on the actual market adoption: failures, moderate successes and successes. For each of these three columns the average and standard deviation are given.

Table IV
SUMI scores for the 57 analysed product target group combinations, divided into three categories of actual market adoption. Services are displayed anonymously.

<table>
<thead>
<tr>
<th>Failure</th>
<th>Moderate</th>
<th>Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>25</td>
<td>47</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
<td>62</td>
</tr>
<tr>
<td>-4</td>
<td>14</td>
<td>55</td>
</tr>
<tr>
<td>14</td>
<td>24</td>
<td>46</td>
</tr>
<tr>
<td>20</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>10</td>
<td>-3</td>
<td>55</td>
</tr>
<tr>
<td>7</td>
<td>-11</td>
<td>59</td>
</tr>
<tr>
<td>19</td>
<td>7</td>
<td>45</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>47</td>
</tr>
<tr>
<td>15</td>
<td>22</td>
<td>46</td>
</tr>
<tr>
<td>9</td>
<td>21</td>
<td>46</td>
</tr>
<tr>
<td>22</td>
<td>24</td>
<td>39</td>
</tr>
<tr>
<td>9</td>
<td>18</td>
<td>54</td>
</tr>
<tr>
<td>-1</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>-9</td>
<td>12</td>
<td>41</td>
</tr>
<tr>
<td>7</td>
<td>18</td>
<td>48</td>
</tr>
<tr>
<td>17</td>
<td>18</td>
<td>58</td>
</tr>
<tr>
<td>18</td>
<td>27</td>
<td>54</td>
</tr>
<tr>
<td>17</td>
<td>21</td>
<td>51</td>
</tr>
</tbody>
</table>

Average 11.5 16.6 48.1
Std. Dev. 8.64 9.77 8.70

A One-Way Anova was used for an analysis of variance of the three means, which showed that there is a significant difference between the three means (p≤0.001). After having determined that differences exist between the means, a number of post hoc range tests and pair wise multiple comparisons were used to determine which means differ. None of these tests indicated a significant difference between failures and moderate successes, while the difference with successes were in all cases significant.

The average SUMI scores and the standard deviations are also depicted in figure 3, which is a graphic representation of the data from table IV. It is clear that the SUMI scores of the successful services differ significantly from the moderate successes. The difference between failures and moderate successes is less clear.
The small difference between failure and moderate success is probably due to the (lack of) criteria for these categories. In the moderate success category are a number of services which also could be qualified as “not a complete failure”. A clearer definition of what a moderate success is, compared to a success is needed. The results of these cases are a first step in the validation of the instrument. They are promising and suggest that the new approach embodied by SUMI can predict market adoption reasonably accurately.

VI. CONCLUSIONS AND DISCUSSION

This paper shows that memetics, a theory of how behaviour is copied and therefore spread throughout a population, appears to lend itself to predicting the adoption of innovations. It does this without resorting to people’s judgements about the future and without relying on past data about other (product related) behaviours.

This approach has a number of unique features. The most important one is that it makes it possible to predict adoption processes that imply completely new behavioural patterns, as is the case in major innovations. Existing methods have difficulties in these cases because the extrapolation of existing behaviour or data is not possible. Using the memetics approach we can bypass the discussion about whether, or how, existing market behaviour is likely to change by simply addressing the question of whether or not a new behaviour (meme) is suited of being adopted by a certain type of person.

Another unique feature of this approach is that it can also be applied very early in the development process. It is possible to make predictions during the concept phase of the development of a product. Of course the predictions are more accurate if the product descriptions are more precise.
The first attempt to validate an instrument, SUMI, based on this theory, compared adoption predictions for a number of products and services to market data. The results are encouraging and suggest that SUMI predictions are reasonably accurate indicators of market potential. Besides making predictions about the market potential the instrument is also useful in making a selection from a number of alternative product concepts. Furthermore it can help in the selection of the most suitable target group and it provides focus for improvement of the product design.

The cases described in this paper come from the Telecom industry and it appears that SUMI is broadly applicable in this sector. We speculate that SUMI will also be applicable in the closely related industry of consumer electronics, as well as other sectors with a high pace of innovation, which directly induces novel consumer behaviour, such as the financial, employment services and fast-moving consumer goods sectors. This is, as yet, speculation and validating case studies in a range of sectors is a priority for further research.

We believe that the approach described in this paper provides a valuable addition to the range of existing methods of forecasting innovations. We call on the scientific community to join us in further exploring its possibilities.

VII. References

Dawkins, R. (1976), The selfish gene, Oxford University Press.
Leeflang, P. and Naert, P. (1978), Building implementable marketing models, Nijhoff Social Sciences Division, Leiden/Boston.
Tupes, E. and Christal, R. (1961), “Recruat Personality Factors Based on Trait Ratings” (ASD-TR-61-97), Aeronautical Systems Division, Personnel Laboratory, Lackland Air Force Base, TX.
Presentation 3:

Memetics: a new theory on copying behaviour

“I don’t know why. I just suddenly felt like calling.”

Source: The New Yorker, July 3, 2000

Genetic principles applied to behaviour

- Memes are the behavioural equivalent of genes
- Memes are successful if:
  - Many copies are made (fecundity)
  - Accurate copies are made (fidelity)
  - Long lived copies are made (longevity)
SUMI: a new instrument based on memetics

Target group traits → Product characteristics

Match (probability of copying)

Likelihood of adoption

SUMI algorithm

Target group characteristics

<table>
<thead>
<tr>
<th></th>
<th>d1</th>
<th>d2</th>
<th>d3</th>
<th>d4</th>
<th>d5</th>
<th>d6</th>
</tr>
</thead>
<tbody>
<tr>
<td>p1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Product characteristics

What is the influence of p2 on the chance that a d3 person:
- Will make copies
- Will make accurate copies
- Will continue to make copies
SUMI results - details

**Match Score**

Innovation X – Target group Y

**Bars**: match between innovation and target group

**Product characteristics**

**Line**: describes the target group.

**Gaps**: focus for improvement

SUMI: validation of the instrument

- Tested for 57 product / target group combinations
- SUMI predictions were compared to market results
- **Three categories**:
  - Failure
  - Moderate success
  - Success
- **Significant differences between categories**

SESSION 6: IMPORTING IDEAS
Conclusions

- Memetics approach is useful to predict the adoption of innovations
- This approach is especially useful if major innovations are concerned
- The SUMI instrument provides quite accurate predictions
- SUMI can also be used to select target groups and to improve product design and market proposition