Final report for Bial Foundation Grant No. 117/16: 'Replication in Parapsychology: The Correlation Matrix Method'

Principal Investigator: Professor Caroline Watt
Co-Researcher: Ana Flores
Advisors: Professor Harald Walach and Dr Ian Tierney

Summary

This research programme (Bial ref 117/16) aimed to validate and replicate Correlation Matrix Method (CMM) studies. The work consisted of one software validation study, and three CMM replication studies. All studies were completed as planned, with variations on some exploratory study hypotheses as agreed with the wider CMM Consortium project to which this work contributes (PI Walach; Bial ref 400/14). The first CMM replication study (105 participants, 200 sessions) obtained significant results supporting the CMM hypothesis. This study also demonstrated that the permutated experimental data obtained the same number of chance correlations as obtained from permutating control session data. This implies that, purely in statistical terms, control sessions are not needed. CMM Replication Studies 2 and 3 (each with 100 participants and 205 sessions) therefore used the permutation method without control sessions. Both studies obtained overall results that did not support the primary CMM hypothesis and therefore did not replicate earlier positive findings. However, in both studies effects were observed in the direction *opposite* to that predicted (i.e. high numbers of significant correlations occurred in the matrices constructed from permutated experimental data, compared to the matrix constructed from the actual experimental data.) This leads us to consider whether there are any *theoretical* reasons why the control sessions are necessary for the CMM paradigm, and we recommend that future studies systematically evaluate this question.

Introduction

The Model of Pragmatic Information (MPI: Lucadou, 1995) and its recent interpretation in terms of entanglement correlations in Generalized Quantum Theory (Lucadou, Römer & Walach, 2007) provides a theoretical approach to understanding phenomena such as decline effects in psi research and the elusiveness of psi. The Correlation Matrix Method (CMM) is a method proposed by Lucadou (2006) and Walach (2014) to test predictions of the MPI. CMM assumes that psi is real and parapsychological effects are non-local correlations according to Generalized Quantum Theory. Thus psi is not considered a causal phenomenon but a correlational phenomenon (Atmanspacher, Römer & Walach, 2002). Furthermore, Lucadou et al. (2007, p.57) propose that greater 'organisational closure' (autonomous self-sustaining connections between psychological and physical systems; Varela, 1981) will lead to greater emergence of non-local correlations.

Several studies have been conducted using the CMM method and a micro-PK task in which participants attempted to mentally influence a computer display of a Mandelbrot set that moved position according to RNG output. Most of the CMM studies so far have reported positive results: an excess of significant correlations in the experimental matrix (where the participant is interacting with the experimental task) compared to a control matrix (where RNG data is collected without any participant present). However, CMM is a relatively ‘young’ method and the studies have been conducted by a narrow range of investigators (e.g., Lucadou, 2006). Therefore, the goal of our research programme was to test and develop the CMM paradigm using newly developed and validated software, and to compare different statistical models for analysis. The development of our work was in part guided by the CMM Consortium led by Walach (Bial ref: 400/14; Walach, 2017).

Study 1: Software validation study

Aims

Several CMM studies reporting significant results, including one conducted by AF in Edinburgh prior to our Bial grant 117/16, employed a software programme developed by Walter von Lucadou. Therefore, one goal was to independently verify AF's study analyses using a newly developed programme. Secondly, it was recommended at the Consortium meeting in Capri in October 2016 that the validation should also investigate the study hardware. Specifically the Markov-chain process used by the Random number generator should be checked over different random processes and also against a True RNG.

Method

AF developed an R language analysis program algorithm following the Monte-Carlo principles to produce data to run against the previous experimental data and double check the initial significant results obtained by the von Lucadou program.
After the R program was written, several verification and validation measures were taken.
The RNG & experiment program was validated following the International Software ISO/IEC/IEEE 29119 Software Testing standards (this includes Installation Protocol, Installation Report, Testing Protocol, Testing Report).
First using a set of testing files, the program was tested to confirm that it was working properly. Afterwards, AF asked an independent researcher, Prof Thomas Filk (TF), to check the entire program against the protocol. TF also wrote another version of the analysis program in C++. The first set of data from the AF's first (pre-Bial grant) study was run by both researchers (TF and AF). Walter von Lucadou also ran AF's data on his computer program.

Results and Discussion

The R language program analysis was verified and certified. The Markov RNG performed as expected. The results obtained by AF's R program were confirmed by two independent researchers using two different computer programs. In conclusion, the validation study supported the original significant findings obtained by AF, and confirmed that AF's program and the Markov RNG could be reliably used in the planned three CMM replication studies.

CMM Replication Study 1: Analysis improvements

Aims

Lucadou and Walach claimed that the CMM method could reliably obtain evidence of anomalous non-local correlations. However, there were aspects of the original studies' analysis method that were sub-optimal due to non-independence of data and also the presence of possibly causal correlations. Therefore, CMM Replication Study 1 was planned to include both the original analysis method for purposes of exact replication, and also an analysis method that contained two improvements in order to extend upon the original work: 1. calculation of correlations that were not subject to possible causal influences (using the superior diagonal part of the matrix); 2. use of a permutation analysis to control the issue of non-independent data.

Method

Experimental task. Participants try to mentally influence a fractal appearing on the computer screen to "shrink", "grow" or "leave" it stable according to the instructions. The instructions to influence the fractal to right, left or center are called trials, 80 trials make one sub-run and three set of 80 trials complete one run. Three repeated runs are one session. Each session should take between 10 and 20 minutes. After each session the computer will run a control session without participants to simulate the behaviour of the system during the experiment. The psychological variables from the participant are used together with the physical variables from the control run to construct the control data.

Creating the correlation matrix. The study has 5 physical dependent variables: 1- TR: the number of times the output of the Markov-chain RNG yields "1" during one run. 2- DT: the number of steps the fractal display deviated from the optimum in either direction or from the central position. 3- KR: deviation of the actual physical output of the Markov-chain RNG from the ideal output. 4- ZT: mean voltage output at the fourth channel out of eight 5- ZV: standard deviation of this voltage output at channel 4.

Each of the 5 physical measures will be found for each of the 9 sub-runs in a session which gives 45 physical data points for a session. Similarly, there are 5 psychological dependent variables describing the behaviour of the participant: 1- T1: number of right shift-key presses 2- T2: number of left shift-key presses 3- T3: number of double presses 4- DR: mean time between key presses 5- DV: variance of time between key presses Each of the 5 psychological measures will be found for each of the 9 sub-runs in a session, which gives 45 psychological data points for a session. The correlation matrix will be generated by correlating each of the 45 physical variables with each of the 45 psychological variables (2025 total correlations) using the session as the unit of analysis. The pure psi correlations that cannot be contaminated by feedback about previous trials are the 900 correlations above the diagonal of the matrix. These are correlation between psychological variables and future physical (RNG) variables and exclude correlations with past physical variables for which the participant received feedback.

Permutation analysis method.
1. Assign a number to each session in a study
(e.g. 1 to 200 for CMM Replication Study 1)
2. Assign the psychological data of one session to the physical data of another **randomly-chosen**
(e.g. from 1 to 200) session
3. Calculate one correlation matrix (45x45 cells as usual)
4. Repeat 2&3 10,000 times to give 10,000 permutation matrices
5. Count how many permutation matrices (N) have >= sig. correlations than the Experimental matrix
(row highlighted in red in table 3)
6. Divide N by 10,000 to obtain true probability that observed result could occur by chance.

Hypotheses. CMM Replication Study 1 was pre-registered on the Koestler Parapsychology Unit Study Registry with ID number KPU_Registry_1031.

Hypothesis 1: The original ZDifference analysis method as used by Walach and von Lucadou will be applied to the full matrix, and it is predicted that this method of analysis will yield greater proportion of significant correlations compared to the control sessions.
Hypothesis 2: The number of significant correlations in the above-diagonal part of the matrix (the part where the psychological data have been collected prior to the physical data) will be significantly greater than the number expected by chance.

Participants. 105 individuals (73 female, 35 male) participated in this study without compensation. The participants were mostly recruited from the general public; 34% were aged 21-30; 20% 31-40; 21% 41-50; and the remainder were in the 51-80 age-bracket.
Experimenters. AF tested 90 participants (185 sessions) and a research assistant tested 15 participants (15 sessions).

Results and Discussion

200 sessions were conducted, as planned. The findings obtained using the original ZDifference analysis method are shown in Table 1. Significant Z-scores are also obtained for the diagonal superior part of the matrix for which causal correlations can be ruled out. Thus, using the original analysis method, both experimental hypotheses are supported.

	Number of significant correlations		
All Matrix (2025 cells)	**P < 0.05**	**P < 0.01**	**P < 0.001**
Experimental matrix	187	66	13
Control matrix	108	23	2
Z =	5.52	6.34	5.50
Diagonal superior (900 cells)			
Experimental matrix	72	28	5
Control matrix	37	4	0
Z =	4.155	8.506	####

Table 1. Number of significant correlations and Z-values for CMM Replication Study 1 (105 participants, 200 sessions).

Thresholds (r=)	**0.12**	**0.14**	**0.16**	**0.18**	**0.20**	**0.22**
1. Exp. (E)	291	183	115	67	41	16
2. Ctrl. (C)	138	73	47	21	7	1
3. Perm. Exp. >= E	25	26	16	12	10	67
4. Perm. Ctrl. >= E	71	56	34	32	24	95
5. Perm. Exp. >= C	9328	8709	4870	5001	6465	8910
6. Perm. Ctrl. >=C	9210	8518	4751	4837	6252	8775
7. Perm. Exp. (av.)	183	97.4	48.0	21.9	9.27	3.61
8. Perm. Ctrl. (av.)	183	97.2	48.0	21.9	9.23	3.58

Table 2. Number of significant correlations obtained by independent validation of CMM Replication Study 1 using permutation analysis. The .05 threshold value is r = 0.14, and the .01 threshold value is r = 0.18.

The findings for the full matrix obtained using the permutation analysis are presented in Table 2. To avoid duplication, we report the permutation analysis conducted by the statistical consultant for the project (TF) which independently confirms AF's conclusions. In the table, "Exp. (E)" refers to the Experimental correlations matrix; "Exp. (C)" refers to the Control correlations matrix; "Perm." refers to control correlations obtained by permutating the Experimental (Exp.) and Control (Ctrl.) data. The numbers in the cells refer to the number of correlations above the threshold values at the head of each column. Row 3 of Table 2 (highlighted in red text) is the key row, indicating the number of permutated experimental matrices that had greater numbers of significant correlations than the actual experimental matrix. The number in each cell, divided by 10,000, gives the true probability that the observed result could occur by chance. For the two threshold values of r = 0.14, and r = 0.18, p = 0.0026 and p = 0.0012 respectively. Thus, the permutation analysis also obtains significant findings.

Interestingly, Table 2 also shows (in rows 7 and 8) that the average number of significant correlations obtained when permutating actual experimental data is almost identical to the number of significant correlations obtained when permutating control data. Therefore, the permutated experimental data is statistically equivalent to control data, implying that it is not necessary to run control sessions.

In summary, CMM Replication Study 1 obtained statistically significant results supporting the experimental hypotheses, both for the original analysis method and for the improved (permutation) analysis methods. The permutation analysis also suggested that control sessions may not be needed in the CMM paradigm. The results continued to be significant even when analysis was limited to the diagonal superior part of the matrix where causal correlations were not possible. We conclude that the first CMM replication study supports the findings of the previous significant CMM studies reported by von Lucadou and Walach, and suggests analysis improvements that help to advance this method.

Deviation from original approved grant programme. As noted in our original approved grant programme: "PLEASE NOTE: There will be a CMM Consortium meeting, supported by Bial Foundation, in October 2016. We will be represented at that meeting, allowing discussion over finer details of CMM analysis and methodology. As a result of the Consortium meeting, it is possible that some aspects of the design and analysis may alter from this proposal."
CMM Replication Study 1 occurred precisely as described in the approved grant programme. Our approved programme for CMM Replication Study 2 was to replicate CMM Replication Study 1 and in addition provisionally *to explore variations in the conduct of the control sessions*. For CMM Replication Study 3 we planned to replicate previous CMM studies and also provisionally *to explore psychophysiological correlates of CMM task performance*. However, as our CMM Study 1 suggested that control sessions were not required, we discussed with the Consortium group and agreed instead to build on CMM Study 1 by testing whether the CMM results replicate when permutated Experimental data is employed as control data. Additionally, following the recommendations of the Consortium group (Walach et al., 2017), Studies 2 and 3 explored conceptual issues (comparing Markov RNG with True RNG). So our main plan to conduct 3 CMM replication studies was unchanged, but some of the exploratory questions were varied.

CMM Replication Study 2: Employing Permutation as Control and Exploring RNG Type

Aims

Because the CMM is a relatively new method for which significant effects have been claimed, the emphasis in this research program is on replication studies where we explore different aspects of the CMM methodology. CMM Replication study 2 had two aims. First, we would apply the same basic CMM task and permutation analysis as was used in Study 1, to see if Study 1 findings replicate without conducting control sessions. Second, as an exploratory question we would compare Lucadou's original Markov-chain RNG with a true RNG. The use of a true RNG acts as a form of conceptual replication of the study and helps to elucidate whether CMM is sensitive to the type of RNG employed, and has also been suggested by the CMM Consortium (Walach et al., 2017).

Method

As this is a replication study, the experimental task, method of producing the correlation matrix, and permutation analysis method, are the same as in CMM Replication Study 1. Therefore, the reader is referred to the previous study Method section for further detail on these aspects of the method. Building on the results of CMM Replication Study 1, no control sessions were conducted. Instead, permutated experimental data is employed for control purposes. RNG type (Markov vs True) will be examined between-subjects.

Random Number Generators. 1. Markov RNG output is smoothed by a Markov-chain window with lag 1 that makes the appearance of the output look more like a natural process and slows the change process. The noise-current of a Zener-diode is used as the random source. The equivalent voltage of the noise-current is amplified and is measured by an analogue- digital converter, which is read by the USB-Interface of the computer. To produce the Markov-chain the momentary 12-bit number (voltage) Ri+1 is compared with the previous one Ri. A decrease of the momentary voltage is recorded as a "1" and an increase as a "0". If no change of the decay rate occurred the event is omitted. 2. True RNG. The “TrueRNG 3” is a commercially available USB hardware true RNG, produced by ubld.it.

Hypotheses. The study hypotheses were pre-registered on OSF (Flores, 2018).
Hypothesis 1: There will be a greater proportion of significant correlations in the Experimental matrix compared to 10,000 permutations of Experimental data as control.
Hypothesis 2: The True RNG will behave in a similar way to the Markov RNG: no significant difference will be found in the number of significant CMM correlations obtained when sessions conducted with the True RNG are compared to sessions conducted with the Markov RNG.

Procedure. The type of RNG used alternates between participants, i.e. participant 1 will do first session with Markov RNG followed by a second session with True RNG; participant 2 will do first experimental session with True RNG and second session with Markov RNG. And so on till the end.

Participants. Participants (41 Female, 58 Male) were recruited primarily from the student community (83% aged 30 years or younger) and were not compensated for their participation.
Experimenter. All participants were tested by a research assistant who had been trained by AF.

Results and Discussion

100 participants contributed two experimental sessions each, though four participants contributed twice. There were 100 sessions with the Markov RNG, and 105 sessions with the True RNG. The results of the permutation analysis for the full matrix are shown in Table 3; the key information is highlighted in red. Overall, Hypothesis 1 was not supported because, contrary to expectation, the permutated experimental data obtained a *greater* proportion of significant correlations than the actual experimental data. Hypothesis 2 was not supported because the True RNG behaved differently from the Markov RNG.

Thresholds (r=)	**0.12**	**0.14**	**0.16**	**0.18**	**0.20**	**0.22**
1. Markov RNG Exp. (E)	368	243	153	85	39	18
2. Markov RNG Perm. Exp. >= E	9365	9340	9284	9529	9827	9878
3. Markov RNG Perm. Exp. (av.)	473	333	226	148	93.6	56.8
4. True RNG Exp. (E)	481	344	222	135	79	39
5. True RNG Perm. Exp. >= E	3073	2710	3605	4581	5092	6475
6. True RNG Perm. Exp. (av.)	449	311	208	133	82.4	48.8

Table 3. Number of significant correlations obtained by independent validation of CMM Replication Study 2 using permutation analysis. The .05 threshold value is r = 0.14, and the .01 threshold value is r = 0.18. Markov RNG N = 100; True RNG N = 105.

These results, though not significantly supporting the experimental hypothesis, are worthy of replication because the effects consistently ran in the direction opposite to that predicted. It is particularly unusual that nearly every permutated experimental matrix in the Markov RNG condition contained a greater number of significant correlations than the actual experimental matrix (row 2 of Table 3), with corresponding Z-scores ranging from -1.226 to -4.362.

CMM Replication Study 3: Replicating Permutation Method and RNG Comparison

Aims

Contrary to the results of previous CMM studies that had used control sessions, Study 2 found that considerably more significant correlations were obtained in the matrices created from permutated Experimental data, compared to the actual Experimental data matrix. We therefore aimed to repeat the method used in Study 2 to assess whether this unexpected finding would replicate. If so, it could be a meaningful finding that would have relevance for the future design of CMM studies. In addition, the study aimed to replicate the RNG comparison from Study 2 that, unexpectedly, found the True RNG obtained relatively better CMM results compared to the Markov RNG.

Method

The method and design for this study was identical to that employed for study 2.

Hypotheses. Hypothesis 1: There will be a greater proportion of significant correlations in the Experimental matrix compared to 10,000 permutations of the Experimental data as control. Hypothesis 2: The True RNG will behave in a similar way to the Markov RNG: no significant difference will be found in the number of significant CMM correlations obtained when sessions conducted with the True RNG are compared to sessions conducted with the Markov RNG.

Participants. 100 individuals participated in this study without compensation (36 Female, 64 Male). Participants were recruited primarily from the student community (83% aged 30 years or younger). **Experimenter**. All participants were tested by the same research assistant who had conducted the previous study.

Results and Discussion

100 individuals contributed a total of 205 sessions (most participants contributed two sessions.) There were 100 sessions with the Markov RNG, and 105 sessions with the True RNG. The results of the permutation analysis for the full matrix are shown in Table 4. Overall, Hypothesis 1 was not supported because, contrary to expectation, the permutated experimental data obtained a greater proportion of significant correlations than the actual experimental data (cells highlighted in red). Although the magnitude of the reversal is smaller than in Study 2, this finding broadly replicates the pattern observed post hoc in our CMM Replication Study 2 and suggests this may be a meaningful outcome. Hypothesis 2 was supported because the True RNG obtained a similar proportion of significant correlations compared to the Markov RNG.

Thresholds (r=)	0.12	0.14	0.16	0.18	0.20	0.22
Markov RNG Exp. (E)	561	410	277	169	101	61
Markov RNG Perm. Exp. >= E	1491	1452	1846	2740	3361	3457
Markov RNG Perm. Exp. (av.)	466	326	221	144	90.4	54.7
True RNG Exp. (E)	526	374	258	160	88	51
True RNG Perm. Exp. >= E	1648	1813	1945	2785	4340	4518
True RNG Perm. Exp. (av.)	457	318	214	138	86.1	51.5

Table 4. Number of significant correlations obtained by independent validation of CMM Replication Study 3 using permutation analysis. Markov RNG N = 100; True RNG N = 105. The .05 threshold value is r = 0.14, and the .01 threshold value is r = 0.18.

Conclusions and Recommendations

The goal of our research programme was to test and develop the CMM paradigm using newly developed and validated software and to compare different statistical models for analysis. All four studies were completed as planned (with a total of 610 sessions in the three CMM replication studies). CMM Replication Study 1 demonstrated that the original ZDifference method of analysis inflates the study effects, probably due to non-independence of data. However, the results remain statistically significant when a statistically appropriate permutation analysis is used: greater numbers of significant correlations were obtained in the experimental matrix, compared to control matrices created from permutated experimental data. Furthermore, the results remained significant even when only the diagonal superior part of the matrix (that is not susceptible to causal correlations) was analysed. Thus, the original CMM results reported by von Lucadou and Walach were replicated. The permutation analysis also indicated that control sessions may not be required.

CMM Replication studies 2 and 3 employed the same basic CMM method, but featured the permutation analysis and no control sessions. These two studies also explored the conceptual question of whether RNG type (Markov vs True) impacted on results. Unexpectedly, in both studies overall CMM results were opposite to expectation, with *fewer* significant correlations in the experimental matrix compared to the matrices created from permutated experimental data. Therefore, the main hypothesis for CMM Replication Studies 2 and 3 was not supported, failing to replicate earlier positive studies including our CMM Replication Study 1.

The fact that the overall CMM effect appeared to decline in Studies 2 and 3 (indeed it significantly reversed in Study 2) raises some questions regarding whether there were any procedural differences between our first CMM replication study and the following two studies that could suggest reasons for the different study outcomes. In fact, there were three salient procedural differences. As this was a *post hoc* finding we can only speculate and suggest ideas for future systematic investigation.

First, it is possible that the motivation of the experimenter was different in studies 2 and 3. AF was the principal researcher behind the Edinburgh CMM studies, which also form part of her PhD work. AF contributed to the 2016 Capri symposium, and was personally involved in running most of the experimental sessions in Replication Study 1. Conversely, in studies 2 and 3 AF delegated data collection to an assistant who did not have the same personal CMM involvement. Therefore, it is possible that the experimenter who tested participants in studies 2 and 3 generated less Organisational Closure, which according to Lucadou et al. (2007) could reduce the occurrence of non-local correlations. This ‘experimenter effect’ hypothesis is a difficult one to systematically test, as there are numerous ways in which experimenter expectancies, mood and behaviour may vary. Unless the conditions for success can be clearly specified in advance, this hypothesis is not very useful. If the CMM is very sensitive to experimenter effects then it does not seem likely that the CMM can be a solution to the problem of ‘elusive psi’ and decline effects.

Second, there was a difference in the participant samples in Studies 2 and 3, compared to Study 1. Study 1 had a sample that was more representative of the general population (66% of the sample was aged 31 years or over), whereas Studies 2 and 3 employed predominantly a convenience sample of students (83% of the sample was under 30). Anecdotally we also observed that sessions lasted longer in Study 1, compared to Studies 2 and 3. So perhaps Study 1 participants were more motivated and engaged with the experimental task than participants in Studies 2 and 3, which might also adversely impact upon the Organisational Closure of the latter studies. This hypothesis could be tested by systematically comparing participant types within an experiment (see also Tierney, Watt & Flores, 2018). However if CMM is really sensitive to participant type then again this does not seem to bode well for a method that aims to overcome issues with ‘elusive psi’.

The final major difference is in our view the one that is most interesting and potentially productive for the underlying CMM theory. Our Study 1 (and previous CMM studies reporting positive results) employed control sessions, whereas our Studies 2 and 3 used permutated experimental data instead of control sessions. It is possible that in eliminating the control sessions, there is less “freedom” in the data to allow non-local correlations to emerge. This could mean that the experimental data is being treated as a “signal”, thus violating the “NT-axiom” that some theorists maintain is fundamental to the emergence of non-local correlations (Atmanspacher et al., 2002; Lucadou, 2006). In other words, while the permutated experimental data may be *statistically equivalent* to data from control sessions, it may not be *theoretically equivalent*. These concepts can be clearly defined and tested experimentally. We recommend that this hypothesis is investigated in future studies by having portions of a CMM experiment conducted with control sessions, while other parts are conducted without control sessions.

In conclusion, our research programme has revealed that even with improved statistical methods, the CMM generates significant discrepancies between experimental and control data, partially replicating earlier positive studies and suggesting that the CMM continues to be a promising avenue for parapsychologists to explore. However, further work needs to be done to understand the variables that affect the outcome of CMM studies.

References

Atmanspacher, H., Römer, H., & Walach, H. (2002). Weak quantum theory: Complementarity and entanglement in physics and beyond. *Foundations of Physics*, *32*(3), 379-406.

Flores, A. (2018). Replication of a psychokinesis study using the Correlation Matrix Method. OSF: https://osf.io/gfzbp/

Lucadou, W. von (1995). The Model of Pragmatic Information (MPI). *European Journal of Parapsychology*, *11*, 58-75.

Lucadou, W. von (2006). Self-organization of temporal structures—A possible solution for the intervention problem. *Frontiers of Time: Retrocausation-Experiment and Theory*, *863(*1), 293-315.

Lucadou, W. von, Römer, H., & Walach, H. (2007). Synchronistic phenomena as entanglement correlations in Generalized Quantum Theory. *Journal of Consciousness Studies*, *14,* 50-74.

Tierney, I., Watt, C., & Flores, A. (2018). Measuring Organisational Closure in the MPI/GQT/CMM Context. *Journal of Parapsychology*, *82*(2), 198-202.

Varela, F. J. (1981). Autonomy and autopoiesis. In G. Roth & H. Schwengler (Eds), *Self-organizing systems* (pp.14-23). Frankfurt/New York: Campus.