Crossing Borders – Interdisciplinary Reviews and Their Effects

An exploration based on new proposals for DFG individual grants (2005 to 2010)

DFG

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1 Summary

This report presents the findings of an analysis, based on internal data, of the practice of interdisciplinary reviews of research proposals submitted to the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation). This is an abridged version of a study published in German in November 2013 [1].

The term 'interdisciplinarity' is generally used to describe the situation in which representatives of different disciplines work together on research. The term 'research discipline' has numerous meanings. In common use it covers both the cognitive aspects of research, such as specific bodies of knowledge, methods and understandings of problems, and the particular social and cultural characteristics of academic communities. It is not possible to define the core of a discipline unambiguously; therefore, it follows that the limits and transitions between disciplines cannot be characterised either. In each instance when empirical access to a subject is required, a new examination must be made of the data and its suitability for a sufficiently robust treatment.

In accordance with its statutes, the DFG funds basic research "in all its branches" – from anaesthesiology to zoology. To fulfil the often very different needs of different research disciplines as effectively as possible, the funding activities of the DFG are organised along the lines of subject areas. This is particularly evident in the review process, which gives the review boards a crucial role in the decision-making process. More than 600 researchers serve on a voluntary basis on a total of 48 of these discipline-oriented bodies, elected by their peers for a four-year period as experts in one of currently 209 subject areas. The main task of each of these review boards is to ensure the quality of the review process within the specific range of their subject areas [2].

This study takes advantage of this subject-based approach, being based on data relating to the review of approximately 20,000 new proposals for DFG individual grants on which decisions were reached between 2005 and 2010. For each proposal, information is available about the review board which examined it. The analyses refer to this subject classification. This is followed by analyses based on the subject focus of the researchers responsible for reviewing a proposal. Here too, a distinction is made between 48 separate areas, corresponding to the review boards, in this case referred to as 'reviewer subjects'. We see particular indications of interdisciplinary research where the expertise of individuals from different subject fields has

1 Cf. DFG 2013: Fachübergreifende Begutachtung: Strukturwirkung und Fördererfolg. Eine Exploration auf Basis von Neuanträgen in der DFG-Einzelförderung (2005 bis 2010), Bonn, November 2013, www.dfg.de/dfg_profil/zahlen_fakten/evaluation_studien_monitoring/studien/

2 For more information see www.dfg.de/en/dfg_profile/statutory_bodies/review_boards/

been utilised. These interdisciplinary reviews are not a direct expression of 'interdisciplinarity' in the sense outlined above, but do indicate that the expertise of researchers from different fields is necessary to review the proposals.

The report is divided into seven chapters and concludes with an appendix of tables. Following the description of the scientific problem in chapter 2 and a description of the data basis and methods used in chapter 3, chapter 4 addresses the question of the significance of interdisciplinary review processes. The overall picture reveals that in around half of all the proposals included in the analysis, experts from different reviewer subjects were involved in the review process. Chapter 5 looks in detail at the relationship between interdisciplinary reviews and funding success. This examination is based on the 289 most common 'reviewer subject pairs', i.e. reviewer constellations such as 'Neurosciences' and 'Psychology'. The chapter also describes the frequency with which these result in success rates within, below or above general expected values. On the basis of these analyses, the chapter finally addresses the question of how stable the outlined findings are over time.

Overall, the results of the analyses indicate that there is no clearly distinguishable, stable relationship between interdisciplinary reviews and funding success. The theory that interdisciplinary reviews generally represent a risk factor for the success of a proposal cannot therefore be confirmed – but nor can the theory that research projects at the boundaries of established subjects can usually expect a 'risk bonus'.

The sixth chapter examines the question of the existence of 'higher-level' boundaries – manifested in groupings of reviewer subjects that are closely interrelated but not strongly linked to subjects in other clusters. To illustrate this, the network of relationships between the reviewer subjects considered is depicted in the form of a network graph. This results in the identification of an overall structure that incorporates all reviewer subjects in a common network through direct and indirect links. Hence, the review process for DFG proposals does not take place in strictly separated, subject-based worlds. Rather, cooperation in many directions is characteristic of the system.

2 Scientific Problem

The study presented here originated from discussions in DFG commissions and committees on the relationship between the interdisciplinarity of DFG proposals and their funding success. Three basic questions can be identified:

1. Are interdisciplinary proposals more successful than monodisciplinary proposals – for example due to the assumption that projects at the boundaries of established subject cultures promise to be particularly fruitful?
2. Are they less successful – which could be explained by the theory that they are moving away from established assessment cultures and are thus subject to a particular risk of rejection as being ‘neither one thing nor the other’?
3. Or is there no statistical correlation at all – which could be interpreted as a sign that subject ‘positioning’ plays a subordinate role to project-specific quality in funding decisions?

In simplified terms, the analyses are based on the assumption that research and the review of research proposals both usually take place within more or less clearly delineated subject cultures. Each of these cultures has specific quality rules that promote consensus on the question of which proposals are deserving or not deserving of DFG funding. Seen in these terms, stepping outside these subject boundaries represents an exception. A special risk (or more rarely, a special opportunity) is attested for these exceptions.

The DFG has a good collection of data on the relationship between project characteristics and the success of proposals. At first glance the available data appears less than ideally suitable for an examination of the aspect under consideration. Although every project submitted to the DFG is classified in a subject category, it is usually assigned to exactly one subject area. It is therefore possible to make statements about the relationship between subject area and funding success, but this information does not allow the effect of interdisciplinarity on the success of DFG proposals to be directly evaluated.

To operationalise the generally hard-to-define phenomenon of interdisciplinarity for the purposes of statistical analysis, a change of perspective is therefore required. Rather than the characteristics of a project, the characteristics of the review process are examined. Because there are usually exactly two reviews for a proposal, it is possible to include the relationship between the subjects of the two reviewers in the analysis. The object of investigation is therefore not the influence of the interdisciplinarity of proposals on funding success, but the extent to which there are differences in funding success between proposals in which the reviewer subjects of the experts involved are the same or different.

3 Data Basis and Method

3.1 Selection of project proposals

The analysis is based on new proposals on which decisions were made between 2005 and 2010. Of these proposals, which amounted to more than 40,000, cases were included if they fulfilled the following criteria:

1. A written review by at least two researchers had been entered in the DFG database.
2. These researchers submitted their own proposals during the period 2003 to 2010 and could therefore be assigned to a particular subject area (cf. DFG 2013).

With this restriction, and after the elimination of cases with incomplete information, the data basis consists of exactly 34,379 new proposals. In the case of 20,232 proposals, it was possible to assign the reviewers to a 'primary reviewer subject'. As persons are not directly classified under a particular subject area in the DFG's proposal database, information from reviewers' own proposal biographies was used instead. Around 60 percent of all the proposals referred to here were reviewed by researchers who themselves submitted one or more proposals to the DFG within a defined period (2003 to 2010). The 'primary reviewer subject' of each reviewer is determined on the basis of the subject areas in which these proposals were classified (for a discussion of method effects, see DFG 2013: 17ff).

3.2 Classification system used

For the categorisation of reviewers in subject areas, the analyses use the DFG classification system. This distinguishes between four levels (cf. for levels a. to c. Table 4 in the appendix[3]):

a. 4 scientific disciplines are divided into
b. 14 research areas with
c. 48 review boards and
d. 209 subject areas

The subject classification for this exploration is carried out at the level of the 48 review boards. The operationalisation of the subject categorisation of reviewers chosen here has implications. Thus, it should be noted that the DFG review boards sometimes vary considerably in size. If we take the total number of proposals for individual grants between 2005 and 2010 as a benchmark, this number ranges from 120 proposals for the review board *Statistical Physics*, *Soft Matter, Biological Physics, Nonlinear Dynamics* to nearly 4,600 for the review board *Medicine*.

The former has no internal distinctions between subject areas. The review board *Medicine*, on the other hand, is split into 32 subject areas.

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3 The subject areas distinguished at level d. document the complete DFG classification system, which can be viewed at www.dfg.de/en/dfg_profile/statutory_bodies/review_boards/subject_areas/.

Accordingly, the 48 DFG review boards may cover a narrow or broad spectrum of subjects. While the review board *Mathematics*, for example, might appear to be relatively clearly defined, the review board Social Sciences covers a very wide range of subject areas[4]. The same applies to various other review boards, particularly in the humanities and social sciences, and, it would appear, especially in those cases where these boards have a collective name[5]. The statistical finding of a 'subject-specific' review, obtained as a result of the method described here, should therefore not be equated with 'disciplinarily isolated'.

3.3 Classification of the subject affiliation of review processes

To investigate the relationship between the subject area affiliation of a review process and the funding success of proposals, we make a distinction between the following constellations:

1. **Subject-specific review:** Two reviewers with the same primary reviewer subject
2. **Interdisciplinary review:** The reviewer subjects are different.

The operationalisation is shown schematically in Figure 1: If the proposals previously submitted by a reviewer were preferentially processed in reviewer subject A, he/she is assigned to subject area A. If the co-reviewer was also primarily active in subject A, the proposal reviewed by both of them is deemed to have undergone a 'subject-specific' review. If the two reviewers are from different reviewer subjects, the review is an 'interdisciplinary' review.

Each proposal is usually reviewed by two people, which is why it is often possible to simplify matters by talking about the 'subject pairs' brought together in this process. Because there are also cases involving three or more reviewers, some proposals are assigned to more than one subject pair[6]. The number of these pairs is therefore slightly higher than the number of proposals. Data is available on a total of 23,260 subject pairs.

Each person who participated in the evaluation of the new proposals considered in the analysis has been assigned to exactly one of 48 possible reviewer subjects. For interdisciplinary reviews, this results mathematically in

$$((48 \times 48) - 48) / 2 = 1{,}128 \text{ possible combinations.}$$

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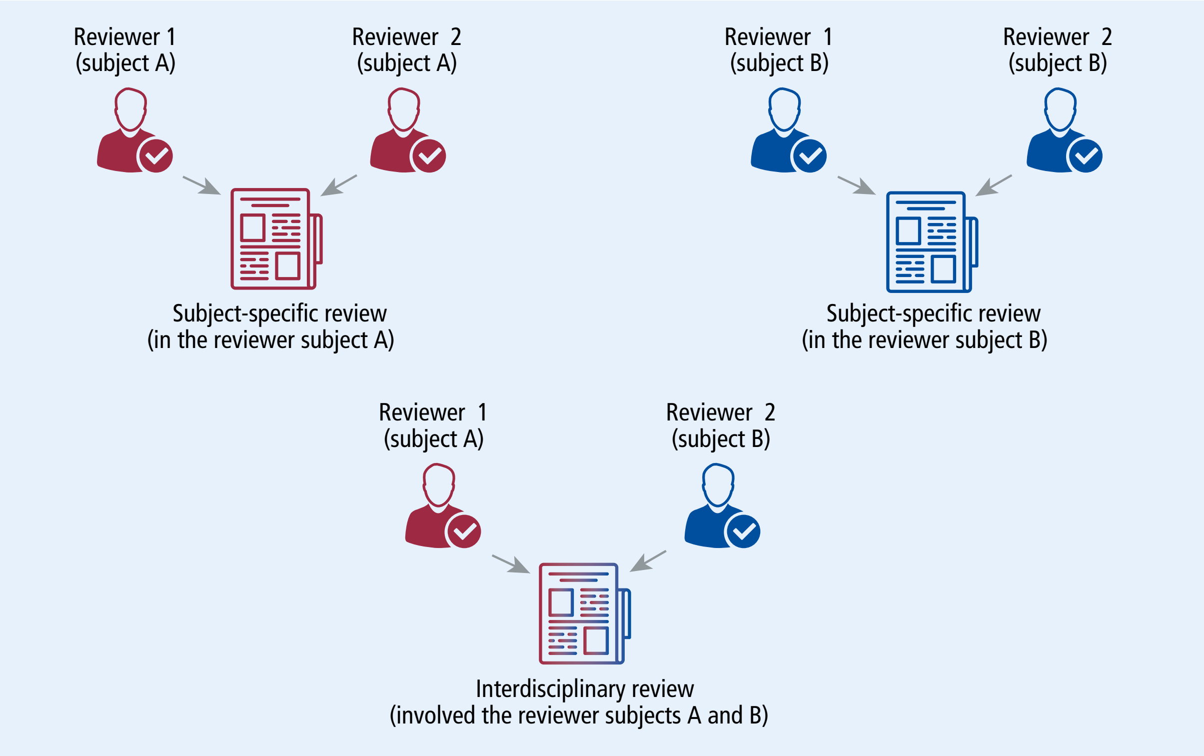
4 The Mathematics review board is also one of the few which are not further subdivided into individual subject areas. RB 111 Social Sciences, on the other hand, handles research proposals from the following areas: 111-01 Sociological Theory, 111-02 Empirical Social Research, 111-03 Communication Sciences and 111-04 Political Science.

5 Other examples include RB 103 Fine Arts, Music, Theatre and Media Studies and RB 106 Non-European Languages and Cultures, Social and Cultural Anthropology, Jewish Studies and Religious Studies. However, this type of combination is not limited to the humanities and social sciences, as is demonstrated by the example of a review board in the natural sciences, 316 Geochemistry, Mineralogy and Crystallography.

6 This is the case in approximately 13 percent of the cases analysed here. If there are three reviewers, this results in three 'subject pairs'. If the reviewers represent subject A, subject A and subject B, then the review will be included in the analysis in the form AA and 2 x AB. If subject A, subject B and subject C are involved, this results in pairs AB, AC and BC. As shown by the first case, a proposal reviewed by three people may therefore have both subject-specific (AA) and interdisciplinary (AB) 'subject pairs'.

Figure 1:
Schema of subject-specific and interdisciplinary reviews



In the data set used there were 644 subject combinations. This corresponds to approximately 57 percent of the theoretically possible combinations. This is a very high figure that also allows room for 'exotic' combinations – such as two reviewers whose primary reviewer subjects are Zoology and Computer Science (eight cases), or Plant Sciences and Chemical Solid State and Surface Research (11 cases). On the other hand there are predictably frequent constellations, for instance between the reviewer subjects Basic Biological and Medical Research and Medicine (604 combinations), or between Medicine and Neurosciences (391 combinations). The frequency of these combinations may be considered 'predictable' partly because these cases involve very large reviewer subjects, but especially because it is difficult to draw a clear boundary between these disciplines.

To take account of the differences in the proximity of reviewer subjects, we divide the sub-segment of interdisciplinary subject pairs into two sub-groups: To take account of the differences in the proximity of reviewer subjects, we divide the sub-segment of interdisciplinary subject pairs into two sub-groups:

2a. **Closely linked:** Relatively frequent interaction between the participating reviewer subjects

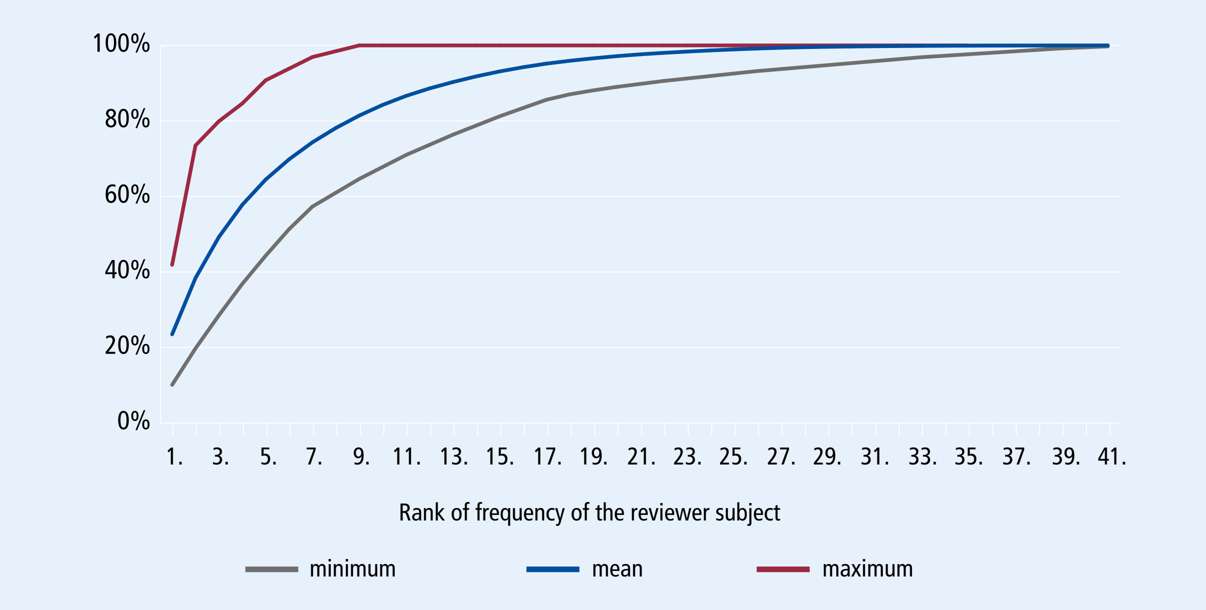
2b. **Distantly linked:** Relatively rare interaction between the participating reviewer subjects

The proximity of reviewer subjects is thus operationalised by means of the frequency with which reviewers from two different subjects review proposals for individual grants. Because it is not possible to specify an absolute threshold for close and distant links owing to the very different size of the reviewer subjects in question, we have chosen a rank order approach.

The categorisation as 'close' or 'distant' therefore follows purely statistical rules and is not intended to serve as a qualitatively based classification.

On average across the 48 reviewer subjects, researchers from 27 subjects interact in varying pair constellations to evaluate DFG research proposals. The figures range from 9 subjects (Jurisprudence) to 43 subjects (Medicine and Computer Science). If we arrange the corresponding subjects for each reviewer subject in order of the frequency of combinations and cumulate the proportions of each, the result is the distribution shown in Figure 2.

Figure 2: Most frequent corresponding co reviewer subjects as a proportion of all partner subject relationships of a subject (cumulative)



As a general average, the first corresponding subject accounts for 24 percent of all interdisciplinary co-reviewer partnerships (middle curve) – ranging from 10 percent (minimum) to 42 percent (maximum). Together with the second most frequent subject, a share of 38 percent (ranging from 20 percent to 74 percent) is reached, while by the sixth subject more than two thirds (70 percent) of all interdisciplinary co-reviewer partnerships have been covered (51 percent to 94 percent).

This means firstly that there is a wide variation in the absolute number of joint reviews by involved partner subjects, and secondly that constellations are mainly concentrated on a limited number of frequently interacting subjects.

Against the background of these figures, from this point onwards the two subjects most commonly involved in co-reviewer partnerships will be combined to form a 'closely linked' group. All the other cases constitute the 'distantly linked' group [7]. A complete overview of the reviewer subjects classified as 'close' can be found in Table 5 in the appendix.

7 In the case of two reviewer subjects, the corresponding subjects that occupy ranks 2 and 3 have the same interaction frequency. In these cases the ‚closely' corresponding group consists of three subjects (cf. Table 5 in the appendix).

4 Importance of interdisciplinary reviews

Table 1 shows the number and proportions of proposals that went through interdisciplinary and subject-specific review processes in the four scientific disciplines. Over half of the proposals (54 percent) were reviewed by researchers with the same primary reviewer subject. Accordingly, 46 percent of all proposals underwent an interdisciplinary review process.

Table 1:
Importance of interdisciplinary reviews in each scientific discipline

Scientific discipline	Total	Review type			
		subject-specific		interdisciplinary	
		N	%	N	%
Humanities and Social Sciences	3,562	2,405	67.5	1,157	32.5
Life Sciences	6,758	3,735	55.3	3,023	44.7
Natural Sciences	4,946	2,298	46.5	2,648	53.5
Engineering Sciences	4,966	2,554	51.4	2,412	48.6
Total	**20,232**	**10,992**	**54.3**	**9,240**	**45.7**

The figures clearly show that interdisciplinary reviews are no exception, but make up a constitutive part of the system. In the life sciences, natural sciences and engineering sciences the span is relatively narrow (45 percent to 54 percent); only in the humanities and social sciences do interdisciplinary reviews play a somewhat subordinate role (33 percent)[8].

We will now change our perspective. While in Table 1 the analysis was based on *proposals*, the remaining analyses will focus exclusively on the *reviewer subjects* that were brought together in review processes. This approach takes account of the fact that, for a detailed consideration, particularly in accordance with the division into 'closely' and 'distantly' linked reviewer pairs described in chapter 3.3, this is the only way to adequately reflect the asymmetry of the constellations in question. For example, for the relatively 'small' reviewer subject of *Psychology*, *Neurosciences* is a frequently occurring partner subject and is therefore a 'closely linked' partner subject; however, viewed the other way round, *Psychology* plays a less prominent role vis-à-vis the comparatively 'larger' *Neurosciences*. From the perspective of *Neurosciences*, Psychology belongs in the 'distantly linked' category. The most frequent (and therefore 'closest') link for *Neurosciences* is with the reviewer subjects *Medicine* and *Basic Biological* and *Medical Research*.

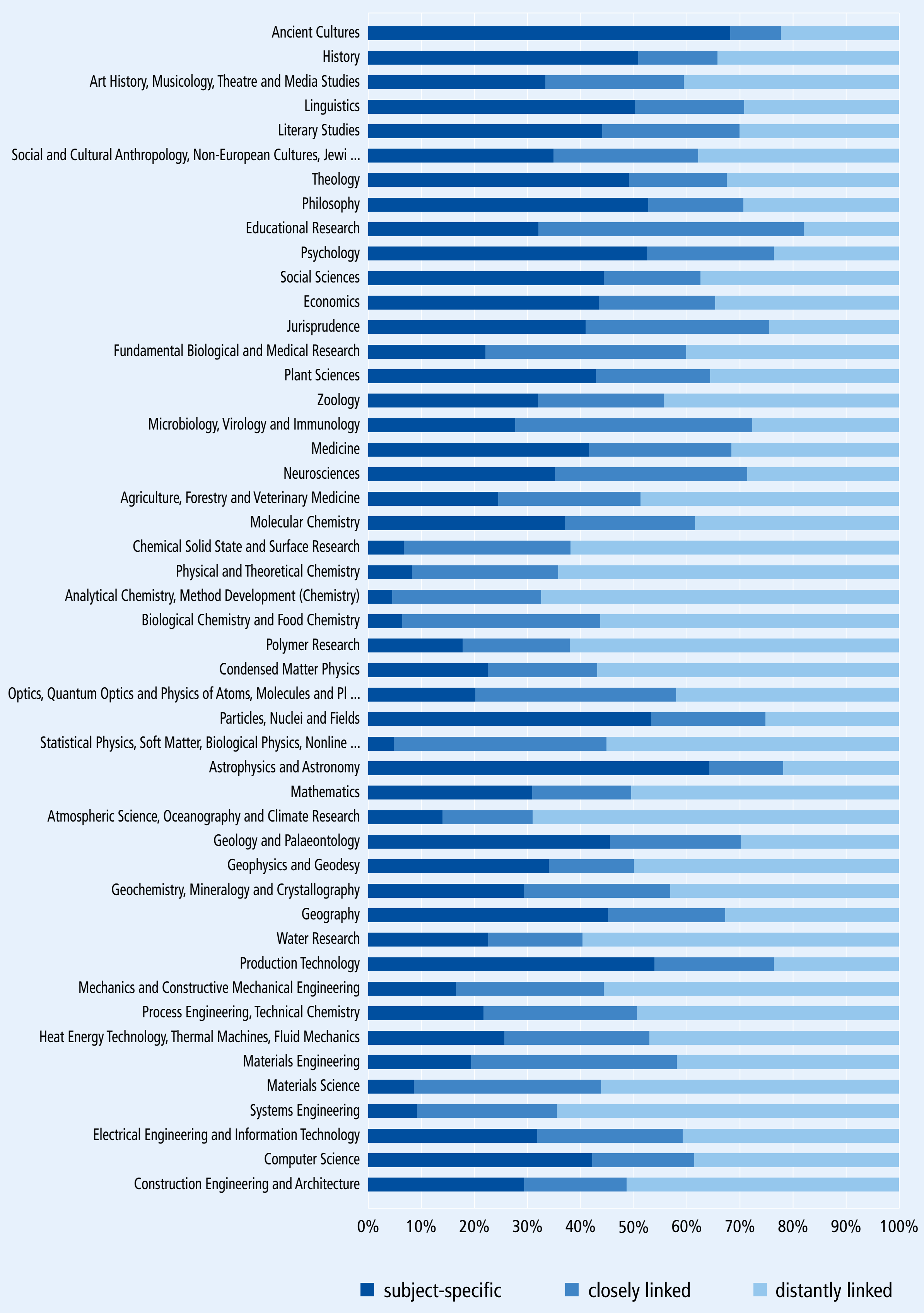
Figure 3 shows the proportion of subject-specific reviews and reviews with closely and distantly linked subjects for the 48 reviewer subjects. As can be seen, the proportions of the three types of reviews vary significantly from one subject to another.

8 As explained in chapter 3.2, the term 'subject-specific' should not be understood as 'monodisciplinary'. In the context of this exploration, this term simply means that reviews categorised as such relate to the spectrum of subject areas assigned to the relevant review board in the DFG classification system.

The proportion of subject-specific reviews ranges from less than 5 percent in the reviewer subject *Method Development (Chemistry)* to 68 percent in *Ancient Cultures*. Conversely, if we look at the importance of cooperation with distantly linked subjects, *Education Sciences* has relatively few such links with 18 percent, while in *Atmospheric Science* and *Oceanography* this type of cooperation clearly predominates with 69 percent.

If we make an attempt at typification, in the humanities and social sciences we see mainly reviews within the spectrum of subject areas that make up a reviewer subject. In the life sciences, nearly three quarters of all review pairs are subject-specific or closely linked reviewer constellations. In the natural sciences, interaction with distantly linked subjects is relatively predominant. Review processes in the engineering sciences are characterised by a distribution close to the general average.

Figure 3:
Proportion of interdisciplinary reviews by reviewer subject



5 Interdisciplinary Reviews and Funding Success

5.1 General relationship at the level of the four scientific disciplines

Having considered in the previous chapter the general importance of interdisciplinary reviews of DFG proposals, in the following analyses we will consider the question of the relationship between the subject-specific or interdisciplinary nature of a review and the funding success of a proposal. This is calculated in the form of success rates, i.e. the ratio of the number of approved proposals to the number of proposals on which a decision was made.

If a proposal is the subject of an interdisciplinary review, the deviation from the general average cannot be taken on its own as a criterion for above-average or below-average funding success. Rather, consideration must be given to the specific subject constellations (chapter 5.2) and fluctuations in success rates over time (chapter 5.3).

If we look at the overall picture, we see a weak correlation at best. In the case of constellations where both reviewers belong to the same reviewer subject, the average success rate is 43.4 percent. For closely related constellations the average is 41.6 percent and for distantly related constellations, 39.7 percent. The overall picture is also confirmed if we look at the detailed level of the 48 reviewer subjects (see Table 8 in the appendix).

Table 2:
Success rates by review type and scientific discipline (%)

Scientific discipline	Total	Review type		
		Subject-specific	Closely linked	Distantly linked
Humanities and Social Sciences	37.4	38.3	33.6	35.7
Life Sciences	43.4	44.4	43.3	41.8
Natural Sciences	45.2	45.5	45.2	42.0
Engineering Sciences	42.8	45.7	44.2	39.2
Total	**42.8**	**43.4**	**41.6**	**39.7**

5.2 Relationship at the level of specific subject pairs

In terms of DFG funding the success rates of subject areas vary, sometimes significantly. The general average success rate of the proposals on which this study is based is, as stated above, around 43 percent (see Table 2). If we differentiate by reviewer subject and only look at those cases where both reviewers have the same primary reviewer subject (subject-specific reviews), the figure ranges from 26 percent to 69 percent. Subject-specific chances of success vary over a range of more than 40 percentage points (cf. in the differentiation of 48 reviewer subjects Table 6 in the appendix).

The question of whether proposals which underwent an interdisciplinary review were more or less successful than proposals which underwent a subject-specific review is therefore a question of perspective: If the value for two subjects with strongly divergent success rates lies between these two rates, this is a success from the viewpoint of one subject and a failure from the viewpoint of the other.

In the following consideration of the success rates of the subjects involved in an interdisciplinary review, we proceed on the basis of a simple hypothesis: interdisciplinary reviews cannot be considered to have a specific effect on the funding success of DFG proposals if on average they produce the same success rate as the sum of all proposals that underwent subject-specific reviews in the two reviewer subjects that make up the review pair. If the interdisciplinary success rate is lower, there is a bias in favour of the subject with the lower success rate. If it is higher, there is a bias in favour of the subject with the higher success rate.

The analysis is based on the following concepts and operationalisations:

- **Combined Rate (CR):** Success rate for proposals that underwent interdisciplinary review (intersection of proposals from subject A and subject B).
- **Subject-specific Reference Rate (SRR):** SRRs contrast with the Combined Rate (CR) as the values that result when in one case a proposal was reviewed solely by reviewers from subject A (SRRA) and in the other case solely by representatives of reviewer subject B (SRRB).
- **Average Subject-specific Reference Rate (ARR):** Average of the Subject-specific Reference Rates of the two reviewer subjects, A and B, involved in a review process.

Example: The Subject-specific Reference Rate (SRR) for proposals evaluated by two reviewers from subject A is 40% and for subject B 50%. This gives an Average Subject-specific Reference Rate (ARR) of

$(SRR_A\text{: } 40\ \% + SRR_B\text{: } 50\ \%) / 2 = ARR_{AB}\text{: } 45\ \%$

If the Combined Rate of the proposals reviewed by representatives of subjects A and B (and therefore in an 'interdisciplinary' review) is 30%, this gives a deviation of the Combined Rate (CR) from the Average Subject-specific Reference Rate (ARR) of

$CR_{AB}\text{: } 30\ \% - ARR_{AB}\text{: } 45\ \% = -15$ percentage points

The applications examined in an interdisciplinary review in this combination thus have a 15 percent lower chance of success than the expected value (ARR) suggests.

The analysis is based on a total of 289 subject constellations with a frequency of at least eight joint reviews. This value has deliberately been set low in order to include distantly linked (and therefore rare) reviewer constellations in the analysis to an adequate degree.

The average Combined Rate for the 289 subject constellations is CR = 40.4 percent and the Average Subject-specific Reference Rate is ARR = 44.6 percent. Proposals evaluated by two reviewers with the same primary reviewer subject therefore exhibit slightly higher chances of success compared with proposals reviewed by researchers from different subject backgrounds.

There is considerable variation: the span in the distance between Combined Rate (CR) and Average Reference Rate (ARR) ranges from – 44 to + 40 percentage points (cf. Table 3). There is an extensive correlation between Combined and Average Reference Rates for a good third of all subject combinations (99 of 289 cases). In 46 percent of subject combinations, success rates are lower. In 20 percent of subject pairs, success rates are higher. Interdisciplinary reviews are therefore associated with more than twice as many below-average success rates as with above-average funding rates.

Table 3:
Difference between Average Reference Rate (ARR) and Combined Rate (CR) by subject pair

Combined Rate (CR) is in relation to the Average Reference Rate (ARR)	**N**	**%**
very much lower (– 44 to –20 percentage points)	31	10.7
much lower (–20 to –10 percentage points)	49	17.0
slightly lower (–5 to –10 percentage points)	52	18.0
about the same (–5 to +5 percentage points)	99	34.3
slightly higher (+5 to +10 percentage points)	28	9.7
much higher (+10 to +20 percentage points)	19	6.6
very much higher (+20 to +40 percentage points)	11	3.8
Total	**289**	**100.0**

Basis: subject combinations with eight or more joint reviews.

In general, it may be noted that the system is highly variable: subject constellations in which interdisciplinary reviews do not result in large deviations from expected values are predominant, and there are combinations where interdisciplinary reviews are both considerably above and considerably below expected values. The fact that the latter has a higher weight is due to the slightly below-average probability of success of interdisciplinary reviews.

5.3 Stability of findings over time

In addition to subject-related differences in a proposal's chances of success, consideration should also be given to time-related effects. DFG success rates are subject to time-based fluctuations – for example because of fluctuation in the number of proposals submitted, because of (usually moderate) fluctuations in the budget made available to a particular subject area, which affects the number of projects that can be funded, and because of variation in the number of good proposals submitted from one period to another.

It is therefore necessary to examine whether and to what extent the observed differences (Table 3) remain stable over time for the 289 individual subject pairs. Is it possible to identify constellations with above- or below-average funding success that remain stable over time, above and beyond the statistical correlation?

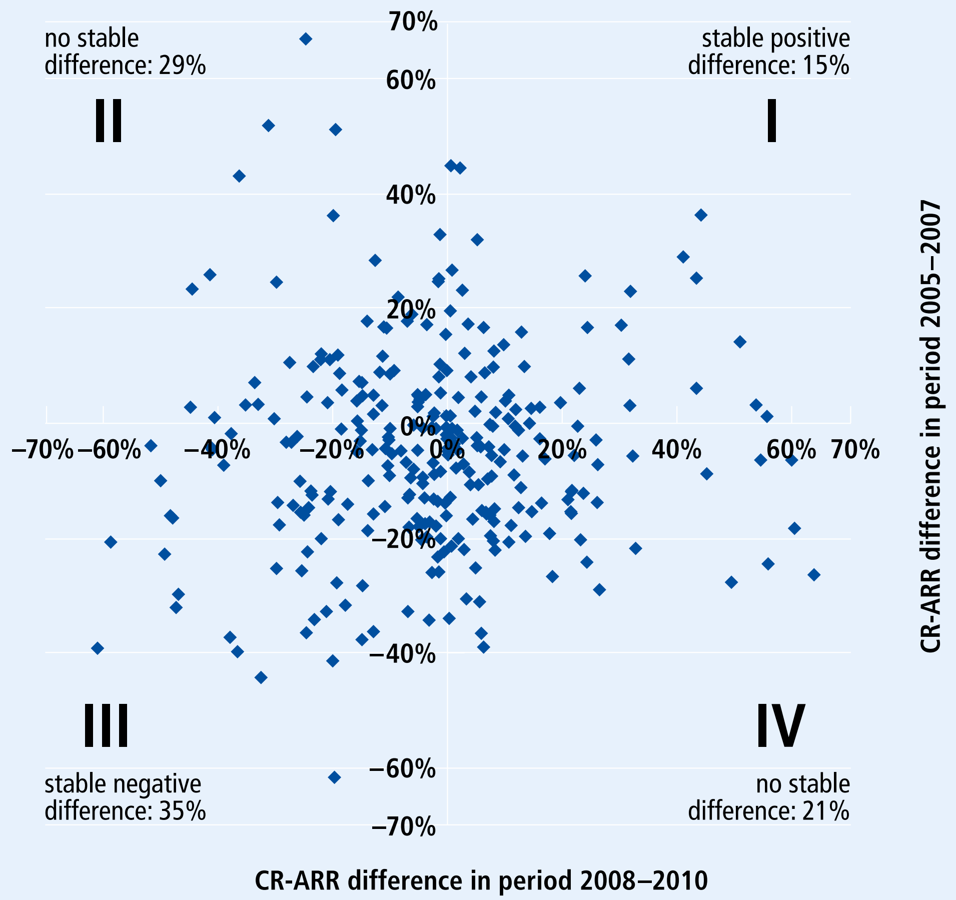
To answer this, we will compare all 289 subject combinations over time. The question is: To what extent does the relationship (higher, same, lower funding success) observed for a combination of two reviewer subjects for the first half of the period under review – 2005 to 2007 – correspond to that for the second three-year period (2008 to 2010)?

Firstly, it should be noted that the difference between Combined Rate (CR) and Average Reference Rate (ARR) applies in both periods: on average the Combined Rate (CR) for the early period is 2.6 percentage points lower than the Average Reference Rate (ARR) (42.6 percent – 45.2 percent), while in the late period the difference is –4.5 percentage points (39.2 percent – 43.7 percent).

A more in-depth examination from the microperspective of individual subject pairs can be found in Figure 4. For all 289 subject combinations, the horizontal axis shows the difference between the Combined Rate (CR) and Average Reference Rate (ARR) for 2005 to 2007 and the vertical axis shows the difference for 2008 to 2010. Accordingly, subject combinations shown in quadrants II and IV are characterised by the fact that the difference between CR and ARR varies between the two periods ('no stable difference'). Subject combinations in quadrants I and III exhibit a similar deviation of CR from ARR in both periods ('stable positive difference' or 'stable negative difference').

The concentration around the intersection of the axes is striking. In many cases, the Combined Rate (CR) and Average Reference Rate (ARR) are very similar when split into two periods. In these cases there is therefore no correlation, or only a stable weak correlation, between interdisciplinary review and funding success.

Figure 4:
Comparison of CR/ARR difference in 2005–2007 and 2008–2010 (scatter diagram for the 289 most frequent subject pairs)



Basis: at least 8 shared reviews, N=289

The broad scatter indicates that there is no clear relationship in the ratio of Combined Rate (CR) and Average Reference Rate (ARR). The 289 points symbolising these pairs are scattered relatively evenly over the four quadrants. In around 50 percent of the cases, the deviation of CR from ARR differs between the two periods ('no stable difference'): proposals with the corresponding review constellations exhibit an above-average approval rate in one three-year period and an above-average rejection rate in the other three-year period. In the remaining half, the correlations are synchronous ('stable negative difference', 'stable positive difference'), i.e. proposals with these review constellations exhibit above- or below-average approval rates in both periods, but here too the scatter is considerable.

Review constellations with the same values and those with deviating values in the two three-year periods approximately balance each other out. In summary, it is not possible to identify either a positive or a negative correlation between the conjunction of two reviewers from specific subjects and the funding success of the evaluated proposals. The answer to the question as to the existence of subject-based review constellations that sustainedly favour or jeopardise funding success is therefore guarded.

6 Structural Impact of Interdisciplinary Reviews

The empirical findings presented here show that interdisciplinary reviews take place frequently. At the beginning we identified the fact that each reviewer subject has a specific set of adjacent subjects – defined as subjects with which co-reviews are frequently carried out and with which a subject therefore has a close relationship. The question that now arises is whether and to what extent these groups of 'neighbours' interact, or whether, conversely, as already refuted for the entity of an 'individual subject', they tend to form self-contained worlds (each with its own proposal and review rules).

Information about these adjacent reviewer subjects is therefore drawn upon to finally examine the overall structure which results from the more or less intensive links between the 48 reviewer subjects. Is it possible to identify clusters that encompass a more or less narrowly delineated area of joint research? What is the relationship between these clusters?

The usual method of analysing relationships between elements is the network analysis. It allows the intensity of relationships to be calculated in relational contexts and enables them to be visually depicted in the form of network graphs. In order to visualise the structures resulting from the interdisciplinary review of DFG proposals, we will use a method developed at the Max Planck Institute for the Study of Societies in Cologne[9].

6.1 Overall subject-based structure

The analysis in the previous chapter was based on exactly 289 subject pairs, each of which was represented by at least eight joint reviews. The network of relationships between these pairs is represented by means of the network analysis undertaken here. The network analysis in Figure 5 is based on a matrix of relationships between 48 reviewer subjects. A relationship is considered to exist if researchers from two reviewer subjects have jointly reviewed at least one proposal.

- In accordance with the threshold value, the thinnest arrow represents 8 co-reviewer partnerships. The widest arrow (between Medicine and Basic Biological and Medical Research) symbolises 604 co-reviewer partnerships.
- In addition, the degree of networking of each reviewer subject is indicated by the size of the circle for each subject. The largest circle is Medicine, which has 2,168 co-reviewer partnerships with 27 other subjects (as indicated above). Compared with a simple enumeration of partner subjects, this calculation of the degree of networking provides extra information allowing the overall intensity of the various interactions to be represented.

9 The visualisations presented here were created by the developer of the method, Lothar Krempel.

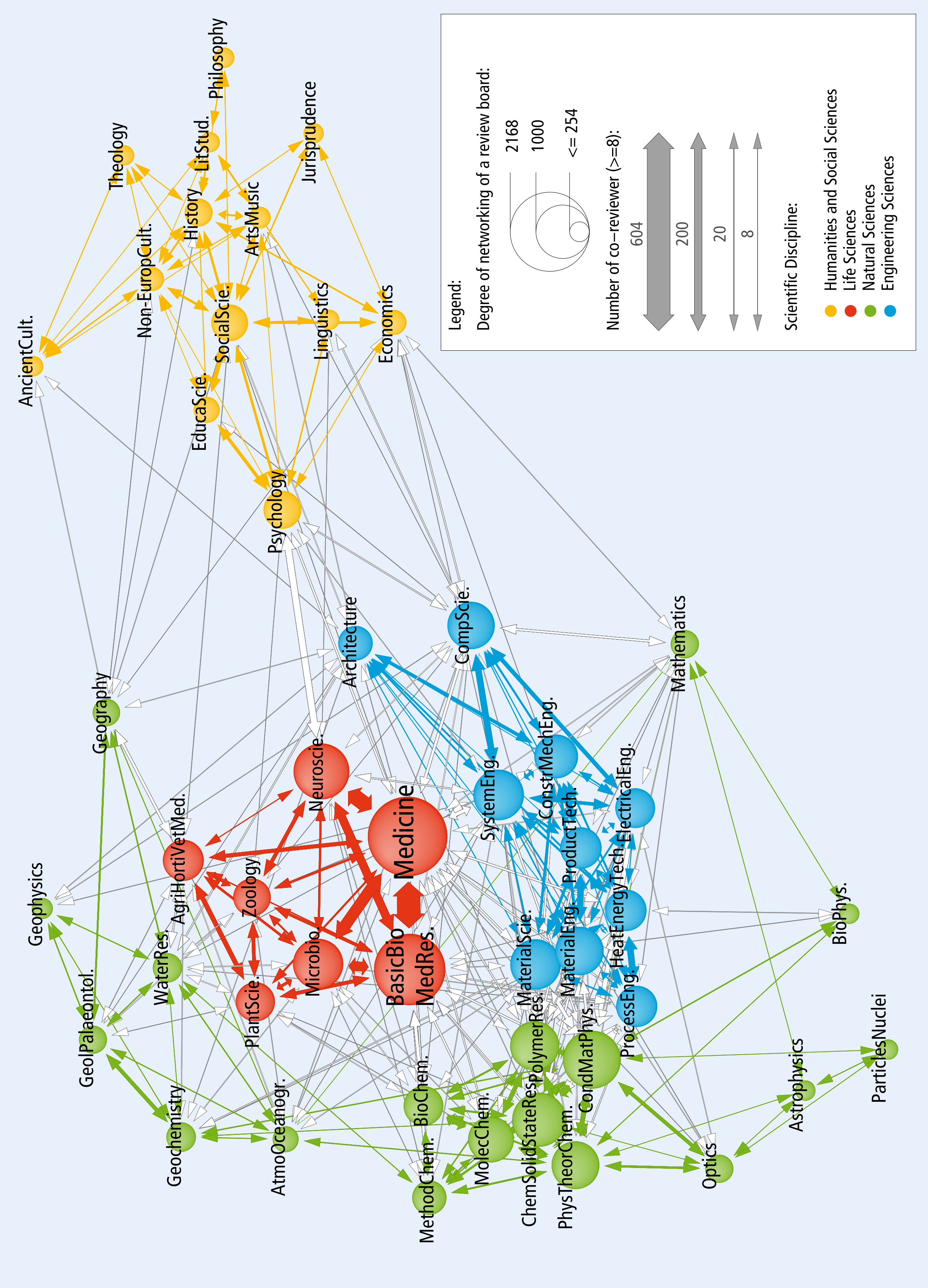
- The colour of a circle indicates to which of the four scientific disciplines defined by the DFG a reviewer subject belongs. Coloured arrows indicate co-reviewer partnerships within one of these disciplines, while white arrows indicate a relationship between two reviewer subjects in different disciplines.
- Finally, the positioning of the nodes should be noted: the diagram is based on an algorithm that places subjects with close contacts near one another and subjects with rare or no contacts far away from one another, using the best possible approximation[10]. The diagram thus clusters subjects which have a close relationship to each other and positions them further apart if they have only an indirect relationship with each other.

Figure 5 shows a complete structure that incorporates all 48 reviewer subjects and is therefore interdisciplinary while also encompassing all subjects. The 'network of subjects' resulting from interdisciplinary reviews in the written process does not contain any separate islands with isolated subject or review cultures. Rather, intensive multidirectional interactions are typical.

An internal structure can be immediately recognised within the network, consisting of two main clusters which are linked together: on the left is a relatively closely networked structure made up of subjects in the life sciences, natural sciences and engineering sciences, while on the right are subjects in the humanities and social sciences. For the latter, the finding stated above can thus be stated in more specific terms: here, not only are interdisciplinary reviews more concentrated on the individual subjects that combine to make up a reviewer subject for the purposes of the DFG review boards, but when they do extend beyond the boundaries of this subject, they predominantly focus on relationships within the humanities and social sciences.

10 There are many algorithms for the visualisation of network data, which lead to solutions that often differ in their details. The positioning of the individual nodes is not therefore intended to be mathematically exact. Other configurations are possible; the complexity of the multidimensional links permits representations that differ in the details. The solution presented here was generated with Gephi and the ForceAtlas algorithm. Like other methods, the algorithm is based on a force model. The attractive forces use factors that include the number of partner nodes and their strength (edge weight), which is of special interest in this case (cf. www.gephi.org).

Figure 5:
Network resulting from interdisciplinary review processes



Note: The complete names of the reviewer subjects, which are labelled in an abbreviated form here, can be found in Table 4 in the appendix.

History occupies a key position within the humanities and social sciences cluster. Reviewers with a DFG proposal biography that includes proposals considered by review board "102 – History" therefore have the broadest set of subject cross-relationships within the spectrum of subjects in this cluster.

Three subjects in the social and behavioural sciences function as bridges to the cluster on the left. Social Sciences, which already appears to be well networked within the humanities and social sciences, forms a link to subjects such as *Architecture*, *Computer Science* and *Geography*. *Psychology* has very strong relationships with medical subjects, especially with subjects that come under *Neurosciences*.

Reviewers whose main subject interest is in Economics often work together with experts in *Mathematics*, *Geography* or *Computer Science* to review DFG proposals. However, there are also links to other subjects in the engineering sciences, such as *Systems Engineering* and *Production Technology*.

On the left, *Neurosciences* and above all *Computer Science* and *Geography* act as bridges to the humanities and social sciences subjects [11]. *Construction Engineering* and *Architecture* is also similarly positioned.

Overall, the layout of the two main clusters corresponds to the English-language model of 'science' (left) vs. 'humanities' (right), with a transitional area consisting mainly of social, behavioural and formal sciences subjects (especially *Mathematics, Computer Science, Systems Engineering*).[12]

For the natural, life and engineering sciences subjects, reference has already been made to the tight-knit structure that characterises the relationships between these subjects. Interactions are many and diverse, but specific patterns and sub-clusters can also be identified. The reviewer subjects in the life sciences (shown in red) are positioned in the middle of this cluster. Below this, reviewer subjects in the engineering sciences (blue) form a sub-cluster. The greatest scatter can be found in the natural sciences subjects (green), which form a kind of 'shell' around the core of the left-hand cluster consisting of subjects in physics (bottom), chemistry (left) and geosciences (top). *Mathematics* occupies a special position: due to its many links with engineering sciences subjects, it is positioned near this group.

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11 One reason that Geography has the character of a typical 'interface subject' is the fact that until the review board reform in 2003, there was a separate review committee '115-Geography' (including subject areas 115-01: Physical Geography and 115-02: Anthropogeography and Economic Geography) within the research area 'Social Sciences'.

12 The DFG publication 'Funding Atlas 2015' documents the results of an analysis of interdisciplinarity in DFG-funded research groups within the framework of the Excellence Initiative. It depicts the network of subjects, differentiated into graduate schools and clusters of excellence. The basic structure is similar to the networks of reviewer subjects shown here. The differences are revealing in detail in that they show different subject participations in the two compared programme lines as well as specific subject interactions (cf. DFG 2016: Funding Atlas 2012: Key Indicators for Publicly Funded Research in Germany, Bonn, www.dfg.de/fundingatlas.

The ‘heart’ of the left-hand cluster is *Basic Biological* and *Medical Research*. Reviewers categorised as belonging to this primary reviewer subject based on their own proposal history occupy a key position in the network of subjects due to the many relationships with other reviewer subjects, which are especially intensive within the life sciences but also exist far outside it (shown in white in the diagram), mainly in the natural sciences.

Medicine has the most partner subjects overall and is connected to them with the highest degree of networking (2,168 contacts with 43 other subjects, of which 27 subjects have a strength >= 8). This is partly due to the sheer size of this subject and partly due to its special connectivity: because links with *Medicine* interconnect all scientific disciplines in many ways, this reviewer subject forms the centre of the entire system.

If we compare the different disciplines, networking is particularly intensive in the engineering sciences. This corresponds to the identification on the basis of Figure 3 of an above-average affinity with interdisciplinary reviews and can also be seen in the virtually universally high intensity of networking in the engineering sciences subjects. In addition to *Computer Science* and *Electrical Engineering*, *Heat Energy Technology, Materials Science* and *Systems Engineering* are very well networked in terms of their review culture – both within and outside the engineering sciences.

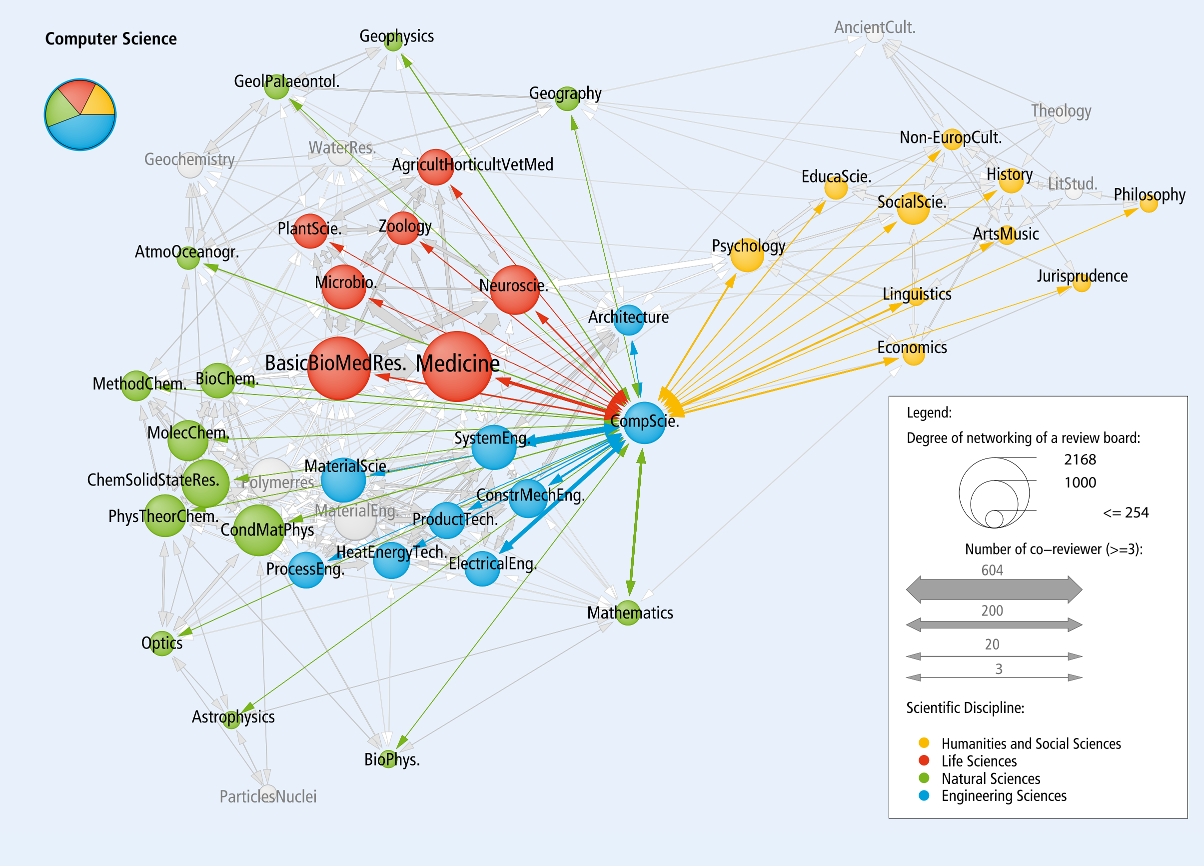
All in all, the analyses of the networking of subjects in the form of joint reviews produce the finding that boundaries both between subjects and between clusters of subjects are fluid. The structure is by no means an ‘anything goes’ model where subjects are related in any old way. Clusters with tight-knit internal networking form specific interdisciplinary cultures which are closely aligned to the DFG’s defined scientific disciplines. The natural sciences have the most clearly differentiated substructure, combining relatively clear sub-clusters defined in the DFG classification system as the research areas of *Mathematics, Physics, Chemistry* and *Geosciences*.

6.2 Subject-specific structure

As a supplement to Figure 5, the appendix to the German-language long version of this study (cf. DFG 2013) shows the direct relationships of each of the 48 reviewer subjects. For these so-called ‘egocentric networks’, the threshold for inclusion has been lowered slightly. To include ‘weak ties’ between subjects, the graphs show all relationships for which at least *three* joint co-reviews were documented. The layout of partner subjects corresponds to the layout in the complete network, whose structure is shown in grey as a background to the egocentric network, which is in colour. The key largely follows the above description for the complete network. In addition, a pie chart shows how the direct relationships with other reviewer subjects are distributed across the four disciplines.

Figure 6 illustrates this using the example of the reviewer subject *Computer Science*, which performs a similarly important role in the complete structure to that of *Medicine*, as described above. Reviewers with a DFG proposal biography that includes proposals evaluated by review board 409 – *Computer Science* interact with experts from all four disciplines. The most intensive interaction can be seen within the engineering sciences subjects, especially with *Systems Engineering* and *Electrical Engineering*, which form a common research area. But subjects in the other three disciplines also participate with approximately equal shares in the ‘computer science network’, as shown in the pie chart (top left).

Figure 6:
Subject network of the reviewer subject Computer Science, based on interdisciplinary reviews



Note: The complete names of the reviewer subjects, which are labelled in an abbreviated form here, can be found in Table 4 in the appendix. The pie chart shows what proportion of interdisciplinary co-reviewer partnerships are represented by each of the four scientific disciplines defined by the DFG

7 Outlook

This study is an initial exploration of the importance of 'interdisciplinarity' in the DFG's funding activities. It uses so-called 'process-generated' data, i.e. information recorded in the DFG's central proposal database as part of the procedure to process submitted proposals. The study profits from the fact that the DFG's funding process is strongly oriented towards the subject areas of the scientific communities it serves. The study uses this data on the subject background of the reviewers involved in DFG research proposals to reach conclusions on the effects of interdisciplinary reviews.[13]

In terms of the DFG's review system, it has firstly been demonstrated that interdisciplinary reviews are not the exception, but largely the rule. In line with this rule, with regard to the chances of success of proposals that undergo interdisciplinary review, there are scarcely any differences compared with proposals that undergo subject-specific review. Where such differences could be identified in the case of specific subject constellations, a comparison over time revealed that the finding lacked stability. The analysis therefore produced no empirical evidence for the oft-expressed theory that interdisciplinary reviews generally represent a risk factor in the funding success of a proposal – and equally little for the theory that research projects at the boundaries of established subjects can usually expect a 'risk bonus'.

For future studies, it may be worthwhile to study the structural effects of interdisciplinary reviews described in the last chapter over time: Can change be observed in sub-structures? Do certain subjects unite to form new clusters? Do different subjects adopt the role of 'bridges' between sub-structures that were previously mostly separate?

Another objective might be to conduct more in-depth analyses for the life sciences. Medicine, which is an especially large reviewer subject for the purposes of this study, is the only research area in which the DFG distinguishes 32 different subject areas (e.g. Human Genetics, Anesthesiology and Otolaryngology). The network of relationships between these subjects and with subjects outside medicine is of particular interest in the question as to the formation and existence of interdisciplinary research fields.

Further new insights would result from an in-depth investigation of the 'supply and demand' structure between subjects, i.e. by examining one-way rather than two-way relationships: Are there subjects with above-average participation in the review of proposals from other subjects? Conversely, in which subjects is there particular demand for review by experts from other subjects? Can any trends be identified here?

13 Cf. in this context the discussion in 'Rick Rylance, 2015: Grant giving: Global funders to focus on interdisciplinarity' . In: Nature 525, 7569: 313–315 (17 September 2015), doi:10.1038/525313a.

These and other conceivable questions demonstrate that the examination of the topic of interdisciplinarity in research funding is still in the early stages. The data collected by the DFG as part of the processing of proposals relating to the subject classification of the research it funds and to interdisciplinary relationships, for example resulting from the review process, also provides a rich resource for future analyses.

8 Appendix of Tables

Table 4:
DFG system of review boards, research areas and scientific disciplines

Label	Review board	Research areas	Scientific disciplines
AncientCult.	Ancient Cultures	Humanities	Humanities and Social Sciences
History	History		
ArtsMusic	Art History, Musicology, Theatre and Media Studies		
Linguistics	Linguistics		
LitStud.	Literary Studies		
Non-EuropCult.	Social and Cultural Anthropology, Non-European Cultures, Jewish Studies and Religious Studies		
Theology	Theology		
Philosophy	Philosophy		
EducaScie.	Educational Research	Social and Behavioural Sciences	
Psychology	Psychology		
SocialScie.	Social Sciences		
Economics	Economics		
Jurisprudence	Jurisprudence		
BasicBioMedRes.	Fundamental Biological and Medical Research	Biology	Life Sciences
PlantScie.	Plant Sciences		
Zoology	Zoology		
Microbio.	Microbiology, Virology and Immunology	Medicine	
Medicine	Medicine		
Neuroscie.	Neurosciences		
AgriHortiVetMed.	Agriculture, Forestry and Veterinary Medicine	Agriculture, Forestry, Horticulture and Veterinary Medicine	
MolecChem.	Molecular Chemistry	Chemistry	Natural Sciences
ChemSolidStateRes.	Chemical Solid State and Surface Research		
PhysTheorChem	Physical and Theoretical Chemistry		
MethodChem.	Analytical Chemistry, Method Development (Chemistry)		
BioChem.	Biological Chemistry and Food Chemistry		
PolymerRes.	Polymer Research		
CondMatPhys.	Condensed Matter Physics	Physics	
Optics	Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas		
ParticlesNuclei	Particles, Nuclei and Fields		
BioPhys.	Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics		
Astrophysics	Astrophysics and Astronomy		
Mathematics	Mathematics	Mathematics	
AtmoOceanogr.	Atmospheric Science, Oceanography and Climate Research	Geosciences (including Geography)	
GeolPalaeontol.	Geology and Palaeontology		
Geophysics	Geophysics and Geodesy		
Geochemistry	Geochemistry, Mineralogy and Crystallography		
Geography	Geography		
WaterRes.	Water Research		
ProductTech.	Production Technology	Mechanical and Industrial Engineering	Engineering Sciences
ConstrMechEng.	Mechanics and Constructive Mechanical Engineering		
ProcessEng	Process Engineering, Technical Chemistry	Thermal Engineering/ Process Engineering	
HeatEnergyTech.	Heat Energy Technology, Thermal Machines, Fluid Mechanics		
MaterialEng.	Materials Engineering	Materials Science and Engineering	
MaterialScie.	Materials Science		
SystemEng.	Systems Engineering	Computer Science, Electrical and System Engineering	
ElectricalEng.	Electrical Engineering and Information Technology		
CompScie.	Computer Science		
Architecture	Construction Engineering and Architecture	Construction Engineering and Architecture	

Table 5:
Closely linked subjects by reviewer subject

Reviewer subject	Subject-spec. Reviews	Reviews with close link to reviewer subject	N
Humanities and Social Sciences			
Ancient Cultures	299	Social and Cultural Anthropology, Non-European Cultures, Jewish Studies and Religious Studies	24
		Geography	18
History	280	Social Sciences	49
		Art History, Musicology, Theatre and Media Studies	33
Art History, Musicology, Theatre and Media Studies	83	History	33
		Literary Studies	32
Linguistics	139	Computer Science	31
		Psychology	26
Literary Studies	104	Art History, Musicology, Theatre and Media Studies	32
		History	29
Social and Cultural Anthropology, Non-European Cultures, Jewish Studies and Religious Studies	105	Social Sciences	50
		History	32
Theology	77	Ancient Cultures	15
		Social Sciences	14
Philosophy	88	Literary Studies	17
		Social Sciences	13
Educational Research	110	Social Sciences	98
		Psychology	74
Psychology	548	Neurosciences	176
		Educational Research	74
Social Sciences	368	Educational Research	98
		Economics	53
Economics	170	Social Sciences	53
		Computer Science	33
Jurisprudence	45	Social Sciences	26
		Economics	12
Life Sciences			
Fundamental Biological and Medical Research	492	Medicine	604
		Microbiology, Virology and Immunology	241
Plant Sciences	396	Agriculture, Forestry and Veterinary Medicine	113
		Fundamental Biological and Medical Research	86
Zoology	229	Neurosciences	87
		Plant Sciences	83
Microbiology, Virology and Immunology	328	Medicine	289
		Fundamental Biological and Medical Research	241
Medicine	1,540	Fundamental Biological and Medical Research	604
		Neurosciences	391
Neurosciences	582	Medicine	391
		Fundamental Biological and Medical Research	208
Agriculture, Forestry and Veterinary Medicine	189	Plant Sciences	113
		Medicine	94
Natural Sciences			
Molecular Chemistry	422	Chemical Solid State and Surface Research	151
		Biological Chemistry and Food Chemistry	130
Chemical Solid State and Surface Research	71	Condensed Matter Physics	182
		Molecular Chemistry	151
Physical and Theoretical Chemistry	70	Chemical Solid State and Surface Research	122
		Condensed Matter Physics	113
Analytical Chemistry, Method Development (Chemistry)	19	Fundamental Biological and Medical Research	74
		Chemical Solid State and Surface Research	44
Biological Chemistry and Food Chemistry	37	Molecular Chemistry	130
		Fundamental Biological and Medical Research	85

Table 5 (continued):
Closely linked subjects by reviewer subject

Reviewer subject	Subject-spec. Reviews	Reviews with close link to reviewer subject	N
Natural Sciences (continued)			
Polymer Research	178	Molecular Chemistry	103
		Physical and Theoretical Chemistry	100
Condensed Matter Physics	333	Chemical Solid State and Surface Research	182
		Electrical Engineering and Information Technology	123
Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	70	Condensed Matter Physics	83
		Physical and Theoretical Chemistry	48
Particles, Nuclei and Fields	57	Astrophysics and Astronomy	14
		Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	9
Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics	6	Condensed Matter Physics	24
		Heat Energy Technology, Thermal Machines, Fluid Mechanics	13
		Physical and Theoretical Chemistry	13
Astrophysics and Astronomy	138	Particles, Nuclei and Fields	14
		Mathematics	8
		Physical and Theoretical Chemistry	8
Mathematics	127	Computer Science	55
		Mechanics and Constructive Mechanical Engineering	22
Atmospheric Science, Oceanography and Climate Research	37	Agriculture, Forestry and Veterinary Medicine	23
		Water Research	22
Geology and Palaeontology	228	Geochemistry, Mineralogy and Crystallography	89
		Geography	34
Geophysics and Geodesy	85	Geology and Palaeontology	23
		Water Research	17
Geochemistry, Mineralogy and Crystallography	124	Geology and Palaeontology	89
		Materials Science	28
Geography	209	Agriculture, Forestry and Veterinary Medicine	68
		Geology and Palaeontology	34
Water Research	86	Agriculture, Forestry and Veterinary Medicine	36
		Construction Engineering and Architecture	32
Engineering Sciences			
Production Technology	689	Materials Engineering	146
		Mechanics and Constructive Mechanical Engineering	142
Mechanics and Constructive Mechanical Engineering	130	Production Technology	142
		Construction Engineering and Architecture	78
Process Engineering, Technical Chemistry	161	Heat Energy Technology, Thermal Machines, Fluid Mechanics	162
		Chemical Solid State and Surface Research	53
Heat Energy Technology, Thermal Machines, Fluid Mechanics	201	Process Engineering, Technical Chemistry	162
		Medicine	53
Materials Engineering	192	Materials Science	238
		Production Technology	146
Materials Science	81	Materials Engineering	238
		Condensed Matter Physics	97
Systems Engineering	88	Computer Science	157
		Medicine	96
Electrical Engineering and Information Technology	255	Condensed Matter Physics	123
		Computer Science	97
Computer Science	556	Systems Engineering	157
		Electrical Engineering and Information Technology	97
Construction Engineering and Architecture	170	Mechanics and Constructive Mechanical Engineering	78
		Heat Energy Technology, Thermal Machines, Fluid Mechanics	34

Table 6:
Success rates by review type of 48 reviewer subjects

Scientific discipline	Type of review					
	subject-specific		closely linked		distantly linked	
	N	FQ[1]	N	FQ[1]	N	FQ[1]
Humanities and Social Sciences						
Ancient Cultures	299	48.2	42	42.9	98	42.9
History	280	48.9	82	41.5	189	38.6
Art History, Musicology, Theatre and Media Studies	83	34.9	65	36.9	101	30.7
Linguistics	139	36.0	57	31.6	81	38.3
Literary Studies	104	37.5	61	27.9	71	39.4
Social and Cultural Anthropology, Non-European Cultures, Jewish Studies and Religious Studies	105	49.5	82	32.9	114	46.5
Theology	77	46.8	29	41.4	51	29.4
Philosophy	88	34.1	30	30.0	49	36.7
Educational Research	110	26.4	172	30.2	62	33.9
Psychology	548	38.3	250	33.2	247	31.2
Social Sciences	368	29.9	151	31.1	311	34.4
Economics	170	32.4	86	27.9	136	40.4
Jurisprudence	45	35.6	38	28.9	27	22.2
Life Sciences						
Fundamental Biological and Medical Research	492	50.8	845	44.4	896	46.4
Plant Sciences	396	47.5	199	38.2	329	44.7
Zoology	229	42.8	170	52.9	318	41.5
Microbiology, Virology and Immunology	328	46.0	530	44.5	329	38.9
Medicine	1.540	41.8	995	42.7	1.173	39.1
Neurosciences	582	44.5	599	43.7	475	41.7
Agriculture, Forestry and Veterinary Medicine	189	37.0	207	36.7	377	40.6
Natural Sciences						
Molecular Chemistry	422	56.2	281	50.9	439	44.9
Chemical Solid State and Surface Research	71	43.7	333	46.2	657	42.0
Physical and Theoretical Chemistry	70	62.9	235	43.4	549	45.9
Analytical Chemistry, Method Development (Chemistry)	19	36.8	118	49.2	284	38.0
Biological Chemistry and Food Chemistry	37	48.6	215	53.0	325	46.5
Polymer Research	178	38.8	203	45.8	624	42.1
Condensed Matter Physics	333	47.1	305	44.6	842	45.1
Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	70	68.6	131	55.0	146	54.8
Particles, Nuclei and Fields	57	54.4	23	56.5	27	33.3
Statistical Physics, Soft Matter, Biological Physics, Nonlinear Dynamics	6	33.3	50	30.0	69	47.8
Astrophysics and Astronomy	138	34.8	30	60.0	47	55.3
Mathematics	127	51.2	77	39.0	208	47.1
Atmospheric Science, Oceanography and Climate Research	37	27.0	45	24.4	183	36.6
Geology and Palaeontology	228	49.1	123	39.8	150	41.3
Geophysics and Geodesy	85	45.9	40	50.0	125	36.0
Geochemistry, Mineralogy and Crystallography	124	47.6	117	41.0	183	31.7
Geography	209	44.5	102	45.1	152	34.2
Water Research	86	29.1	68	39.7	228	33.3
Engineering Sciences						
Production Technology	689	41.2	288	50.3	302	43.4
Mechanics and Constructive Mechanical Engineering	130	44.6	220	48.6	439	41.0
Process Engineering, Technical Chemistry	161	47.8	215	45.1	367	34.9
Heat Energy Technology, Thermal Machines, Fluid Mechanics	201	50.2	215	44.7	370	38.1
Materials Engineering	192	45.8	384	47.4	416	46.6
Materials Science	81	45.7	335	46.3	533	42.6
Systems Engineering	88	43.2	253	41.5	619	38.6
Electrical Engineering and Information Technology	255	49.8	220	38.2	328	37.5
Computer Science	556	44.4	254	38.2	510	35.1
Construction Engineering and Architecture	170	44.1	112	42.0	298	33.9

[1] FQ: Success rate of proposals

Table 7:
Success rates for the 74 most common subject pairs over time, 2005 – 2007 and 2008 – 2010, and overall (2005 – 2010)

Reviewer subject A	Reviewer subject B	Total							2005 – 2007							2008 – 2010						
		Number of cases			Success rate in %				Number of cases			Success rate in %				Number of cases			Success rate in %			
		A&B[1]	A	B	CR[2]	SRR_A[3]	SRR_B[4]	ARR[5]	A&B	A	B	CR	SRR_A	SRR_B	ARR	A&B	A	B	CR	SRR_A	SRR_B	ARR
Fundamental Biological and Medical Research	Medicine	604	492	1,540	43.2	50.8	41.8	46.3	257	209	663	46.3	51.2	41.2	46.2	347	283	877	40.9	50.5	42.3	46.4
Medicine	Neurosciences	391	1,540	582	41.9	41.8	44.5	43.2	141	663	227	40.4	41.2	43.6	42.4	250	877	355	42.8	42.3	45.1	43.7
Microbiology, Virology and Immunology	Medicine	289	328	1,540	42.2	46.0	41.8	43.9	114	152	663	43.9	46.7	41.2	43.9	175	176	877	41.1	45.5	42.3	43.9
Fundamental Biological and Medical Research	Microbiology, Virology and Immunology	241	492	328	47.3	50.8	46.0	48.4	109	209	152	49.5	51.2	46.7	49.0	132	283	176	45.5	50.5	45.5	48.0
Materials Engineering	Materials Science	238	192	81	45.8	45.8	45.7	45.8	103	93	33	47.6	46.2	45.5	45.8	135	99	48	44.4	45.5	45.8	45.6
Fundamental Biological and Medical Research	Neurosciences	208	492	582	47.1	50.8	44.5	47.7	84	209	227	50.0	51.2	43.6	47.4	124	283	355	45.2	50.5	45.1	47.8
Chemical Solid State and Surface Research	Condensed Matter Physics	182	71	333	46.7	43.7	47.2	45.4	79	26	158	49.4	34.6	44.3	39.5	103	45	175	44.7	48.9	49.7	49.3
Psychology	Neurosciences	176	548	582	34.7	38.3	44.5	41.4	53	206	227	37.7	36.4	43.6	40.0	123	342	355	33.3	39.5	45.1	42.3
Process Engineering, Technical Chemistry	Heat Energy Technology, Thermal Machines, Fluid Mechanics	162	161	201	46.3	47.8	50.3	49.0	76	75	96	48.7	44.0	45.8	44.9	86	86	105	44.2	51.2	54.3	52.7
Systems Engineering	Computer Science	157	88	556	40.8	43.2	44.4	43.8	68	42	266	33.8	52.4	41.0	46.7	89	46	290	46.1	34.8	47.6	41.2
Molecular Chemistry	Chemical Solid State and Surface Research	151	422	71	45.7	56.2	43.7	49.9	65	180	26	53.9	62.2	34.6	48.4	86	242	45	39.5	51.7	48.9	50.3
Production Technology	Materials Engineering	146	689	192	50.0	41.2	45.8	43.5	59	313	93	52.5	38.7	46.2	42.5	87	376	99	48.3	43.4	45.5	44.4
Production Technology	Mechanics and Constructive Mechanical Engineering	142	689	130	50.7	41.2	44.6	42.9	66	313	58	50.0	38.7	48.3	43.5	76	376	72	51.3	43.4	41.7	42.5
Molecular Chemistry	Biological Chemistry and Food Chemistry	130	422	37	56.9	56.2	48.7	52.4	53	180	12	67.9	62.2	50.0	56.1	77	242	25	49.4	51.7	48.0	49.8
Condensed Matter Physics	Electrical Engineering and Information Technology	123	333	255	41.5	47.2	49.8	48.5	52	158	115	36.5	44.3	50.4	47.4	71	175	140	45.1	49.7	49.3	49.5
Chemical Solid State and Surface Research	Physical and Theoretical Chemistry	122	71	70	38.5	43.7	62.9	53.3	43	26	35	44.2	34.6	57.1	45.9	79	45	35	35.4	48.9	68.6	58.7
Plant Sciences	Agriculture, Forestry and Veterinary Medicine	113	396	189	35.4	47.5	37.0	42.3	51	184	96	43.1	48.9	36.5	42.7	62	212	93	29.0	46.2	37.6	41.9
Physical and Theoretical Chemistry	Condensed Matter Physics	113	70	333	48.7	62.9	47.2	55.0	42	35	158	64.3	57.1	44.3	50.7	71	35	175	39.4	68.6	49.7	59.1
Molecular Chemistry	Polymer Research	103	422	178	45.6	56.2	38.8	47.5	34	180	67	47.1	62.2	37.3	49.8	69	242	111	44.9	51.7	39.6	45.6
Physical and Theoretical Chemistry	Polymer Research	100	70	178	46.0	62.9	38.8	50.8	47	35	67	44.7	57.1	37.3	47.2	53	35	111	47.2	68.6	39.6	54.1
Polymer Research	Condensed Matter Physics	100	178	333	43.0	38.8	47.2	43.0	42	67	158	50.0	37.3	44.3	40.8	58	111	175	37.9	39.6	49.7	44.7
Educational Research	Social Sciences	98	110	368	30.6	26.4	29.9	28.1	45	53	154	26.7	22.6	33.1	27.9	53	57	214	34.0	29.8	27.6	28.7
Electrical Engineering and Information Technology	Computer Science	97	255	556	34.0	49.8	44.4	47.1	41	115	266	39.0	50.4	41.0	45.7	56	140	290	30.4	49.3	47.6	48.4
Condensed Matter Physics	Materials Science	97	333	81	47.4	47.2	45.7	46.4	44	158	33	50.0	44.3	45.5	44.9	53	175	48	45.3	49.7	45.8	47.8
Chemical Solid State and Surface Research	Polymer Research	96	71	178	40.6	43.7	38.8	41.2	34	26	67	41.2	34.6	37.3	36.0	62	45	111	40.3	48.9	39.6	44.3
Medicine	Systems Engineering	96	1,540	88	42.7	41.8	43.2	42.5	36	663	42	41.7	41.2	52.4	46.8	60	877	46	43.3	42.3	34.8	38.5
Medicine	Agriculture, Forestry and Veterinary Medicine	94	1,540	189	38.3	41.8	37.0	39.4	44	663	96	38.6	41.2	36.5	38.8	50	877	93	38.0	42.3	37.6	40.0
Geology and Palaeontology	Geochemistry, Mineralogy and Crystallography	89	228	124	40.5	49.1	47.6	48.4	35	115	59	60.0	53.0	50.9	51.9	54	113	65	27.8	45.1	44.6	44.9
Zoology	Neurosciences	87	229	582	56.3	42.8	44.5	43.6	39	108	227	46.2	51.9	43.6	47.7	48	121	355	64.6	34.7	45.1	39.9
Fundamental Biological and Medical Research	Plant Sciences	86	492	396	41.9	50.8	47.5	49.1	34	209	184	44.1	51.2	48.9	50.1	52	283	212	40.4	50.5	46.2	48.4
Fundamental Biological and Medical Research	Biological Chemistry and Food Chemistry	85	492	37	47.1	50.8	48.7	49.7	38	209	12	44.7	51.2	50.0	50.6	47	283	25	48.9	50.5	48.0	49.3
Plant Sciences	Zoology	83	396	229	49.4	47.5	42.8	45.1	32	184	108	56.3	48.9	51.9	50.4	51	212	121	45.1	46.2	34.7	40.5
Condensed Matter Physics	Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	83	333	70	54.2	47.2	68.6	57.9	33	158	23	60.6	44.3	73.9	59.1	50	175	47	50.0	49.7	66.0	57.8
Systems Engineering	Electrical Engineering and Information Technology	80	88	255	41.3	43.2	49.8	46.5	29	42	115	41.4	52.4	50.4	51.4	51	46	140	41.2	34.8	49.3	42.0
Mechanics and Constructive Mechanical Engineering	Construction Engineering and Architecture	78	130	170	44.9	44.6	44.1	44.4	40	58	79	40.0	48.3	39.2	43.8	38	72	91	50.0	41.7	48.4	45.0
Molecular Chemistry	Physical and Theoretical Chemistry	76	422	70	47.4	56.2	62.9	59.5	26	180	35	61.5	62.2	57.1	59.7	50	242	35	40.0	51.7	68.6	60.1
Chemical Solid State and Surface Research	Materials Science	75	71	81	32.0	43.7	45.7	44.7	23	26	33	34.8	34.6	45.5	40.0	52	45	48	30.8	48.9	45.8	47.4
Fundamental Biological and Medical Research	Analytical Chemistry, Method Development (Chemistry)	74	492	19	46.0	50.8	36.8	43.8	25	209	12	40.0	51.2	50.0	50.6	49	283	7	49.0	50.5	14.3	32.4

[1] **A&B:** Number of proposals that underwent interdisciplinary review in reviewer subjects A and B; [2] **CR:** Combined Rate: Success rate for proposals that underwent interdisciplinary review in reviewer subjects A and B; [3] **SRR_A:** Success rate of proposals that underwent subject-specific review in reviewer subject A; [4] **SRR_B:** Success rate of proposals that underwent subject-specific review in reviewer subject B; [5] **ARR:** Average Reference Rate: Average success rate of proposals that underwent subject-specific review in both subjects.

Table 7 (continued):
Success rates for the 74 most common subject pairs over time, 2005 – 2007 and 2008 – 2010, and overall (2005 – 2010)

Reviewer subject A	Reviewer subject B	Total							2005 – 2007							2008 – 2010						
		Number of cases			Success rate in %				Number of cases			Success rate in %				Number of cases			Success rate in %			
		A&B[1]	A	B	CR[2]	SRR_A[3]	SRR_B[4]	ARR[5]	A&B	A	B	CR	SRR_A	SRR_B	ARR	A&B	A	B	CR	SRR_A	SRR_B	ARR
Educational Research	Psychology	74	110	548	29.7	26.4	38.3	32.3	34	53	206	32.4	22.6	36.4	29.5	40	57	342	27.5	29.8	39.5	34.6
Medicine	Computer Science	72	1,540	556	33.3	41.8	44.4	43.1	29	663	266	34.5	41.2	41.0	41.1	43	877	290	32.6	42.3	47.6	44.9
Condensed Matter Physics	Materials Engineering	70	333	192	52.9	47.2	45.8	46.5	28	158	93	57.1	44.3	46.2	45.3	42	175	99	50.0	49.7	45.5	47.6
Agriculture, Forestry and Veterinary Medicine	Geography	68	189	209	48.5	37.0	44.5	40.8	32	96	91	34.4	36.5	49.5	43.0	36	93	118	61.1	37.6	40.7	39.2
Mechanics and Constructive Mechanical Engineering	Materials Engineering	65	130	192	50.8	44.6	45.8	45.2	26	58	93	61.5	48.3	46.2	47.3	39	72	99	43.6	41.7	45.5	43.6
Fundamental Biological and Medical Research	Zoology	64	492	229	54.7	50.8	42.8	46.8	33	209	108	54.6	51.2	51.9	51.5	31	283	121	54.8	50.5	34.7	42.6
Plant Sciences	Microbiology, Virology and Immunology	63	396	328	44.4	47.5	46.0	46.8	23	184	152	43.5	48.9	46.7	47.8	40	212	176	45.0	46.2	45.5	45.8
Mechanics and Constructive Mechanical Engineering	Systems Engineering	61	130	88	42.6	44.6	43.2	43.9	23	58	42	47.8	48.3	52.4	50.3	38	72	46	39.5	41.7	34.8	38.2
Production Technology	Materials Science	60	689	81	46.7	41.2	45.7	43.5	26	313	33	50.0	38.7	45.5	42.1	34	376	48	44.1	43.4	45.8	44.6
Chemical Solid State and Surface Research	Materials Engineering	59	71	192	49.2	43.7	45.8	44.7	23	26	93	56.5	34.6	46.2	40.4	36	45	99	44.4	48.9	45.5	47.2
Mechanics and Constructive Mechanical Engineering	Materials Science	56	130	81	44.6	44.6	45.7	45.2	21	58	33	47.6	48.3	45.5	46.9	35	72	48	42.9	41.7	45.8	43.8
Fundamental Biological and Medical Research	Physical and Theoretical Chemistry	55	492	70	43.6	50.8	62.9	56.8	17	209	35	52.9	51.2	57.1	54.2	38	283	35	39.5	50.5	68.6	59.6
Mathematics	Computer Science	55	127	556	41.8	51.2	44.4	47.8	27	49	266	55.6	55.1	41.0	48.0	28	78	290	28.6	48.7	47.6	48.2
Medicine	Heat Energy Technology, Thermal Machines, Fluid Mechanics	53	1,540	201	39.6	41.8	50.3	46.0	24	663	96	54.2	41.2	45.8	43.5	29	877	105	27.6	42.3	54.3	48.3
Production Technology	Systems Engineering	53	689	88	47.2	41.2	43.2	42.2	29	313	42	58.6	38.7	52.4	45.5	24	376	46	33.3	43.4	34.8	39.1
Social Sciences	Economics	53	368	170	32.1	29.9	32.4	31.1	21	154	75	23.8	33.1	24.0	28.6	32	214	95	37.5	27.6	39.0	33.3
Chemical Solid State and Surface Research	Process Engineering, Technical Chemistry	53	71	161	41.5	43.7	47.8	45.7	22	26	75	63.6	34.6	44.0	39.3	31	45	86	25.8	48.9	51.2	50.0
Microbiology, Virology and Immunology	Agriculture, Forestry and Veterinary Medicine	53	328	189	47.2	46.0	37.0	41.5	30	152	96	50.0	46.7	36.5	41.6	23	176	93	43.5	45.5	37.6	41.5
Psychology	Social Sciences	52	548	368	26.9	38.3	29.9	34.1	23	206	154	30.4	36.4	33.1	34.8	29	342	214	24.1	39.5	27.6	33.5
Condensed Matter Physics	Systems Engineering	51	333	88	39.2	47.2	43.2	45.2	12	158	42	33.3	44.3	52.4	48.3	39	175	46	41.0	49.7	34.8	42.2
Social and Cultural Anthropology, Non-European Cultures, Jewish Studies and Religious Studies	Social Sciences	50	105	368	34.0	49.5	29.9	39.7	20	36	154	30.0	58.3	33.1	45.7	30	69	214	36.7	44.9	27.6	36.3
Fundamental Biological and Medical Research	Condensed Matter Physics	50	492	333	42.0	50.8	47.2	49.0	21	209	158	38.1	51.2	44.3	47.8	29	283	175	44.8	50.5	49.7	50.1
Polymer Research	Production Technology	50	178	689	42.0	38.8	41.2	40.0	26	67	313	26.9	37.3	38.7	38.0	24	111	376	58.3	39.6	43.4	41.5
Polymer Research	Mechanics and Constructive Mechanical Engineering	50	178	130	40.0	38.8	44.6	41.7	28	67	58	42.9	37.3	48.3	42.8	22	111	72	36.4	39.6	41.7	40.7
Polymer Research	Materials Science	50	178	81	36.0	38.8	45.7	42.2	21	67	33	33.3	37.3	45.5	41.4	29	111	48	37.9	39.6	45.8	42.7
Zoology	Medicine	49	229	1,540	32.7	42.8	41.8	42.3	25	108	663	28.0	51.9	41.2	46.5	24	121	877	37.5	34.7	42.3	38.5
History	Social Sciences	49	280	368	42.9	48.9	29.9	39.4	24	121	154	45.8	43.8	33.1	38.5	25	159	214	40.0	52.8	27.6	40.2
Psychology	Medicine	49	548	1,540	28.6	38.3	41.8	40.1	17	206	663	47.1	36.4	41.2	38.8	32	342	877	18.8	39.5	42.3	40.9
Fundamental Biological and Medical Research	Molecular Chemistry	49	492	422	51.0	50.8	56.2	53.5	21	209	180	71.4	51.2	62.2	56.7	28	283	242	35.7	50.5	51.7	51.1
Physical and Theoretical Chemistry	Optics, Quantum Optics and Physics of Atoms, Molecules and Plasmas	48	70	70	56.3	62.9	68.6	65.7	13	35	23	61.5	57.1	73.9	65.5	35	35	47	54.3	68.6	66.0	67.3
Medicine	Materials Science	47	1,540	81	38.3	41.8	45.7	43.8	19	663	33	42.1	41.2	45.5	43.3	28	877	48	35.7	42.3	45.8	44.1
Heat Energy Technology, Thermal Machines, Fluid Mechanics	Systems Engineering	46	201	88	39.1	50.3	43.2	46.7	21	96	42	57.1	45.8	52.4	49.1	25	105	46	24.0	54.3	34.8	44.5
Microbiology, Virology and Immunology	Neurosciences	45	328	582	37.8	46.0	44.5	45.3	22	152	227	40.9	46.7	43.6	45.2	23	176	355	34.8	45.5	45.1	45.3
Chemical Solid State and Surface Research	Analytical Chemistry, Method Development (Chemistry)	44	71	19	54.6	43.7	36.8	40.3	15	26	12	66.7	34.6	50.0	42.3	29	45	7	48.3	48.9	14.3	31.6
Medicine	Process Engineering, Technical Chemistry	42	1,540	161	38.1	41.8	47.8	44.8	16	663	75	50.0	41.2	44.0	42.6	26	877	86	30.8	42.3	51.2	46.7
Zoology	Agriculture, Forestry and Veterinary Medicine	41	229	189	41.5	42.8	37.0	39.9	25	108	96	44.0	51.9	36.5	44.2	16	121	93	37.5	34.7	37.6	36.2
Medicine	Biological Chemistry and Food Chemistry	40	1,540	37	0.4	0.4	0.5	0.5	15	663	12	0.5	0.4	0.5	0.5	25	877	25	0.4	0.4	0.5	0.5
Molecular Chemistry	Condensed Matter Physics	40	380	304	0.4	0.6	0.5	0.5	19	138	129	0.4	0.6	0.4	0.5	21	242	175	0.5	0.5	0.5	0.5

1) **A&B:** Number of proposals that underwent interdisciplinary review in reviewer subjects A and B; 2) **CR:** Combined Rate: Success rate for proposals that underwent interdisciplinary review in reviewer subjects A and B; 3) **SRR_A:** Success rate of proposals that underwent subject-specific review in reviewer subject A;
4) **SRR_B:** Success rate of proposals that underwent subject-specific review in reviewer subject B; 5) **ARR:** Average Reference Rate: Average success rate of proposals that underwent subject-specific review in both subjects.

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