



NW

Programme Cognition

Final evaluation

NWO Programme Cognition

Final evaluation

The Hague, December 2010
Netherlands Organisation for Scientific Research



Fruits of Enlightenment

Detailed information on the programme is presented in a accompanying document entitled 'Evaluation Addenda'. In this report references are made to these addenda.

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Introduction - The programme in short

Background and origin of the programme

In the past sixty years, cognition has become accessible to systematic, conceptual, computer and experimental analysis. A basic understanding of the relations between structure, storage and acquisition of knowledge, neural function, behaviour and communication appears to be within reach. Communication and cooperation between the most immediately relevant scientific disciplines - including, among others, neuroscience, biology, linguistics, psychology, artificial intelligence - are crucial.

In 1997 a national advisory committee, the OCV Verkenningscommissie Cognitiewetenschappen, reported to the Minister of Education, Culture and Science on the state of the cognitive sciences in The Netherlands. In their report *'De kennisraffinaderij: De cognitiewetenschappen in Nederland'* the following recommendations were made by this committee:

- the establishment of a national research facility for neurocognition;
- the stimulation of research, especially in the areas of knowledge transfer, education, work and organization, and the quality of life;
- the launching of a special program to support basic research in the cognitive sciences;
- the institution of an advisory council for the cognitive sciences within NWO.

This report effectively triggered several important initiatives. In the first place the decision was reached to establish the much needed national neurocognitive research facility recommended by the OCV advisory committee. The F. C. Donders Center in Nijmegen opened its gates in the fall of 2000. Secondly, a project dealing with some features of knowledge transfer was launched under the name *ToKen2000*. The follow-up on the third recommendation of the advisory committee came about when NWO revealed its plans for the period 2000-2004. NWO assigned highest priorities to the cognitive sciences and to biomolecular informatics. Subsequently, the NWO Governing Board decided to launch a Special Program for the Cognitive Sciences. In May 2000 the Board instituted a programme preparation committee to draft a plan for such a programme (see addendum x for the

composition of this committee).

Fruits of Enlightenment

The programme preparation committee published the programme brochure 'Fruits of Enlightenment' in February 2001 (see addendum x). This brochure provided the outlines for the realisation of the programme Cognition, which started in the fall of 2001 by issuing the First Call for Proposals for Research Projects.

Main objectives

In 'Fruits of Enlightenment' the programme preparation committee identified the following goals for the programme:

- Strengthening the theoretical and empirical foundations of the cognitive sciences,
- Strengthening the cross-disciplinary coherence between the cognitive sciences,
- Contributing to the national coherence of the cognitive sciences,
- Establishing a solid level of public acceptance and support for the cognitive sciences.

These goals were specified by the programme committee in the following six objectives:

- Stimulating research on new cognitive interface themes; to encourage new research areas and new scientific communities;
- Stimulating the application of knowledge resulting from cognitive science in applied projects;
- Strengthening the methodological foundations of the cognitive sciences, and contributing to their coherence as an active intellectual community;
- Supporting integrative cognitive science education programmes;
- Broadening public support for cognitive science research and its applications;
- Establishing cognitive science institutionally, within NWO, universities, and elsewhere.

Thematic focus within the programme

In order to ensure sufficient focus for the programme in its entirety, four

major areas were defined that are receptive to advanced multi-disciplinary research, based on the following objectives:

– *Neuron to cognition*

At present the most noticeable trend in the cognitive sciences is the emergence of cognitive neuroscience. Recent advances in experimental techniques present unprecedented opportunities for studying the whole gamut of cognitive functioning, from individual signals at the neural level to the complex behaviors of the entire organism. Progress in this domain requires the development of formal models of cognitive functioning that are not only neuroscientifically grounded but also behaviorally relevant.

– *Unconscious and planned behaviour*

Action control is a central issue in the cognitive sciences. While some cognitive activity takes place under deliberate control, many behaviors, simple and complex, appear to be 'automatic' or 'unconscious'. Understanding how smooth adaptive behavior comes about requires a thorough structural analysis of the (natural and social) context in which that behavior takes place. This raises the problem of formally describing such behavior in terms of computational theories.

– *Communication and cognition in social context*

Human cognition evolved as a consequence of the social reality of human existence. In the process a number of communicative tools emerged, of which language is the most extraordinary example. These culturally determined tools serve to overcome the limitations of the individual brain by enabling the complex exchange of information between the individuals in a group. Research on the biological, psychological and social determinants of socially shared cognition, is of fundamental importance for understanding how a community can share a common view of reality.

– *Organisation and accessibility of knowledge*

Two major achievements in the ways we can organize and handle knowledge have been the development of a theory of computation and complexity on the one hand, and that of the theories of learnability and proof on the other. Together these would seem to provide the mathematical vehicle for the cognitive sciences. The major challenge for the near future is to determine how the two hang together as steps on the way towards a general theory of learning and memory.

A detailed description of these four thematic areas is presented in the programme brochure 'Fruits of Enlightenment'.

Activities and funding instruments

During the start-up phase of the programme an action plan was defined in which the objectives of the Cognition programme were linked to different types of funding instruments and different types of activities to be executed (see table 1).

Table 1: Objectives, funding instruments/activities, and budget

	Objectives	Action line	Activity / funding instrument	Total (M€)
1	Interdisciplinary collaboration Integration from molecular to environmental level, theory and methodology Application	Research	1st Call for Proposals for research programmes 2001 Call for Preparatory Projects 2002 Final Call for Integrated Research projects 2003 Call for Application-Oriented Cognitive Research Projects (from 2004) Call for Cognitive Science Pilot Projects (2007)	10
2	Community building	Forum	Strategic scientific symposia Advanced studies groups Network Grants for other network activities	0,6
3	Education	Education	Integration Grants (for interdisciplinary educative activities)	0,3
4	Public support within policy/politics, societal institutions and general public	Dissemination to public	non-scientific seminars, open seminars for specific target groups (teachers, industrial researchers) A la Carte Grants (activities directed at the general public)	0,5
5	Community building	Dissemination within research community	Electronic news letter Programme website Website cognitie.nl	0,2
6	International collaboration	International collaboration	EUROCORES CNCC	0,2

7	Programme management	Management costs and programme coordinator	0,9
	total		12,7

Organisation and management

Management and control

The Cognition programme was jointly funded by the Ministry of Education, Culture and Science, the Governing Board of NWO, the NWO divisions Earth and Life Sciences, Exact Sciences, Humanities, Social and Behavioural Sciences and Medical Sciences, the Technology Foundation STW and ZonMW. The total budget amounted to 12.7 M€. This budget was used for funding research, stimulating interdisciplinary education and dissemination, international collaboration and programme management. The allocation of the budget is presented in table 1.

The management of the programme was structured according to the NWO guidelines for thematic programmes, i.e. a programme committee and a steering committee. The programme committee was formed by representatives of the Dutch research community with backgrounds in psychology, ethology, psychiatry, philosophy, neuroscience, artificial intelligence etc. (see addendum 5.1). The committee is responsible for the scientific content and quality of the programme, and should aim to reach the goals set out at the start of the programme. The programme committee advises the steering committee.

The steering committee was formed by scientific and societal representatives of the Cognition & Behaviour theme, and was chaired by an independent chairman (see addendum 5.2). The steering committee has a controlling and deciding function. At the start of the programme, their tasks and responsibilities were defined in a job description (see addendum 3). Both committees were assisted by a NWO programme manager. A programme coordinator was appointed for the duration of the programme to stimulate (inter)national forum activities, dissemination in the broadest possible sense, public support for the cognitive sciences and internal coherence of the research field. Administrative support and financial control were supplied by the Earth and Life Sciences Division (ALW) of NWO. Yearly progress reports were asked for of the project coordinators. The programme started in 2001. The last two projects will end in spring 2011.

Selection of research proposals

Eight separate Calls for Proposals were communicated to all Dutch universities and research institutes. Full proposals were assessed by international referees. After ranking of these proposals by the programme committee (until 2004) or the review panel (from 2004), the steering committee decided on funding. Funding was possible for research projects, for advanced studies, for pilot projects, preparatory grants, network grants, integration grants and *à la carte* grants. More detailed information is presented in addendum 5.

Within the programme 346 proposals were submitted, of which 120 were selected for funding (see addendum 5). 21 Research projects were granted, as well as 36 grants for preparatory activities and 63 grants aimed at meetings, events and education. More information on Calls and the corresponding figures is presented in addendum 5. The content of the research projects and other grants is specified in addendum 7.

Follow-up of the programme Cognition

To ensure a continuation of the activities promoted by the Cognition programme it was evident that follow-up activities should be initiated long before the completion of this programme. In addition various Dutch universities had made considerable investments in brain and cognitive research in these years, and also the exchange between researchers from the brain and cognition disciplines was considerably strengthened, due in part to the Cognition programme. The Dutch research landscape seemed ripe for an approach which would bridge the gaps between the molecule and the complete organism (human and animal), and between gene and behaviour. Most brain and cognition researchers supported this move to bridge gaps in our understanding of fundamental mechanisms that underlie processes in brain and cognition.

In October 2005 the NWO councils ALW, GW, MaGW and ZonMW took the initiative to explore the possibilities for follow-up activities within the neuro- and cognitive sciences. The ambition was to obtain funding for a new curiosity-driven research programme as well as for research programmes addressing important societal issues like education, health and communication. In 2006 the task force Brain & Cognition, chaired by Dr. J. Terlouw, explored in collaboration with the national research field the

thematic topics for such programmes and at the same time investigated the interest of societal, governmental and business partners for these developments. The task force published their results in the brochure 'Contours of the National Initiative on Brain & Cognition: Mind the Brain'.

Subsequently the four NWO councils implemented a new bottom-up research programme entitled 'Brain & Cognition: an integrated approach'. This programme strongly promotes integrative brain and cognition research. Within this framework, four specific goals were set:

- Stimulation of excellent research;
- Formation of (inter)national interdisciplinary networks;
- Interdisciplinary education of high-potential junior investigators;
- Contribution to new insights into neural substrates of human cognition.

This programme started with a first Call for Joint-Forces Networks in 2007 and has a budget of 7,5 M€.

The clear interest of governmental, societal and business partners in the brain and cognition field resulted in collaboration with six Dutch ministries leading to a joint proposal for the Fonds Economische Structuurversterking (FES), a Dutch governmental funding opportunity for research aimed at societal innovation. In 2009 the resulting FES programme 'Brain & Cognition: societal innovation in health care, education and social safety' was granted 20M€ for a period of five years. This programme brings together national research partners from various disciplines, as well as a wide variety of societal and business partners. Simultaneously, this meant the realisation of the Dutch National Initiative Brain & Cognition.

This major Dutch umbrella programme, placed at the interface of science and society, aims to use cutting-edge science to study the human brain and its role in our social behaviour. The ultimate goal is to use that knowledge to improve people's quality of life and society as a whole. The Initiative brings together scientific and societal partners to address questions relating to cognition and behaviour. The Initiative is financed by the Netherlands Organisation for Scientific Research (NWO) together with the Dutch Departments of Education, Culture and Science, Health, Welfare and Sport, Justice, Defence, Interior and Kingdom Relations and Youth. The Netherlands

Organisation for Scientific Research (NWO) supports and coordinates this National Initiative.

Evaluation of the programme

A half-term self-evaluation by the programme and steering committee was planned and executed in 2004. This evaluation resulted in a number of recommendations (see addendum 4). The programme and steering committee took these recommendations seriously and decided to implement the recommendations in the second half of the programme. For instance, the implementation of the Preparatory Grant format was advocated in two other interdisciplinary programmes, and several adjustments to mandates of programme and steering committee were put in place. Furthermore, the transparency of the assessment procedure was enhanced by effectuating the NWO Code of Conduct on Conflicts of Interest.

The NWO programme Cognition, which started in the spring of 2001, is now completed and according to standard NWO procedure a final evaluation was carried out. The results thereof can be found in this report.

Evaluation criteria and questions

The evaluation criteria have been set at the start of the programme. The evaluation is based on the objectives of the programme as defined in the programme's brochure 'Fruits of Enlightenment', and the practical implementation of these plans by the programme committee (see page xx). A questionnaire on the main standard NWO evaluation topics provided guidance for the evaluation process (see addendum x).

Evaluation procedure

The evaluation consisted of a self-evaluation by the programme committee in which they formulated their conclusions and suggestions for future activities. Subsequently, the steering committee formulated its conclusions and recommendations. Finally, the process was completed through an evaluation by the international evaluation committee (see table 2). This independent committee expressed their opinion of the programme and its results, and presented a forward look for this interdisciplinary research field. The evaluation by all committees was based on their own experience and the background information presented in the Appendices. The combined reports will be presented to the NWO divisions involved, the Governing Board of NWO, and the Ministry of Education, Culture and Science.



The great sleep experiment

2. Evaluation report by the external evaluation committee

Utrecht, November 25, 2010

1. Summary and recommendations

1.1 The evaluation committee is of opinion that the programme achieved its main objectives.

The programme resulted in some very high-quality research in the cognitive sciences, meeting international standards in all respects. The highlights listed in general journals such as *Nature* and *Science* are good examples of the high quality of research, but significant results were also published in specialised journals such as *Cognition*, the major interdisciplinary journal for psycholinguistics in cognitive science. The committee recognizes the work from the projects 'Conflicts in language

interpretation' (of Prof. Hendriks) and 'Reasoning and the brain' (of Dr Geurts) to be prime samples of the high quality and innovative character of the research carried on in the Cognition programme. Unfortunately, application-oriented research could not be realized to the extent originally foreseen due to the use of a - for this field - inadequate selection mechanism (the STW procedure).

- 1.2 Much of the research accomplished in this field of Cognition would not have been possible without this NWO programme; this is especially so for the integrative interdisciplinary projects, innovatively prepared through the instrument of 'preparatory grants' and for the cutting-edge high risk research that was funded by the pilot grants.

The support of summer schools proved to be a very fruitful initiative in that it ensured interaction between young scientists from different disciplines.

The overall programme, and also the striking public events such as 'The great sleep experiment' and 'Illusio', have created considerable awareness among a wide public about cognitive sciences and their importance.

- 1.3 The evaluation committee was impressed very positively by the enthusiastic atmosphere prevailing among the researchers, as experienced at the final symposium, and also within the two managerial committees (programme committee and steering committee).

- 1.4 The evaluation committee noted that, as anticipated, much of the focus of the programme Cognition was on interactions between behavioural and brain sciences, whereas interactions with social sciences and humanities played a relatively minor role (e.g., linguistics, philosophy). While this conforms to a broad international trend it should be realized that the field of cognition spans more than just the brain/behaviour dimension. While interdisciplinarity is essential to the programme, it should be realized that the cognitive dimension is essential if researchers are to pose appropriate questions and to define fruitful approaches in the future.

- 1.5 The management of the programme was excellent. The evaluation committee recognizes that the management of the programme encountered a number of difficulties during the first phase, which led to the first programme committee stepping down, but the programme went on to resolve these problems with considerable success.

1.6 All in all the committee congratulates the Netherlands research community and NWO for this foresighted programme and its general the outcome. Given that interdisciplinary research is still difficult to fund through disciplinary programmes, and also that during the course of the Cognition programme, a new national Netherlands initiative 'Brain and Cognition' started with an emphasis on brain research, the evaluation committee advises the NWO to continue the programme on Cognition with emphasis on all approaches to cognitive functioning. Where appropriate, the 'preparatory grant' mechanism should be used as a tool to foster interdisciplinarity,

2. Objectives

Generally speaking the programme achieved its main objectives. The programme stimulated research on new cognitive interface themes. In this respect, the 'preparatory grants' and 'pilot grants' proposed by the second programme committee played an active role in promoting new research. The programme made research possible that otherwise could not have been done, or that would have met with severe difficulties in obtaining funding from the traditional NWO channels. The Cognition programme contributed to fostering coherence in the field and to creating an active intellectual community, even though there are still gaps between different disciplines within cognitive science. It triggered integrated cognitive science education programmes that have led to new courses in the universities. The summer schools were apparently very successful in stimulating interactions particularly among junior scientists, but it would be valuable to follow up attendees to see what they are doing now and how these schools may have helped to steer their career. The public events broadened public support and contributed to the birth of the new national initiative 'Brain and Cognition'.

Unfortunately, the application-oriented projects did not develop to the same extent as other parts of the programme, mainly due to the use of an inappropriate selection mechanism using the STW. The STW focussed on direct, short term applications with a strong participation of users and industrial partners, while the nature of cognitive research has longer term objectives that require completion before industrial collaboration becomes possible. On the whole, the programme committee should have used more appropriate criteria in selecting application-oriented projects within the field of cognitive science.

3. Influence on scientific results

The programme resulted in excellent quality research in the cognitive sciences, meeting international standards in all respects. In considering the long list of highlights and publications, the evaluation committee feels that one may even conclude that it exceeded the expectations in certain respects. The articles highlighted in the general journals *Nature*, *Science*, *PNAS* are good examples of this, but significant results were also published in high ranking specialised field journals such as *Journal of Neuroscience*, *Journal of Cognitive Neuroscience*, *Trends in Neurosciences*, *Trends in Cognitive Sciences*, and *Cognition*, among others. Without judging other research as being of less value, the committee recognizes the work in the projects 'Conflicts in language interpretation' (of Prof. Hendriks) and 'Reasoning and the brain' (of Dr Geurts) as prime samples of the high quality and innovative character of the research done in the programme. During the final symposium the evaluation committee appreciated the elegance of work presented on 'cognitive learning by young children' by Prof. Van der Maas and Prof. Van Geert, and on integrative approaches to 'memory processes' by Dr Jensen and Prof. Murre.

The committee endorses the conclusion of the steering committee that the instrument of 'preparatory grants', devised by the programme committee, significantly contributed to fostering the quality and interdisciplinarity of research proposals in the second call for proposals. The very successful 'pilot grants' enabled researchers to try out cutting edge high risk research approaches.

As far as the international aspects of the programme are concerned, the summer schools succeeded in bringing together young people from a variety of countries and disciplines. Furthermore the programme committee also made it financially possible for Dutch researchers to participate in the ESF-programme 'Consciousness in a natural and cultural context'. Many of the results of these endeavours have been published in international refereed journals and presented at important international conferences. During the programme period, the visibility and international prestige of the Dutch cognitive science research became prominent enough that the international community organized the international 2008 Cognitive Science Society Conference in Amsterdam, to recognize this, and also the Heineken

Prize for Cognitive Science.

4. Programme cooperation

In the course of the programme, some mutual understanding and common language developed between researchers from a wide variety of disciplines. This forms an important asset for the further development of an interdisciplinary field like 'Cognition' in all its manifestations, as it will help to define optimal research questions and to initiate promising approaches.

The Evaluation Committee noted that in the first phase of the programme some of the projects financed, although of high quality, were rather monodisciplinary in character. In the second phase, the programme committee installed the 'preparatory grant' option, which proved much more successful in promoting interdisciplinary projects.

During the course of the Cognition programme, a number of universities created M.Sc. degree courses in this field, crossing the traditional boundaries between faculties. Although the programme was probably not the only contributor to this development, it certainly stimulated the introduction of such courses. It is important to encourage such initiatives that depend on the collaboration between different disciplines, in order to consolidate these new interdisciplinary initiatives within the universities.

The programme has enabled a number of projects that otherwise would have been either impossible, or extremely difficult to realize, in the regular compartmentalized funding structure of NWO. This aspect is arguably the most valuable achievement of the Programme and it deserves praise.

5. Social relevance

The programme focussed mainly on long term research - typical for most of the international work in the field - with the general aim of finding underlying principles of cognitive processes. Deeper insights in these principles are very relevant for example for educational, health and care programmes. In the new national initiative 'Brain and Cognition' a number of these insights will be capitalized on the sub-programmes for Health, Learning and Safety.

Regarding the application-oriented projects, the programme encountered serious limitations in the form of inappropriate selection procedures as

applied by STW which focussed on direct applications in the short-term for users in collaboration with industrial partners (see under par. 2).

In addition the Cognition programme organized also a number of impressive public events, contributing significantly to public awareness of the scope and importance of the cognitive sciences.

6. Programme organization

In the first part of the programme there were management difficulties between the programme and steering committees, that eventually led to the first programme committee stepping down. Most of the problems resulted from different expectations of researchers versus programme committee members from different sub-disciplines. The first programme committee was installed through a collaborative action of several NWO divisions in advance of the appointment of a Steering Committee, and this led to initial difficulties in identifying the most appropriate directions for programme development.

The Steering Committee succeeded in resolving the problems after an intervention of the NWO general board, and appointed a new programme committee able to follow clearer courses of action. From then on the programme was characterised by effective management and the introduction of a number of improvements, e.g., the creation of new subsidy instruments such as the 'preparatory' and 'pilot grants'. These new options were introduced, accepted smoothly, and proved very successful.

For NWO this experience with one of the first truly multidisciplinary NWO programmes constitutes a learning experience in terms of the management of scientific programmes.

7. Final assessment

All in all, the evaluation committee congratulates the Netherlands research community and NWO with this foresighted programme and its outcomes. Most of the initial objectives were realized. The programme resulted in an appreciable number of internationally recognized highlights. Some of the research could not have been carried out without the programme. It helped to create a common language in the field of Cognition for researchers with different backgrounds. It contributed to launching M.Sc. programmes in the universities that transcend traditional Faculties lines. It increased the visibility

and awareness of the cognitive sciences and their scientific and societal importance. It was, however, less successful in the realisation of applied research projects. Nevertheless, the Evaluation Committee emphasizes that this is not the end, but only the beginning of exciting new developments in the field of cognitive sciences in The Netherlands. The programme set up a fine starting position, as is demonstrated, for example, by the growing number of successful applications by cognitive scientists in the regular NWO 'Veni Vidi Vici' procedure.

While the Cognition programme was going on a new national Netherlands initiative 'Brain and Cognition' started, for which the way was paved in part by the results and awareness being created by the Cognition Programme. This new national initiative has - besides interesting applied sub-programmes in Health, Education and Safety - an emphasis on brain research, with cognitive approaches placed somewhat more in the background. But to foster further the interdisciplinary field of Cognitive Science, the Evaluation Committee strongly advises the NWO to continue the Cognition programme with a strong emphasis on all dimensions of cognition research. Here the 'preparatory' and 'pilot grants' can be used as tools to strengthen interdisciplinarity, although not all research in such a new programme need necessarily be interdisciplinary. And for application-oriented research within such a programme, the NWO should set up and use an appropriate selection mechanism adapted to the field of the cognitive sciences.

8. Evaluation committee

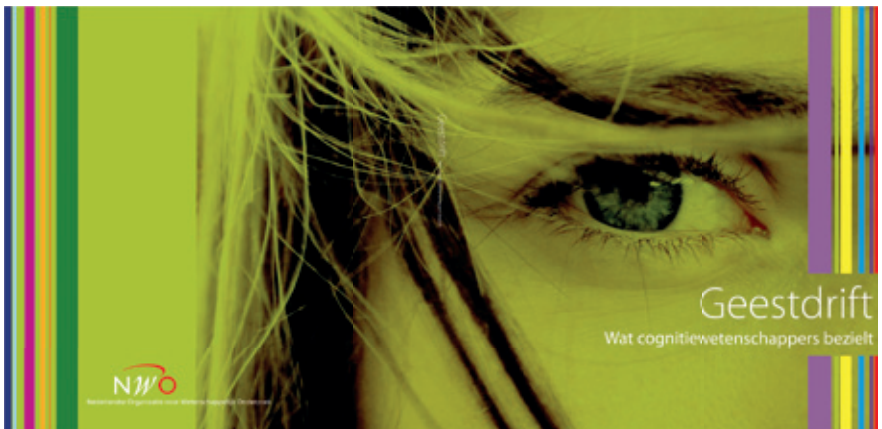
- Professor Fernando H. Lopes da Silva , Emeritus Professor, University of Amsterdam, Chair.
- Professor Eve V. Clark, Richard W Lyman Professor of Humanities, Stanford University.
- Professor Richard G.M. Morris, Royal Society/Wolfson Professor of Neuroscience, University of Edinburgh.
- Professor Nancy J. Nersessian, Georgia Institute of Technology, Atlanta.
- Professor Wolfgang Prinz, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig.

3. Self evaluation report by the steering committee

Preamble

In this report the steering committee for the NWO Theme Cognition and Behaviour provides a final self evaluation of the Special Programme 'Cognition'. The evaluation follows the evaluation protocol as agreed 18 November 2003 (see Add. 1) and has taken as its input the documents received from the programme committee for consideration, in its meeting of 28 September 2010. This documentation consists of reports of all the activities within this programme, research and other, performed under the aegis of the programme, in addition to a self-evaluation performed by the programme committee.

On the basis of this information the steering committee is of the opinion that overall the programme has met the objectives adopted by the programme committee from those stated in the initial proposal, known as "*Fruits of Enlightenment*". In terms of successful, relevant research projects; interdisciplinary initiatives; facilitation of national and international co-operation; furthering cognitive science among young professionals as well as among the public at large, the programme has spent its available means well in line with these objectives.



In the light of these achievements, the steering committee concludes that the programme has also met its principal goal as an incentive for the fast growing field of cognitive science. This conclusion is supported in a major way by the joint decision, a year ago, by the Ministry of Education, Culture & Science and NWO to launch a follow-up programme in the domain of Brain and Cognition at a substantially larger scale.

Realization of original objectives

In the programme brochure 'Fruits of Enlightenment' (2001) four goals were identified for the programme. These were specified by the programme committee in the following six objectives:

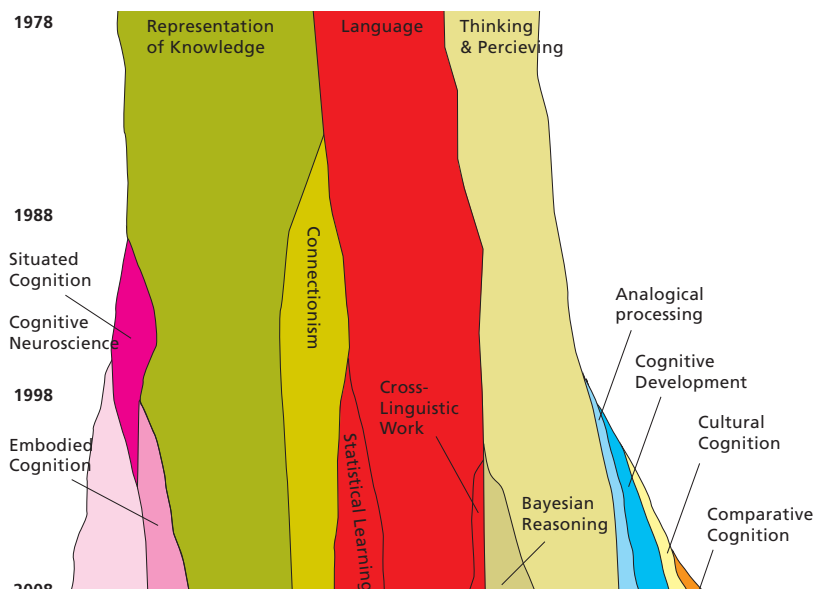
- Stimulating research on new cognitive interface themes, and encouraging new research areas and new scientific communities;
- Stimulating the application of knowledge resulting from cognitive science in applied projects;
- Strengthening the methodological foundations of the cognitive sciences, and contributing to their coherence as an active intellectual community;
- Supporting integrative cognitive science education programmes;
- Broadening public support for cognitive science research and its applications;
- Establishing cognitive science institutionally, within NWO, universities, and elsewhere.

The steering committee has accepted and adopted the interpretation of the objectives as formulated by the programme committee. This interpretation had the advantage of being specific enough to be met effectively, once it became known how much money was available. Thus, these objectives appear to have enabled an adequate match between means and ends.

Concerning the realization of the objectives the steering committee feels that the programme has certainly been the impulse it was intended to be. The programme has been successful in achieving the much needed and desired interdisciplinary coherence in its projects, both in terms of promoting interesting new developments and in terms of furthering mutual understanding between scientists with different disciplinary backgrounds. As professor Marian Joëls, who was actively involved in the programme, puts it

in the book 'Geestdrift': "Cross-fertilization between the cognitive sciences has become more and more common. [...] The Cognition Programme has induced me to pay much greater attention to the psychological aspects of my research."¹ At the same time, however, the programme has also made visible how large the gap between the different cognitive disciplines was and still remains. There may even be growing tendencies towards divergence, as is shown in the diagram below. The steering committee is aware of the fact that this seems to be the case internationally, perhaps simply as a consequence a natural differentiation caused by the rapid growth and progress of the field.²

Histomap of areas within Psychology in Cognitive Science



Rise and fall of Cognitive Science areas between 1978 and 2008.

From: D. Gentner, Psychology in cognitive science: 1978-2008.

Topics in Cognitive Science, 2010, 2, 328-344 [Fig. 5; p. 335]

Stimulating research on new cognitive interface themes

- 1 Geestdrift: Wat cognitiewetenschappers bezielt. The Hague: NWO, 2010.
- 2 See, e.g., Topics in cognitive science, 2010, 2(3), 321-419.

The steering committee concludes that the programme committee has succeeded in stimulating research on new interdisciplinary themes, especially through the adjustments the programme committee was asked to make after evaluating the results of the first Call for Proposals (2001). The projects resulting from that call were of excellent scientific quality, but in the opinion of the steering committee these projects did not quite meet the level of innovative interdisciplinary collaboration as intended. The programme committee decided to put more weight on interdisciplinary collaboration and integration across the cognitive disciplines in its subsequent Call for Integrated Research Proposals (2003). Prior to this call, 'preparatory grants' were funded on the basis of a separate call that enabled applicants to better tune their proposals to this requirement. The steering committee observes that this means of quality control has been highly successful. In its opinion the preparatory grant instrument has contributed significantly to the quality of the proposals submitted in the Call for Integrated Research Proposals, as well as to the efficiency of the assessment procedure.

From the start of the programme the steering committee has taken into account the need for a balanced distribution of attention and means over, in principle, all cognitive disciplines. The pressure from the neuroscience approach was and remains high which, in the committee's opinion harbours the risk that this research approach might eventually come to dominate the behavioural and cognitive approach. The steering committee wishes to emphasize that both approaches remain essential for a further successful development of the cognitive sciences as a strong and growing focus of scientific research.

The steering committee highly appreciates the various efforts of the programme committee to introduce new funding instruments such as the preparatory grants, and the call for "integrative and ground-breaking" pilot projects, all aimed at the realization of the programme's objectives.

Stimulating the application of knowledge resulting from cognitive science in applied projects

The attempt to select and fund application-oriented research projects in collaboration with the Technology Foundation STW must be considered as the least successful activity of the Cognition programme. The steering committee agrees with the conclusion of the programme committee that this was primarily caused by differences in perspectives and assessment criteria

that proved hard to overcome. For this reason quite a few proposals that, from a cognitive science perspective, offered really promising approaches towards application failed to pass the STW assessment procedure. The four projects that were successful not only aimed at application of cognitive science knowledge, but also qualified in terms of 'technology appeal'. The steering committee supports the recommendation of the programme committee to define much more explicit practical procedures for future joint calls with the STW and other co-financing organizations, in order to avoid similar differences in perception. Such procedures should fit the perspectives of the research fields involved as well as those of the intended societal and/or industrial partners.

At the start of the Cognition programme, it was understood that curiosity-driven projects should be given priority over application-oriented ones. The latter would have required immediate and direct involvement of industrial and/or (semi-)public partners, each of them likely to add economic and pragmatic constraints of doubtful scientific value. Later in the course of the programme such 'joint ventures' might have been encouraged (although the differences with STW reported in the previous paragraph, may suggest otherwise). By then, however, the preparations leading to the new FES-programme 'Brain and Cognition: Societal innovation in health care, education and social safety' had already gotten well underway. Consequently any further initiative by the programme committee toward such 'joint ventures' would have been relatively ineffective, in view of the expected, much higher level of funding of this new programme: the themes health care, education and social safety will be receiving focal attention. These themes had already been identified as 'major topics' in the report of the Overlegcommissie Verkenningen (OCV), 'De Kennisraffinaderij' (1997). The steering committee is very pleased to see that these themes will finally come to fruition.

Strengthening the methodological foundations of the cognitive sciences, and contributing to their coherence as an active intellectual community

The steering committee compliments the programme committee for its efforts to focus the attention of researchers involved in the programme's projects on interdisciplinary integration and collaboration. The programme committee's active attitude towards the researchers, especially by means of site-visits appears to have paid off quite well. The steering committee

concludes that the emphasis on integration and collaboration in calls, assessment procedures and research projects has led to excellent results. The Cognition programme was meant to demonstrate the benefits of such an approach. In this respect it has clearly succeeded.

The programme brochure 'Fruits of enlightenment' (2001) recommended establishing a permanent 'forum debate' on theoretical and methodological issues in order to contribute to the depth and coherence of the programme. The steering committee regrets that a broader discussion of these issues did not materialize. In its opinion it is necessary to reconsider, at least intermittently, the conceptual foundations of the scientific method in order to make substantive progress. The steering committee recognizes issues in at least three domains:

- *Conceptual issues*: A considerable effort towards greater conceptual clarification is necessary if concepts such as 'mind', 'consciousness' or 'intention' are to be investigated unambiguously from a scientific perspective.
- *Methodological issues*: The empirical method deals with phenomena that are permanently and publicly observable. Individual events cannot easily be analysed in such an empirical setting and the empirical method can therefore not be adopted unconditionally in the study of cognitive phenomena.
- *Complexity issues*: In the context of cognitive science it is evident that the traditional, physically inspired, approach is frequently ineffective. Limits to and alternatives for physical reductionism remain therefore crucial points for consideration.

A 'forum debate' could strengthen the methodological foundations of the cognitive sciences and bring issues of discord into sharper focus. The steering committee recognizes that ultimately this objective was too ambitious: it requires long term efforts that would have vastly exceed the scope of the Cognition programme. Yet, as this objective is of the essence to the progress of science, the steering committee strongly recommends the explicit pursuance in some suitable 'plenary format' as part of the follow-up programmes that are to be part of the National Initiative Brain & Cognition.

Supporting integrative cognitive science education programmes

In order to successfully stimulate interdisciplinary collaboration it is essential to educate young cognitive researchers from, thus far, mostly monodisciplinary backgrounds to do research in a truly interdisciplinary setting. In the Cognition programme a granting opportunity was launched to stimulate the organization of summer schools for young researchers: the Integration Grants for Summer Schools. These summer schools offered incipient researchers (PhD students and post docs) an opportunity to meet their counterparts from other disciplinary backgrounds, to learn from each other and to experience – and cope with – the difficulties of bridging the gaps between disciplines. For these summer schools prominent international experts working on interdisciplinary topics were invited to share their enthusiasm, experiences and insights with the students. The steering committee underscores the eminent importance of these educational activities. Summer schools constitute an investment in a solid interdisciplinary development of the cognitive sciences and they result in lasting international contacts and collaboration of inestimable value. The steering committee has noticed that this funding instrument is being continued appropriately in the follow-up NWO programme ‘Brain & Cognition: An integrated approach’.

In addition the steering committee recommends for further consideration if and how a relevant basic (undergraduate) curriculum for the early stages of the training of cognitive scientists might be structured. The committee realizes that this issue lies clearly outside the concerns of a research programme, and perhaps of NWO in general. Yet, the considerable differences between the basic curricula that young researchers presently follow prior to the graduate and early post-doc levels, may well lead to unnecessary inefficiencies that may adversely affect the research training at a later stage.

Broadening public support for cognitive science research and its applications

In the context of the programme quite a few initiatives have been undertaken to broaden public support for cognitive science. The so-called *A la Carte* grants resulted in a number of interesting activities for the general public, including expositions, websites and symposia (see Add. 5.6.9). The programme committee did initiate a series of annual public events (see Add. 9) that were directed mainly at different target groups in society, such as teachers, medical professionals in cognitive revalidation and professionals

active in the area of law and public safety. The public event ‘Het Grote Slaapexperiment’, in which primary school children (11-12 years old) became actively involved in experimental research on sleep, was in the opinion of the steering committee perhaps the most spectacular of this series: it may even have made a lasting impression on some of the young participants. Moreover, not only did this activity attract a lot of media attention, but the experiments performed by the children and the researchers have led to several refereed scientific publications.

The events that directly solicited the attention of the public at large have been well-received, each time drawing a reasonably sized genuinely interested public. In 2010, following the same intention of reaching out to interested outsiders, a collection of interviews with prominent researchers was published under the title ‘Geestdrift: Wat cognitiewetenschappers bezielt’. In the opinion of the steering committee this excellent volume should be distributed widely as it seems an effective agent to establish public support for the cognitive sciences, as well as a better understanding among professionals and academics from other disciplines.

In summary, the steering committee concludes that the Cognition programme has had a positive impact on public support, especially if one takes into consideration that only modest means were available for these activities.

Establishing cognitive science institutionally, within NWO, universities, and elsewhere

The steering committee was initially supposed to play an active role in designing the interface between society, government, politics and cognitive sciences and to acquire additional funds in favour of the theme. This was reflected in the committee’s initial composition that included members from a scientific background as well as from societal echelons as health care, law and public safety. In the light of the initiative (started as early as 2005) of the NWO councils Earth and Life Sciences, Humanities, Social Sciences and ZonMW (health research and development) to obtain funding for a new curiosity-driven research programme as well as for application-driven research programmes addressing important societal issues such as education, health, public safety, and communication, the steering committee deemed it wise not to actively pursue the initial goal any further, as these overlapped

with the new initiative. Instead the steering committee commended these tasks to the care of these councils, following their progress in a critical and constructive way. The steering committee is pleased with the realization of the initiative resulting in new research programmes and the Dutch National Initiative Brain & Cognition, and it is convinced that the Cognition programme has laid, at least partly, the foundations for its success. Altogether the impact of the programme on the national establishment of cognitive science has been considerable. In addition to the initiative by NWO and the governmental partners, extra structural funds were made available by several universities to establish interdisciplinary focus areas for an integrative approach of neuro- and cognitive science topics within these universities.

Benefits of the programme in an (inter)national context

Nowadays science cannot thrive without international collaboration. All researchers involved in the Cognition programme have their own international contacts, networks and other collaborations. Even though such collaborative activities tend to take good care of themselves, the Cognition programme has actively stimulated the establishment of new international contacts through funding instruments such as the Preparatory Grants, the Network Grants and, specifically, the ESF EUROCORES 'Consciousness in a Cultural and Natural Context' (CNCC). The programme's allocated budget for international collaboration has been invested in participation in this EUROCORES programme. The steering committee agrees with the programme committee that this investment is an excellent example of creating a successful link to international research with a comparatively small amount of money. The steering committee would like to add that 'consciousness' is a central issue in the cognitive sciences which might be rendered useless as an object for empirical research because of its broad definition. In line with its recommendation mentioned in Sec. 4.1.3, an unambiguous definition is in the opinion of the steering committee a sine qua non condition for any empirical investigation of consciousness.

Scientific output

The Cognition programme has, so far and still counting, resulted in 21 research projects and 99 smaller grants (see Add. 5.5.2). The projects have yielded a total of 387 publications in refereed scientific journals, including a number of high impact journals, 62 chapters in reviewed books, 56 popular

scientific publications as well as 29 PhD theses. Of the research projects only one had to be terminated prematurely, because of external administrative reasons. The steering committee concludes this yield is in all respects qualitatively and quantitatively acceptable.

Organizational structure of the programme

The first programme committee was already in place when the steering committee was installed. The steering committee believes that the composition of this programme committee was less balanced than was required for an interdisciplinary programme with the explicit and perhaps even daunting task to instigate interdisciplinary collaboration and an integrative research approach, in a field that, until that time, had been organized primarily in a monodisciplinary fashion. This intrinsic unbalance did lead repeatedly to serious differences of opinion among the first programme committee, with which the steering committee then had to deal later. After the resignation of the first programme committee a new programme committee was installed. This second programme committee has been much more balanced, in the opinion of the steering committee. Not surprisingly, the co-operation within this committee has been of a more harmonious nature, as have been its relations with the steering committee. Irrespective of these comments, the steering committee wishes to emphasize that it is convinced that all members of both programme committees have contributed to the best of their abilities to the success of the Cognition programme.

The steering committee also recommends that ad hoc committees in the NWO context, including programme committees and steering committees are invested, not only with responsibilities, but also with the required, commensurate authority. Absence or inadequacy of the latter may lead to procedural inefficiencies.

The steering committee wishes to emphasize its gratitude for the way the NWO bureau has assisted the programme throughout its entire time span, at each and every relevant level. The competence and dedication of the supporting officers has contributed significantly to the programme's success.

Main conclusions and recommendations for the future

The Cognition programme has facilitated pioneering research in a scientific

field in which many fundamental research questions are still waiting for 'evidence-based answers'. The methods and technical approaches necessary to achieve this aim are within reach, but interdisciplinary collaboration is essential.

The programme has amply fulfilled its expectations. The modest size of the programme (M€ 12.5) made it necessary to choose wisely from the options the programme committee had at its disposal. The steering committee concludes that the programme committee has indeed succeeded in making a prudent choice: it has selected a relevant set of options that have indeed resulted in a successful completion of the programme as anticipated in 'Fruits of Enlightenment.

The programme has led to an important step in the direction of a coherent and interdisciplinary cognitive research community. From the outset the steering committee was convinced that the broad thematic approach of the Cognition programme should be followed by a more focussed approach in follow-up programmes. Concentrating future research efforts around important socially important problem areas such as education, health, communication and safety seemed a proper strategy to follow, thus anticipating their incorporation in these follow-up activities of the Cognition programme.

Within the NWO theme Cognition & Behaviour the Cognition programme has a sister programme under the name Evolution & Behaviour for which the steering committee is responsible too. This programme aims at expanding the insights into the evolutionary basis of human behaviour, stimulating the adoption of evolutionary approaches in the social and behavioural sciences generally, and promoting active collaboration between scientists from the life sciences and the social and behavioural sciences (See: www.nwo.nl/eandb). The steering committee attaches great importance to evolutionary and behavioural research perspectives for the further development of the cognitive sciences; it therefore recommends active participation of these research communities in future programmes.

Other recommendations based on the course of events and the outcomes of the Cognition programme have already been stipulated earlier in this report. To summarize:

- The steering committee has recommended the continuation of the ‘preparatory grant’ as an efficient and effective way of eliciting high-quality project proposals.
- Also the steering committee has argued in favour of a continued attention for a balanced regarding the various disciplines that contribute to cognitive science.
- The importance of ‘forum activities’ is emphasized, with respect to the foundational issues (concepts, methods and complexity) that are of importance to academics, as well as with respect to the interests of the public at large. ‘Brain and cognition’ constitutes a prominent field of interest, as can be gathered from the number of popular books and the attention received in the media. Yet, the steering committee is left with the impression that this prominence does not reveal itself adequately in the public arena and, more specifically, in the debate about the ‘knowledge society’. The follow-up programme, the National Initiative on Brain and Cognition, will hopefully succeed in redressing this undervaluation of the potential of the cognitive sciences.

4. Self evaluation report by the programme committee

The NWO Programme Cognition was the first programme in which six different NWO divisions participated. The programme's brochure 'Fruits of Enlightenment' characterized the cognitive sciences in a very broad context spanning such disciplines as neuroscience, biology, psychology, artificial intelligence, computational sciences, logic, linguistics and philosophy. The NWO special Programme on Cognition was meant to boost this highly interdisciplinary area across traditional academic boundaries. In order to accomplish this ambitious goal, six general aims were formulated:

1. Stimulating research on new cognitive interface themes; to encourage new research areas and new scientific communities;
2. Stimulating the application of knowledge resulting from cognitive science in applied projects;
3. Strengthening the methodological foundations of the cognitive sciences, and contributing to their coherence as an active intellectual community;
4. Supporting integrative cognitive science education programmes;
5. Broadening public support for cognitive science research and its applications;
6. Establishing cognitive science institutionally, within NWO, universities, and elsewhere.

Altogether, the Programme aimed at stimulating research, community building on a national and international level, forum activities, education, public presence and information dissemination. The Cognition programme opened various opportunities for grants. Detailed information on these granting opportunities is presented in addendum 5.6.

The Cognition Programme was relatively sizable with a budget of M€ 12.5 and extended over a period of 10 years. The programme was co-financed by the Ministry of Education, Culture and Science. The interest from policy makers continued to exist during the course of the programme, as several departments joint their forces and submitted a FES programme that was

granted in 2009. Given the involvement of these ministries in brain and cognition research, the relevance of the programme has wide support. In this self-evaluation report, the current Programme Committee evaluates the programme as a whole, thereby including conclusions from the Midterm Evaluation.

Realisation of original objectives

Stimulating research on new cognitive interface themes

First Call for Research Projects (2001)

The programme Cognition opened several separate Calls for Proposals in order to accomplish the first aim, namely 'stimulating research on new cognitive interface themes and to encourage new research areas and new scientific communities'. The programme was quite successful in accomplishing this ambitious aim. The first Call for Research Projects in 2001 was driven bottom-up and resulted in nine large research projects (total budget 4.7 M€). More detailed information on this Call and its resulting projects is presented in addendum 5.6.1. From the results of this Call the programme committee concluded that the proposals originated from research disciplines spanning the full width of Dutch cognitive sciences, and reflected the international state of the art of this research field. The proposals were of very high scientific quality, but in general still seemed to lack in innovative interdisciplinary collaboration.

Call for Preparatory Grants (2003)

To improve the interdisciplinary character of the proposals in the foreseen Call for Integrated Research Projects, the programme committee introduced the Call for Preparatory Grants. This format offered researchers the financial opportunity to organise a workshop or a meeting with (inter)national fellow researchers from different disciplinary backgrounds in order to prepare larger grant applications. This innovative idea stimulated collaboration between the various disciplines very well, whereas the financial costs were limited (total budget 0.2 M€ see also 5.6.2). It had an immediate result in the Integrated Research Projects Call (2003), as the proposals in this call were substantially more interdisciplinary in character than the proposals received in the first Call in 2001. As shown in table 1 and the chart below, the chances of success in the Call for Integrated Research Projects for applicants that had obtained a Preparatory Grant turned out to be much higher (22%) than for

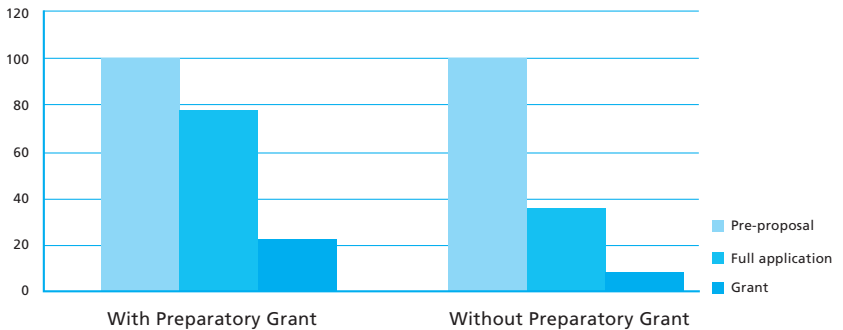
applicants that did not obtain a Preparatory Grant (8%).

Table 1: Success applicants Preparatory Grants in Call for Integrated Research Projects (IRP) relative to the number of pre-proposals

	Pre-proposal IRP		Full proposal		Grant	
	N	%	N	%	N	%
With Preparatory Grant	18	100	14	78	4	22
Without Preparatory Grant	50	100	18	36	4	8
Total	68	100	32	47	8	12

Chart 1: Success applicants Preparatory Grants in Call for Integrated Research Projects relative to the number of pre-proposals

Success applicants with and without Preparatory Grants in Call for Integrated Research Projects relative to the number of pre-proposals



The programme committee was very much taken with the positive impact of the Preparatory Grants format and the success of it led to similar preparatory calls for proposals in the NWO Programme Evolution & Behavior and the new NWO Programme 'Brain and Cognition: an integrated approach'.

Call for Integrated Research Projects (2003)

The Call for Integrated Research Projects was launched in 2003. Through this Call the programme committee and the steering committee wished to achieve further integration across the cognitive disciplines. This Call therefore invited strong research groups working in different domains of the

cognitive sciences to submit proposals for collaborative research projects. In the Call eight projects were granted (total budget 3.1 M€). More detailed information on the Call and its resulting projects is presented in addendum 5.6.2.

There has been a feeling among researchers in the field and members of the program committee that some of the research areas involved in this field submitted more proposals and were more successful in obtaining grants than other research areas. More specifically, the neuroscience proposals would have been more successful than the cognition proposals. In order to find out whether this feeling can be justified, a scan has been executed of the first Call and the Call for Integrated Research Projects based on three broadly defined categories. The first category 'neuroscience' consists of disciplines like neuroscience, biology, experimental psychology and medical sciences. The second category 'cognition' is composed of disciplines like behavioural psychology, logics, philosophy, linguistics and computational science. The third category 'neurocognition' consists of combination of a 'neuroscience' discipline and a 'cognition' discipline in one project. The results of the scan are shown in table 2 below.

Table 2: Scan success of neuroscience (N), neuro-cognition (NC) and cognition (C) in the first Call (2001) & Call for Integrated Research Projects (2003)

First Call & Call for Integrated Research Projects	Number submitted	Number granted	Percentage granted
Neuroscience	63	9	14
Neuro-cognition	15	4	27
Cognition	52	4	8
Total	130	17	13

The results of this scan show that in the neuroscience category the highest number of proposals (63) was submitted, followed by the cognition category (52) and the neuro-cognition category (15). Of all submitted proposals, the neuro-cognition proposals have been most successful in these calls (27% granted). The difference in success between the neuroscience (14 % granted) and the cognition proposals (8% granted) seems too small to draw a clear

conclusion in whatever direction. The only 'safe' conclusion that can be drawn from this scan is that the combination of disciplines from the fields of neuroscience and cognition was apparently considered as more exciting than interdisciplinarity within only neuroscience or cognition.

Call for Cognitive Science Pilot Projects (2007)

Besides the success of the above calls, there was also a high response in the Call for Cognitive Science Pilot Projects (2007). This call asked for promising, integrative, ground-breaking and risky cognitive science pilot projects at the intersection of different cognitive disciplines which might form a basis for successful (inter)national applications for funding. This call appeared to be extremely attractive, uncovering a need in the scientific community for such small-scale projects. Given the popularity of the call and the high quality of the submitted applications, it was unfortunate that a limited budget was available and only 10 projects could be funded (total budget 0.5 M€, see also 5.6.6.). A way to quantify the success of this call is to investigate how many of these projects resulted in grant applications for the Call for Programmes for Excellence (2009) in the follow-up NWO Programme 'Brain and Cognition: an integrated approach'. The results are shown in table 3 below.

Table 3: Success of applicants who submitted a Cognition Pilot Grant (CPG) in the Cognition programme in Call for Programmes for Excellence of the follow-up programme 'Brain and Cognition: an integrated approach'

	Pre-proposal submitted	Full proposal submitted	Number granted	Percentage granted
Applicants that have submitted CPG	31	15	8	26
All other applicants	79	20	6	8
Total	110	35	14	13

Although the chances for success in the Call for Programmes for Excellence were equal for both groups prior to the assessment, the results show that the researchers who submitted a Cognition Pilot Grant were more successful in the Call for Programmes for Excellence (26% of their pre-proposals were granted) than researchers who did not apply for a Cognition Pilot Grant (8% granted). This result clearly underpins the quality and success of the funding

instrument and the programme committee therefore strongly advises to reserve a higher budget for future calls in other NWO programmes.

Other grant opportunities

Apart from the above-mentioned calls, there have been five other grant possibilities: Call for Application-oriented Cognitive Research Projects (from 2004), Call for Advanced Studies Initiatives (2006), Network Grants for scientific meetings (from 2003), Integration Grants for Summer Schools (from 2003) and A la Carte Grants for activities directed at the general public (from 2003). These calls will be evaluated in the subsequent sub-sections.

Stimulating the application of knowledge resulting from cognitive science in applied projects

Call for Application-Oriented Research Projects (2004)

The Call for Application-Oriented Cognitive Research Projects (2004), started up together with the Technology Foundation STW, directly focused on the second main aim – stimulating the embedding of results from cognitive science in society through applied projects. The call resulted in only four funded projects and was in this respect less successful than expected (total budget of 1.6 M€ see 5.6.4). The budget of this call even would have sufficed for additional funding of projects (available budget 2.25 M€). The idea of joining forces with STW turned out to be inadequate for its purpose because of its chosen procedural set-up. The submitted proposals were included in the Open Technology Programme of STW in which the term ‘applied’ is interpreted as ‘applied as in the technical sciences’ instead of ‘applied from a cognitive perspective’. In other words, cognition did not have priority in this STW Programme and, consequently, the success rate for these proposals was only 13%. For the future, the programme committee therefore strongly advises to adapt the procedural organization of calls like these to suit the state-of-the-art of the research fields involved and the potential societal and/or industrial partners. However, the four proposals that have been funded, did achieve first-class results. The projects have been relevant for application within the industry and health care.

Impact of knowledge resulting from the programme

For the greater part of the projects, the societal meaning of the results of the Programme Cognition for societal organizations, NGO’s and industry is indirect; the development of knowledge contributes to new developments.

Application of the results from several projects and public events was realized in the areas of artificial intelligence (smart systems, robotics), human-computer interaction, embodied cognition, knowledge management (people with mental handicaps, aphasia, and dyslexia), education and quality of life (public safety, health, aging, stress management). Moreover, some projects contributed to the start of companies and contacts with the industry. Finally, in the near future, the results of a few studies will be implemented in clinical settings and/or organization structures.

The results of several research projects as well as of some public activities could also be relevant for policy. However, this relevance is, for the time

Cognition public event 'Illusio'



being, much more dissemination-oriented than application-oriented. In the areas of cognition and education, cognition and law and cognitive revalidation, the programme was successful in organizing events where scientists and professionals were brought together. These activities led to an enhanced awareness in these groups of professionals that knowledge derived from neuro- and cognitive science could play an essential role in their work. However, its application in practice will still take time.

Strengthening the methodological foundations of the cognitive sciences, and contributing to their coherence as an active intellectual community

In the past, NWO programmes usually tried to integrate multiple individual projects. Integration of separate projects often did not meet the expectations, since the majority of the project groups naturally tended to go their own way during the course of the project. By funding solely integrated interdisciplinary research projects, the Cognition programme reversed such separation tendencies and successfully strengthened the methodological foundations of the cognitive sciences. It also contributed to the mutual coherence within the research community as well as within the programme itself. Nevertheless, supervision over the projects was still necessary to ensure the integration of the projects. The programme committee stimulated this by their site visits, i.e. visits by one or more delegates of the committee to the project groups.

Secondly, by providing the opportunities to apply for Preparatory Grants, Network Grants for scientific meetings and Advanced Studies Initiatives, the Programme actively stimulated the national and international field to exchange potential ideas and results between the various cognitive disciplines and to contribute to the coherence as an active intellectual community. The programme continuously updated its programme website, launched the website www.cognitie.nl and introduced a monthly email-alert to transfer relevant news items within the Dutch cognition community (with approximately 600 subscribers). For more detailed information see addenda 5.6 and 9.

Thirdly, in consideration of community building the programme committee has initiated a series of events: the annual scientific symposia and a series of annual internal scientific meetings for researchers funded by the Cognition Programme. At the internal scientific meetings, project leaders, PhD students

and postdoctoral researchers presented the progress and results of their projects and had the opportunity to exchange ideas and experiences. The annual scientific symposia strengthened the interdisciplinary character of the programme by addressing an interdisciplinary theme from various disciplinary perspectives. More information is presented in addendum 9.

Supporting integrative cognitive science education programmes

The fourth aim - supporting integrative cognitive science education programmes – was tackled by opening a specific Call for Integration Grants (from 2003). With this funding instrument, that allowed the organization of for example summer schools, the programme committee actively stimulated the collaboration of research schools on a national level (total budget 0.2 M€ see 5.6.8). The programme supported the initiative of four prominent research schools in the area of cognitive science (i.e. NICI (Nijmegen), Helmholtz (Utrecht and Rotterdam), EPOS (Amsterdam and Leiden) and BCN (Groningen)) to organize a series of summer schools. The programme also contributed financially to the annual Summer School Series of the Cognitive Science Center Amsterdam (CSCA). Because of the great success of this instrument, it also found continuation in the follow-up programme 'Brain and Cognition: an integrated approach'.

Broadening public support for cognitive science research and its applications

The programme committee undertook several successful activities to create public support for cognitive science research and its applications.

Call for A la Carte Grants (from 2003)

The Call for A la Carte Grants was meant for activities directed at the general public. This call resulted in 16 successful public activities like exhibitions, websites, symposia, etc. that were accessible for a broader public or for one or more societal target groups (total budget 0.13 M€, see 5.6.9). Some of these activities generated a lot of publicity around cognitive science in general.

Public events

Secondly, the programme committee organized a couple of public events during the course of the programme:

November 2002	Between Brain and Consciousness	broad scientific public
February 2004	The Future of Learning	teachers
July 2006	The Big Sleeping Experiment	children
October 2007	Symposium Cognitive Revalidation	health care
November 2007	Law and Cognition	neuroscientists and legal practitioners
September 2009	Illusio	broad scientific public
2007 – 2010	Exposition "Use your Brain"	general public; adults and children

The effort in time and manpower needed to generate interest in these matters should not be underestimated. Considering the enthusiastic attendance of over 500 people at the Cognition public event on 'The Future of Learning' and 'Illusio', the effort was most certainly worthwhile.

Public knowledge transfer

Not all research projects lent themselves easily to public activities, but many researchers presented their results in semi-scientific programmes on national television (for example Hart en Ziel and Klokhuis) as well as on the radio (Hoe?Zo!; BNN). Researchers connected to the programme also gave interviews to national newspapers (Volkskrant; NRC; AD) and popular scientific magazines. Moreover, the Programme Committee published the book *'Geestdrift, wat cognitiewetenschappers bezielt'*. This popular scientific book contains interviews with well-known Dutch cognitive scientists and was written to introduce cognitive science to the public. For instance, the books were distributed for free among the attendees of the public event which is organized yearly by the Hersenstichting Nederland, a societal organization aiming at public dissemination of knowledge of the brain and its disorders.

Establishing cognitive science institutionally, within NWO, universities, and elsewhere

The Programme Cognition played a role, both directly and indirectly, in institutionalizing cognitive science within NWO, universities, and elsewhere. Because cognition became a focus of interest within NWO, the topic became more prominent at universities as well. This enhanced the awareness of the need for activities like specialized research masters such as for example the Master Behavioral and Cognitive Neurosciences in Groningen.

Another spin-off of the programme was that several researchers, once funded by the Programme Cognition, thereafter received additional financial support to further their career (inter)nationally. Some of them were given a permanent contract at the university or were appointed professor. Others received VIDI and VICI grants or received grants in one of the other NWO programmes. Although difficult to quantify, the programme no doubt contributed to these developments.

Furthermore, the results were of significance for accomplishing a follow-up for the programme that has already been described in the Introduction (see 1.3). Within NWO, four divisions joined their forces and implemented a new bottom-up programme entitled 'Brain and Cognition: an integrated approach'. The clear interest of governmental, societal and business partners in the brain and cognition field resulted in granting of the FES Programme 'Brain and Cognition: societal innovation in health care, education and social safety'. This programme brings together national research partners from various disciplines, as well as a wide variety of societal and business partners. Simultaneously, the foundation of the National Initiative Brain and Cognition was realized. The Initiative is financed by NWO together with the Dutch Departments of Education, Culture and Science, Health, Welfare and Sport, Justice, Defense, Interior and Kingdom Relations and Youth. NWO supports and coordinates this National Initiative.

Benefits of the programme in an (inter)national context

Within the budget of the programme, 250 k€ was reserved for internationalization costs. The Programme invested all this money in participation in the ESF EUROCORES programme 'Consciousness in a Cultural and Natural Context' (CNCC). The theme of this ESF-programme was clearly cognitive and the bandwidth of the disciplines corresponded largely with the disciplines of the Programme Cognition. Because of this support by the programme Cognition to the ESF Programme, other NWO Divisions namely Earth and Life Sciences, Social Sciences and Humanities also decided to contribute to a total of 500k€. This enabled granting of all three Dutch participants in five by the ESF approved proposals. The investment in the CNCC programme is an excellent example of creating a successful link to international research with a relatively small amount of money.

A second way in which the programme created a link to the (inter)national research field is by funding several summer schools, workshops and conferences. Due to these Network, Integration and Preparatory Grants, several of the organized meetings ensured that interdisciplinary cognition research in the Netherlands came into sight and led to quite a few new (inter)national collaborations.

Scientific output

The gains of the programme are not only reflected in newly established interactions between disciplines, but also more directly in the number and quality of the publications resulting from the programme. Up to now, the projects of the programme have resulted in 28 PhD theses from 42 PhD students; 4 students stopped prematurely, 8 PhD students finished their PhD position without a thesis (yet) and 2 PhD students will finish their position in 2011. See table 4 below for more facts and figures of the scientific output of the programme.

Table 4: Facts and figures of the scientific output of the programme up to September 2010

	Year	Scientific Publications	Books and chapters in books	Outreach and other	Total
First Call for Research Projects	2002-2009	177	22	25	224
Integrated research projects	2004-2011	105	12	24	141224
Pilot Projects	2007-2008	11	11	1	23
Application-oriented Cognitive Research Projects	2005-2010	47	1	6	54
CNCC	2007-2011	36	16	0	52
Total		376	62	56	141577

As can be seen in table 4, the projects produced a total of 376 publications in refereed scientific journals among which the following 11 publications in high-impact journals such as Science, Nature and PNAS (Proceedings of the National Academy of Sciences of the USA).

High-impact publications

1. Schoffelen JM, Oostenveld R, Fries P. Neuronal coherence as a mechanism of effective corticospinal interaction. *Science*. 2005 Apr 1;308(5718):111-3.
2. Womelsdorf T, Schoffelen JM, Oostenveld R, Singer W, Desimone R, Engel AK, Fries P. Modulation of neuronal interactions through neuronal synchronization. *Science*. 2007 Jun 15;316(5831):1609-12.
3. Cornelissen, FW, & Vladusich, T (2006). What gets filled-in during filling-in? *Nature Reviews Neuroscience* 7, (October 2006) | doi:10.1038/nrn1869-c1.
4. Dunn, F.A., Lankheet, M.J., Rieke, F. (2007) Light adaptation in cone vision involves switching between receptor and post-receptor sites. *Nature* 449 (7162), pp. 603-606.
5. Hu K, Van Someren EJW, Shea SA and Scheer FA (2009) Reduction of scale invariance of activity fluctuations with aging and Alzheimer's disease: involvement of the circadian pacemaker. *PNAS* 106:2490-2494.
6. Van Der Werf YD, Altena E, Schoonheim MM, Sanz-Arigita E, Vis JC, De Rijke W and Van Someren EJW (2009) Sleep benefits subsequent hippocampal functioning. *Nat Neurosci* 12:122-123.
7. Van Der Werf YD, Van Der Helm E, Schoonheim MM, Ridderikhoff A and Van Someren EJW (2009) Learning by observation requires an early sleep window. *PNAS* 106:18926-18930.
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Organisational structure of the programme

At the start of the programme, all members of both the programme committee and the steering committee received a description of each other's activities. However, the reality of everyday life sometimes turned out to be harder to interpret than the description. After the midterm evaluation, the programme committee resigned and the current programme committee was installed. This programme committee is pleased with the way she was able to do her work. The steering committee adopted a facilitating attitude and stimulated the programme committee with new ideas.

During the course of the programme, the programme office was composed of a coordinator as well as a secretary. The assistance of the programme office was in general very good and proved to be essential in for example evaluation procedures and in organizing events. Towards the end of the programme, when the projects were either completed or running and consequently the workload diminished, the vacancy for a new coordinator caused by a career change of the current coordinator was called off since it would rely unnecessarily heavy on the budget for overhead costs. However, during peak periods of for example public events, some activities were delayed because of this decision. In the future, one should be prepared for peak periods like these at the end of the programme and might adjust the composition of the team accordingly.

Main conclusions and recommendations

The programme Cognition covered a broad spectrum of different disciplines and research activities on very diverse cognitive research subjects. This offered a very rich opportunity to bring high quality researchers from different cognitive backgrounds together. Overall, it can be concluded that the programme was successful in stimulating research on new cognitive interface themes. It encouraged new research areas and new scientific communities that would not have been there without the programme's explicit emphasis on interdisciplinarity and integration.

The programme committee recommends a continuation of the cognition research theme within NWO. The committee is pleased with the realization of follow-up activities like the National Initiative Brain & Cognition and its research programmes. There is a concern, however, that with the emphasis

on 'neuro' in these new programmes, pure cognition projects will fail to benefit from these research funds. This causes concern because pure cognition research investigates information processes that can not (yet) be investigated by cognitive neuroscience. For future activities, the committee advises that the programme cores to be addressed should be determined by a mix of junior and senior experts active in the research community and should be coordinated with international actions. Bilateral collaborations with international research councils should preferably be initiated before or directly at the start of the programme in order to synchronize more extensively in international actions.

Funding instruments

With the variety in funding instruments, the programme clearly answered the need of the cognition field and gave many researchers in the Netherlands the opportunity to take advantage of the programme's budget. It offered opportunities for purely fundamental research, research directed towards societal interests, and application-oriented research.

The Pilot projects and Advanced Studies projects provided successful seed money that in general led to interesting and innovative developments. In future programmes, it is recommended to reserve a larger budget for funding instruments like the Pilot Project Grants. The call made clear that such a granting scheme fills in an import niche in the granting landscape in the Netherlands. Unfortunately, due to a limited budget, too few of the excellent proposals could be financed.

Funding instruments like the Network Grants, the Integration Grants and the A la Carte Grants clearly facilitated the realization of an interdisciplinary research community, and also raised an interest in neuroscience and cognitive topics for the general public and more specific groups of professionals. For these instruments, proposals could be submitted continuously until the budget became exhausted. The programme committee recommends avoiding continuous submission of proposals for small funding instruments, since this makes the procedure time-consuming for the committee that has to evaluate the proposals. It would be more efficient to create for example two or three moments a year for submission.

The Preparatory Grant format has substantial merits when implemented in

research programmes aiming at stimulating interdisciplinary research. It is recommended to open highly interdisciplinary programmes through a Call for Preparatory Grants. For interdisciplinary research projects a fixed budget of k€400 for double position research projects guarantees an optimal size regarding mutual collaboration and its function as a focal point for further (inter)national contacts. In order to maximize interdisciplinarity, the programme committee recommends defining calls for research projects less openly than has been done in the programme brochure 'Fruits of Enlightenment'. By defining focused research questions within each theme that cannot be executed in a mono-disciplinary fashion, the interdisciplinarity of the programme can be influenced positively.

Fundamental research versus societal and application-oriented research

As mentioned above, the Programme Cognition offered opportunities for purely fundamental research as well as research directed towards societal interests and application-oriented research. The programme committee stresses that a reasonable balance should be found between these types of research. On the one hand, societal and application-oriented research can only be carried out if there is a broad basis of strategic fundamental research to build on. On the other hand, it turned out that application of scientific knowledge needs a specific approach and calls for commitment and opportunity. In retrospect, only few application-oriented proposals were successful. This was probably caused by application-oriented proposals not being considered as 'applied from a cognitive perspective' by STW. The programme committee therefore strongly suggests including stakeholders at an early stage of the programme in order to maximize the societal relevance of a research programme and to reserve extra budget for bridging the gap between knowledge and practical and societal implementation of this knowledge. This is especially important considering the societal pressure to apply fundamental knowledge of human cognition. When striving for application-oriented calls, the programme should strive for procedures that suit the state-of-the-art of the research fields involved and take into account the questions of the potential societal and/or industrial partners.

Finally, the programme committee is convinced that the research activities of this programme have contributed to the intensification of cognition research in the Netherlands. The Dutch cognitive research community has by now developed an excellent reputation and is able to compete with other

Appendix: list of committee members

Evaluation committee

Prof E.V. Clark	Stanford University (USA)
Prof N. J. Nersessian	Georgia Institute of Technology (USA)
Prof R. Morris	University of Edinburgh (GB)
Prof W. Prinz	Max Planck Institute (Germany)
Prof F.H. Lopes da Silva	University of Amsterdam (NL)

Programme committee

From 2001 until 2004

Prof J.F.A.K. van Benthem, chair	University of Amsterdam
Prof C.J. ten Cate	Leiden University
Prof P. Hagoort	F.C. Donders Centre
Prof H.J. van den Herik	University of Maastricht
Prof M. Joëls	University of Amsterdam
Prof R. de Jong	University of Groningen
Prof R.S. Kahn	University Medical Centre Utrecht

From 2004 until 2010

Dr M. van Turenhout	F.C. Donders Centre for Cognition (until 2008)
Prof L.C. Verbrugge	University of Groningen
Prof. T.G.G. Groothuis	University of Groningen
Prof A.A. Maes	University of Tilburg
Prof J.M.J. Murre	University of Amsterdam
Dr D. Posthuma	Free University of Amsterdam
Prof J.B.J. Smeets	Free University of Amsterdam
Prof W.B. Verwey	University of Twente
Prof A. Visser	University of Utrecht

Steering committee

Prof J.A. Michon	Professor Emeritus, Leiden University
Prof P. Adriaans	University of Amsterdam
Prof J.C.J.M. van den Bergh	Free University of Amsterdam (until 2008)
Prof H. Duifhuis	University of Groningen
Prof H.G.M. Rooijmans	Raad voor Gezondheidsonderzoek (until 2007)
Dr A.D. Wolff-Albers	KNAW
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