

Sequelae of vaccine preventable diseases –
increasing knowledge, risk perception and the intention to vaccinate

Dissertation

Zur Erlangung des akademischen Grades

Doktor der Philosophie (Dr. phil.)

der

Erziehungswissenschaftlichen Fakultät

der Universität Erfurt

vorgelegt von

Sarah Eitze

Erfurt, 2022

Erstes Gutachten: Prof. Dr. Cornelia Betsch
Zweites Gutachten: Prof. Dr. Inga Glogger-Frey
Drittes Gutachten: Prof. Dr. Guido Mehlkop

Datum der Disputation: 09.09.2022

Datum der Promotion: 09.09.2022

urn:nbn:de:gbv:547--202200519

Ehrenwörtliche Erklärung

Ich erkläre hiermit ehrenwörtlich, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe; die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht. Bei der Auswahl und Auswertung des Materials sowie bei der Herstellung des Manuskripts habe ich Unterstützungsleistung von folgenden Personen erhalten:

Prof. Dr. Cornelia Betsch

Dorothee Heinemeier

Weitere Personen waren an der geistigen Herstellung der vorliegenden Arbeit nicht beteiligt. Insbesondere habe ich nicht die Hilfe einer Promotionsberaterin bzw. eines Promotionsberaters in Anspruch genommen. Dritte haben von mir weder unmittelbar noch mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen.

Die Arbeit oder Teile davon wurden bisher weder im Inland noch im Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde als Dissertation vorgelegt. Ferner erkläre ich, dass ich nicht bereits eine gleichartige Doktorprüfung an einer Hochschule endgültig nicht bestanden habe.

Erfurt, den 12.02.2022

Ort, Datum

Unterschrift

Informationen über Spätfolgen impfpräventabler Krankheiten. Wissen, Risikowahrnehmung und Impfintention erhöhen – Zusammenfassung

Einleitung

Mit der Coronavirus (COVID-19) Pandemie 2020 ist deutlich geworden, dass Infektionskrankheiten die Welt verändern. Dies betrifft nicht nur neu auftretende Infektionskrankheiten, sondern auch altbekannte Gefahren, wie die jährlich auftretende Influenza würden Gesundheitssysteme überlasten, gäbe es keinen Schutz durch Impfungen. Die Grippesaison 2017/2018 wurde vom Robert Koch-Institut als die schwerste Saison seit Beginn der systematischen Überwachung verzeichnet (Buda et al., 2018): Von rund 334.000 nachgewiesenen Erkrankungen wurden rund 60.000 Fälle in ein Krankenhaus eingewiesen. 58% dieser Patienten waren über 60 Jahre alt. Insgesamt verstarben in der Grippewelle 2017/2018 1.674 Menschen an oder mit einer Influenza, davon 87% im Alter ab 60 Jahre. Grippe-Erkrankungen sind damit nicht nur eine wiederkehrende Herausforderung für das Gesundheitssystem, sie sind hauptsächlich eine Gesundheitsgefahr der älteren Bevölkerung (Nichol et al., 1998). Trotz des Zusammenhangs zwischen Alter und schweren Grippe-Verläufen unterschätzt eben diese Zielgruppe ihr Risiko, an Influenza zu erkranken, erheblich (Heinemeier et al., in prep.). Die vorgelegte Dissertation versucht, diesen Widerspruch wissenschaftlich zu dokumentieren und Ursachen aufzuzeigen. Als theoretische Basis werden Konzepte der Protection Motivation Theory (PMT) herangezogen (Prentice-Dunn & Rogers, 1986). Anschließend wird eine mögliche Lösung experimentell getestet. Dafür wurden drei Artikel verfasst. Im ersten Artikel wird durch eine repräsentative Umfrage dargelegt, dass Menschen über 60 der Zusammenhang zwischen Grippe und Spätfolgen nicht ausreichend bekannt ist. Im zweiten Artikel wird dieser Zusammenhang evidenzbasiert zu Gesundheitsinformationen aufgearbeitet. Diese werden auf ihre Wirkung auf Wissen, Risikowahrnehmung und Intention untersucht. Dabei werden potenzielle Einflussfaktoren

wie die Fähigkeit zum Verständnis und Handlung mit Gesundheitsinformationen (Health Literacy, Sørensen et al., 2012) und Reaktanz (Brehm & Brehm, 2013) genauer betrachtet. Im dritten Artikel liegt der Fokus auf der Kommunikation von Spätfolgen und wie sich diese langfristig beweisen kann –mehr als drei Monate nachdem die Gesundheitsinformationen präsentiert wurden, werden Wissen, Risikowahrnehmung sowie Impfindention und -verhalten erneut erfasst.

Artikel 1: Determinants of Sepsis Knowledge: A Representative Survey of the Elderly Population in Germany; veröffentlicht in Critical Care

Die Sepsis, allgemein bekannt als Blutvergiftung, ist eine lebensbedrohliche Komplikation von Infektionskrankheiten (Chousterman et al., 2017). In zwei repräsentativen Telefonumfragen wurden N = 701 Senior:innen aus Deutschland und N = 700 Senior:innen aus Thüringen befragt. Wissen über Grippe und Sepsis wurde neben Impfindention, der 5C-Skala (Betsch, Schmid, et al., 2018), soziodemographischen Variablen und Items zur Erreichbarkeits- und Kampagnenplanung erhoben. Die zentralen Ergebnisse belegen ein erhebliches Wissensdefizit der Bevölkerung über 60 Jahre im Bereich Sepsis: Obwohl über 80% den Begriff Sepsis kannten, scheiterten 39% an der korrekten Definition. Nur ein geringer Teil der Stichprobe (12.4% bzw. 24%) wusste, dass eine Sepsis durch eine Grippe oder eine Lungenentzündung entstehen kann. Eine schrittweise Regression mit soziodemographischen Variablen im ersten Schritt und Quellen von Gesundheitsinformationen im zweiten Schritt ergab, dass jüngeres Alter, höhere Bildung und Lebensraum in ländlicher (gegenüber urbaner) Umgebung mit höherem Sepsiswissen assoziiert waren. Die einzige Quelle an Gesundheitsinformationen, die mit höherem Sepsiswissen zusammenhängt sind Apotheken.

**Artikel 2: Rain on the Parade of Vaccine Hesitancy: Evaluating the Sequelae
Information Approach in Three Experimental Studies (eingereicht bei: Journal of
Health Communication)**

In drei Online-Experimenten wird der Ansatz der Spätfolgenkommunikation am Beispiel Grippe und Sepsis auf Wirksamkeit und unerwünschte Effekte überprüft. Der Aufbau der drei prä-registrierten Experimente entspricht dem folgenden Schema: Basisinformationen über die Grippe und die Gripeschutz-Impfung stellen das Material der Kontrollgruppe dar.

Unterschiedliche Variationen der Spätfolgenkommunikation werden damit verglichen, um den Mehrwert des Ansatzes gegenüber bestehenden Informationsmaterialien zu ermitteln. So wird evidenzbasiert der Ansatz der Spätfolgenkommunikation optimiert. Die Ergebnisse der vergleichbaren Gruppen aller Experimente wurden in einer internen Meta-Analyse zusammengefasst.

Das erste Experiment untersuchte darüber hinaus den Einfluss von narrativer vs. sachtextlicher Darstellung der Spätfolgenkommunikation, so wie den zusätzlichen Wert von Informationen über die Rehabilitationsphase nach der Erkrankung. Hier wurde mit $N = 431$ Personen im Alter von 18-82 Jahren die Spätfolgenkommunikation zuerst an einer Stichprobe getestet, die durch eine repräsentative Quotierung auf den Merkmalen Alter, Geschlecht und Bildung der deutschen Gesamtbevölkerung entspricht. Es zeigte sich, dass es innerhalb der Spätfolgenkommunikation keine Vorteile von narrativer Darstellung oder weiteren Informationen über die Rehabilitationsphase gibt. Darüber hinaus wurden keine signifikanten Vor- oder Nachteile für Menschen mit geringer Health Literacy gefunden. In der kritischen Betrachtung von Reaktanz als Einflussfaktor wurde ebenfalls kein Effekt auf die Intention gefunden.

Im zweiten Experiment werden die Ergebnisse an $N = 121$ Personen über 60 Jahre aus Deutschland repliziert. Informationen über die Rehabilitationsphase wurden allerdings nicht

mehr als Experimentalvariationen mit aufgenommen. In dieser Studie wurde das Sepsiswissen und die Risikowahrnehmung durch die Spätfolgenkommunikation signifikant erhöht. Befunde in Bezug auf Intention, Health Literacy und Reaktanz sind nicht signifikant. Im dritten Experiment wurde die Spätfolgenkommunikation mit einem U.S.-amerikanischen Sample repliziert. Hier wurden keine Spätfolgen mehr als Narrative präsentiert oder Informationen über die Rehabilitationsphase dargeboten. Stattdessen wurde die Methode der Spätfolgenkommunikation einer Sepsis mit 2 zusätzlichen Gruppen mit einer anderen Spätfolge von Grippe überprüft. Als zweite Spätfolge von Grippe wurde Herzinfarkt gewählt. Mit N = 620 Teilnehmenden ab 60 Jahren wurde das Experiment als Convenience Sample ohne Anspruch auf quotenbasierte Verteilung für Merkmale wie Alter, Geschlecht und Bildung erhoben. Die Spätfolgenkommunikation führte hier ebenfalls erfolgreich zu einer Steigerung des Sepsiswissens (in den Gruppen mit Sepsis als Spätfolge) und zur erhöhten Intention im Vergleich zur Kontrollgruppe, die nur Basisinformationen über Grippe erhielt. Die Kommunikation über Herzinfarkt führte zu mehr Wissen über Herzinfarkte. Keine der Spätfolgen erhöht die Risikowahrnehmung für Grippe als Primärkrankheit. Die Impfintention wird durch die Spätfolgenkommunikation auch im dritten Experiment signifikant erhöht, dabei unterscheiden sich Herzinfarkt oder Sepsis nicht in ihrer Effektivität als Spätfolge der Grippe. Auch im dritten Experiment findet sich kein Vor- oder Nachteil von Health Literacy Fähigkeiten. Auch zeigte sich kein signifikanter Effekt von Reaktanz auf die Intention nach der Auseinandersetzung mit Folgeerkrankungen einer Grippe.

Die Meta-Analyse zum Vergleich aller Studienbefunde zeigte abschließend, dass Spätfolgenkommunikation generell eine höhere Intention und höheres Wissen generiert, jedoch nicht zu einer größeren Risikowahrnehmung im Vergleich zu Informationen über Grippe und die Grippe-Impfung allein führt.

Artikel 3: Decreasing vaccine hesitancy with extended health knowledge: Evidence from a longitudinal randomized controlled trial; veröffentlicht bei Health Psychology

Da der Ansatz der Spätfolgenkommunikation kurzfristige positive Effekte auf Wissen und Intention produziert hat, wurde in einem prä-registrierten Online-Experiment die Langzeitwirkung auf Wissen, Risiko, Impfindention und tatsächliches, selbstberichtetes Impfverhalten untersucht. Eine Stichprobe von N = 585 Teilnehmenden über 60 Jahre wurden verschiedene Flyer online präsentiert Dabei kamen drei Stimuli zum Einsatz: Eine Interventionsgruppe erhielt die aktuelle Broschüre über Gripeschutz im Alter der Bundeszentrale für Gesundheitliche Aufklärung (BZgA). Unter dem Motto „Wir kommen der Grippe zuvor“ wird hier über Gripeschutz und Krankheit aufgeklärt. Die Teilnehmenden der zweiten Interventionsgruppe erhielten hingegen die Informationsbroschüre von „impfen60+“, die über Grippe und Sepsis aufklärt. Zusammen mit Prä-Post-Messungen ergibt sich ein 3 x 3 mixed-measurement Design (Broschüre: Bewegung vs. Grippe vs. Spätfolgenkommunikation; Zeitpunkt: T1 (vor der Broschüre) vs. T2 (nach der Broschüre) vs. T3 (nach 3 Monaten über die Grippesaison)).

Das Verhalten in der follow-up Studie unterschied sich nicht signifikant zwischen den Gruppen. Die Broschüre über Spätfolgen führte im Gruppenvergleich direkt nach der Präsentation zu signifikant höherem Wissen über Grippe, Pneumokokken und Sepsis, zu höherer Risikowahrnehmung und auch zu höherer Impfindention. Das Wissen über Sepsis blieb langfristig nach der Spätfolgenkommunikation höher als in den Vergleichsgruppen. In einer Mediation zeigte sich, dass die Spätfolgenkommunikation zu einem höheren Wissen zu T2 (direkt im Anschluss der Präsentation) geführt hat, das mit höherer Risikowahrnehmung zu T3 (drei Monate später) assoziiert ist. Diese wiederum stand in positivem Zusammenhang zur langfristig erhöhten Impfindention. Auch wenn die einmalige Präsentation der

Spätfolgenkommunikation das Verhalten nicht steigert, führt sie langfristig gesehen über Wissen und Risikowahrnehmung zu erwünschten Verhaltenseffekten.

Konklusion

Die Spätfolgenkommunikation ist eine wirksame Methode, um die Impfintention kurz- und langfristig zu steigern. Darüber hinaus profitieren Menschen von gesteigertem Wissen über diese Spätfolgen, da deren schnelle Diagnose und anschließende professionelle medizinische Versorgung lebensentscheidend sein kann. Es gibt in den Ergebnissen dieser Dissertation keinen Hinweis darauf, dass Health Literacy den Erfolg der Spätfolgenkommunikation beeinflusst. Die Ergebnisse der Experimentalstudien zeigen kleine Effekte, wenn man den Ansatz der Spätfolgenkommunikation mit Informationen über Grippe allein vergleicht.

Basierend auf den vorgestellten Befunden erscheint es für nachfolgende Forschung ratsam, die Studien für unterschiedliche Primärerkrankungen sowie Spätfolgen in anderen Zielgruppen zu replizieren. Aus gesundheitskommunikativer Sicht empfiehlt es sich, die Spätfolgenkommunikation als einen Hebel für die informierte Impfscheidung mit anderen effektiven Botschaften und Merkmalen (z.B. Framing) zu verknüpfen, um optimale Ergebnisse zu erzielen.

Literaturverzeichnis der Zusammenfassung

Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PloS One*, *13*(12), e0208601.

Brehm, S. S., & Brehm, J. W. (2013). *Psychological reactance: A theory of freedom and control*. Academic Press.

- Buda, S., Prahm, K., Dürrwald, R., Biere, B., Schilling, J., Buchholz, U., & Haas, W. (2018). *Bericht zur Epidemiologie der Influenza in Deutschland Saison 2017/18*.
- Chousterman, B. G., Swirski, F. K., & Weber, G. F. (2017). Cytokine storm and sepsis disease pathogenesis. *Seminars in Immunopathology*, *39*(5), 517–528.
<https://doi.org/10.1007/s00281-017-0639-8>
- Heinemeier, D., Schmid, P., & Betsch, C. (in prep.). *Influenza and pneumococcal vaccine hesitancy in the elderly population: Results from two representative surveys in germany and thuringia*.
- Nichol, K. L., Wuorenma, J., & von Sternberg, T. (1998). Benefits of Influenza Vaccination for Low-, Intermediate-, and High-Risk Senior Citizens. *Archives of Internal Medicine*, *158*(16), 1769.
<https://doi.org/10.1001/archinte.158.16.1769>
- Prentice-Dunn, S., & Rogers, R. W. (1986). Protection motivation theory and preventive health: Beyond the health belief model. *Health Education Research*, *1*(3), 153–161.
- Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., Brand, H., & (HLS-EU) Consortium Health Literacy Project European. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health*, *12*(1), 80.
<https://doi.org/10.1186/1471-2458-12-80>

Contents

<u>ACKNOWLEDGEMENTS</u>	12
<u>OVERVIEW</u>	13
PUBLICATIONS INCLUDED IN MY DISSERTATION	13
ADDITIONAL PUBLICATIONS	14
<u>GENERAL INTRODUCTION</u>	18
VACCINE HESITANCY	18
CHOOSING A THEORY OF HEALTH BEHAVIOR	20
EVIDENCE-BASED INTERVENTIONS FOR VACCINE HESITANCY	23
PSYCHOLOGICAL OBSTACLES: HEALTH LITERACY AND REACTANCE	25
<u>FOCUS OF THE PAPERS — RESEARCH QUESTION OF THE DISSERTATION</u>	28
<u>ARTICLE 1: DETERMINANTS OF SEPSIS KNOWLEDGE</u>	31
<u>ARTICLE 2: RAIN ON THE PARADE OF VACCINE HESITANCY</u>	32
<u>ARTICLE 3: DECREASING VACCINE HESITANCY WITH EXTENDED HEALTH KNOWLEDGE</u>	33
<u>GENERAL DISCUSSION</u>	34
SUMMARY OF RESULTS	35
DISCUSSION	110
CONCLUSION	115
<u>GENERAL REFERENCES</u>	41
<u>SUPPLEMENT</u>	131

Acknowledgements

It takes a village to raise a child and it takes more than a university to finish a dissertation. I would like to thank the members of the PIDI Lab team for their dedication to research for their encouragement and their constant support. I have learnt from everyone in this team. Most of all, I would like to thank my supervisor Prof. Dr. Cornelia Betsch for giving me constant chances to learn, to grow and to prove myself. This opportunity has taken me to places and knowledge I could never have imagined.

Special thanks go also to the vaccination 60+ project partners and especially to my Erfurt colleagues: Philipp Schmid, Dorothee Heinemeier, Winja Weber, Anne Reinhard and Nora Schmid-Küpke. Without you, I wouldn't have started, continued nor finished this thesis.

I would also thank all of my numerous roommates. Most of all, I would like to thank those who taught me that friends can become family.

Gratitude goes to the people who have carried me a great part of the way: I would like to thank my family for supporting me in the best possible manner. They taught me that strong women are the rule, not the exception. And that knowledge is always valuable and help is always just a phone call away.

Overview

In the following section, the three publications included my dissertation are listed first.

Subsequently, a complete list of my scientific publications in the field of health psychology research is provided. Next, the author contributions are given for all included papers of the dissertation.

Publications included in my dissertation

Article / Position in the dissertation	References and overview of contributions	5-Year Impact factor of the journal
1	Eitze, S., Fleischmann-Struzek, C., Betsch, C., & Reinhart, K. (2018). Determinants of sepsis knowledge: a representative survey of the elderly population in Germany. <i>Critical Care</i> , 22(1), 1-11.	5.358
2	Eitze, S & Betsch, C. (subm.). Rain on the parade of vaccine hesitancy. <i>Submitted: Journal of Health Communication</i>	1.648
3	Eitze, S., Heinemeier, D., Schmid-Küpke, N. K., & Betsch, C. (2021). Decreasing vaccine hesitancy with extended health knowledge: Evidence from a longitudinal randomized controlled trial. <i>Health Psychology</i> , 40(2), 77.	4.352

Table 1. Articles included in the dissertation, distributions of author contributions, and the journal's impact.

Note. Impact factors refers to the journal's impact in 2021. Information on journals' impact factor was retrieved from Wikipedia. Note that Article 2 is in submission status.

Please note that the numbering of the tables and figures in each article begins anew.

Moreover, vaccine decision-making is an interdisciplinary field of research and the articles and supplements included in this dissertation are attached as they are. This means that the layout of the articles and supplements vary depending on the respective journal and do not necessarily match APA style.

Additional publications

Peer-reviewed journals:

The following list shows my contributions to the field of research of health psychology.

Adeyanju, G. C., Engel, E., Koch, L., Ranzinger, T., Shahid, I. B. M., Head, M. G., **Eitze, S.**

& Betsch, C. (2021). Determinants of Influenza Vaccine Hesitancy among Pregnant Women in Europe: A Systematic Review. *European Journal of Medical Research*. 2021 Sep;26(1):116. DOI: 10.1186/s40001-021-00584-w. PMID: 34583779; PMCID: PMC8477621.

Betsch, C., Böhm, R., Schmid, P., Korn, L., Steinmeyer, L., Heinemeier, D., **Eitze, S.** &

Küpke, N.K. (2019). Impfverhalten psychologisch erklären, messen und verändern. *Bundesgesundheitsblatt*, 1-10. <https://doi.org/10.1007/s00103-019-02900-6>

Betsch, C., Korn, L., Sprengholz, P., Felgendreff, L., **Eitze, S.**, Schmid, P., & Böhm, R.

(2020). Social and behavioral consequences of mask policies during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences of the United States of America*, DOI: <https://doi.org/10.1073/pnas.2011674117>.

Betsch, C., Korn, L., Felgendreff, L., **Eitze, S.**, & Thaiss, H. (2021). School opening during

the SARS-CoV-2 pandemic: Public acceptance of wearing fabric masks in class. *Public Health in Practice*, 100115. DOI: <https://doi.org/10.1016/j.puhip.2021.100115>

Betsch, C., Rossmann, C., Pletz, M.W., **Eitze, S.** et al. Increasing influenza and

pneumococcal vaccine uptake in the elderly: study protocol for the multi-methods prospective intervention study Vaccination60+. *BMC Public Health* 18, 885 (2018). <https://doi.org/10.1186/s12889-018-5787-9>

Betsch, C., Sprengholz, P., Siegers, R., **Eitze, S.**, Korn, L., Goldhahn, L., Schmitz, J.M.,

Giesler, P., Knauer, G. & Jenny, M. A. (2021). Empirical evidence to understand the human factor for effective rapid testing against SARS-CoV-2. *Proceedings of the*

National Academy of Sciences of the United States of America, 118(32).

<https://doi.org/10.1073/pnas.2107179118>

Eitze, S., Felgendreff, L., Korn, L., Sprengholz, P., Allen J., Jenny, M., Wieler, L., Thaiss, H., De Bock, F., & Betsch, C. (2021) Vertrauen der Bevölkerung in staatliche Institutionen im ersten Halbjahr der Coronapandemie: Erkenntnisse aus dem Projekt COVID-19 Snapshot Monitoring (COSMO). *Bundesgesundheitsblatt*.

<https://doi.org/10.1007/s00103-021-03279-z>

Felgendreff, L., Korn, L., Sprengholz, P., **Eitze, S.**, Siegers, R. & Betsch, C. (2021). Risk information alone is not sufficient to reduce optimistic bias. *Research in Social and Administrative Pharmacy*. <https://doi.org/10.1016/j.sapharm.2021.01.010>

Grill, E., **Eitze, S.**, De Bock, F., Dragano, N., Huebl, L., Schmich, P., Wieler, L.H., & Betsch, C. (2021). Sociodemographic characteristics determine download and use of a Corona contact tracing app in Germany—Results of the COSMO surveys. *PloS one*, 16(9), e0256660.

Habersaat, K., Betsch, C., Danchin, M., Sunstein, C., Böhm, R., Falk, A., Brewer, N.T., Omer, S.B., Scherzer, M., Sah, S., Fischer, E.F., Scheel, A.E., Fancourt, D., Kitayama, S., Dubé, E., Leask, J., Dutta, M., MacDonald, N.E., Temkina, A., Lieberoth, A., Jackson, M., Lewandowsky, S., Seale, H., Fiethe, N., Schmid, P., Gelfand, M., Korn, L., **Eitze, S.**, Felgendreff, L. Sprengholz, P., Salvi, C., Butler, R (2020). Ten considerations for effectively managing the COVID-19 transition. *Nature Human Behavior*.
doi.org/10.1038/s41562-020-0906-x

Jenny, M. A., Lein, I., Jung-Sendzik, T., **Eitze, S.**, Drosten, C., & Betsch, C. (2021).

Kommunikationsempfehlungen zur Verbesserung des Verhaltens bei der Verwendung von PoC Antigen-Schnelltests und Selbsttests. [Communication recommendations to increase the use of PoC antigen rapid tests and self-tests.] <https://doi.org/10.25646/8481>

Korn, L., Siegers, R., **Eitze**, S., Sprengholz, P., Taubert, F., Böhm, R., & Betsch, C. (2021).

Age Differences in COVID-19 Preventive Behavior: A Psychological Perspective.

European Psychologist, 26(4), 359–372. <https://doi.org/10.1027/1016-9040/a000462>

Sprengholz, P., **Eitze**, S., Felgendreff, L., Korn, L., & Betsch, C. (2021). Money is not everything: experimental evidence that payments do not increase willingness to be vaccinated against COVID-19. *Journal of Medical Ethics*.

<http://dx.doi.org/10.1136/medethics-2020-107122>

Sprengholz, P., Siegers, R., Goldhahn, L., **Eitze**, S., & Betsch, C. (2021): Good night:

Experimental evidence that nighttime curfews may fuel disease dynamics by increasing contact density. *Social Science & Medicine*.

<https://doi.org/10.1016/j.socscimed.2021.114324>

Book chapters:

Weber, W., **Eitze**, S., Rossmann, C. Betsch, C., Hanke, R., & vaccination60+ study group.

(2018). Evidenzbasierten Kampagnenplanung: Potenziale und Grenzen. In: P. Stehr, D.

Heinemeier & C. Rossmann (Hrsg.), Evidenzbasierte/evidenzinformierte

Gesundheitskommunikation, 19 (S. 99-111). Baden-Baden: Nomos.

Author's contributions

For all included papers, the following applies:

- All authors conceived and designed the experiments.
- All authors approved the final draft.
- I performed the experiments and the analyses of the data.
- I wrote and submitted the manuscripts. In Article 1, Carolin Fleischmann-Struzek participated in writing the first draft and in editing the manuscript with a focus on

providing literature on sepsis from a medical perspective. In Article 3, Dorothee Heinemeier participated in writing the first draft and in editing the manuscript.

- Committed to the principles of Open Science, I pre-registered all experimental research of article 2 and 3. Also, for every Article, I uploaded all experimental materials, raw data, data analysis scripts and supplementary materials in the Open Science Framework.

General Introduction

“You can't fix the world if all you have is a hammer.”

Frank Turner. *1933 (Be more kind, 2018)*

Sequelae of vaccine preventable diseases – increasing knowledge, risk perception and the intention to vaccinate

Emerging and long-known infectious diseases are significant threats to individual wellbeing, economies, and societies. The Spanish flu, the coronavirus pandemic, severe measles epidemics, the annual flu epidemic, and the subtle human papillomavirus (HPV) that can end in cancer diseases in men and women all pose threats to our health. There are effective and safe vaccinations against all listed diseases. Immunization programs, in general, are among the most effective public health initiatives, saving more lives than any other intervention, except for reliable access to clean water (Plotkin & Plotkin, 2004).

Nevertheless, the effectiveness of all vaccines is decreasing because vaccines, as a public health initiative, depend largely on public acceptance (Cameron, 1996; Ritvo et al., 2003). The Strategic Advisory Group of Experts on Immunization (SAGE) defined vaccine hesitancy as the delay or denial of some or all vaccines, despite their availability (Dubé et al., 2014). In 2019, the World Health Organization (WHO) defined vaccine hesitancy as one of the top 10 threats to world health (WHO, 2019). Experts predict that the situation will change for the worse, due to the COVID-19 pandemic (Dubé & MacDonald, 2020), among other factors, and due to our increased use of social media (Wilson & Wiysonge, 2020).

In every population, there are significant differences in peoples' socialization, personality traits, abilities to deal with health information, and health statuses (Dubé et al., 2014). Consequently, interventions aiming to decrease vaccine hesitancy must reflect this diversity, not only in the selection of information presented but also in the chosen methods of communication. Only if 75–95% of the population is vaccinated—depending on the vaccine and the infectious disease of interest—can herd immunity be reached (Fine et al., 2011). In this dissertation, the primary goal is to evaluate a new approach to educational interventions for vaccine acceptance. The primary focus is to increase seniors' intention to vaccinate against influenza. The novel information in this approach is the probability and

characteristics of high-risk secondary diseases (sequelae), such as sepsis. Sepsis is largely unknown, although it is a common sequela of infectious diseases. Sepsis is a medical emergency that can result in organ failure and death. When information about secondary diseases is provided, risk perceptions of the primary infection and vaccine acceptance should increase.

Vaccine Hesitancy

Vaccine hesitancy is defined as “delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context specific, varying across time, place and vaccines” (MacDonald, 2015, p. 4161). On a continuum between total vaccine acceptance (accepting all vaccines) and total vaccine denial (declining all vaccines available), individual and environmental factors are important. Several individual reasons for vaccine hesitancy are well known and widely found in recent literature.

McDonald et al. (2015) established the 3C model, where *confidence* (trust in the safety and effectiveness of vaccines), *complacency* (underestimation of one’s own risk of infection probability and severity of infectious, vaccine-preventable diseases), and *convenience* (barriers to the vaccination opportunity, such as everyday stress, and systematic difficulties, such as the availability of appointments outside of working hours) are the three major issues that impact a vaccination decision. The 5C model (Betsch et al., 2018) added *calculation* (the need for information that might end in *fence-sitting*, or the inability to make a decision) and *collective responsibility* (versus relying on others’ vaccination for herd immunity, or so-called free-riding). The factors were added after Betsch et al. (2018) conducted a construct validation of the 5C scale to measure the antecedents of vaccine acceptance. A systematic review (Schmid et al., 2017) revealed that all five dimensions influence current research, with *confidence* being the most researched construct.

The vaccination rates for influenza in Europe demonstrate an urgent need to further investigate the reasons for vaccine hesitancy. Even though a recommendation by health authorities is an official policy in every member state of the European Union (EU), seasonal influenza vaccination rates differ greatly between countries. In the 19 member states that reported data, vaccination of people over 60 varied between 2% in Estonia and 72.8% in Scotland (European Centre for Disease Prevention and Control, 2018). None of the member states achieved the 75% EU target (Mereckiene, 2018). In recent years, the influenza vaccination rate in Germany has decreased from over 60% in 2010 to 51.4% in 2016 (Rieck et al., 2017). The major differences between regions and the declining vaccination rate over time show that the annual vaccination decision is influenced by more than just previous behavior; rather, there are relevant attitudes, prior knowledge, and intentions that influence behavior. Theories of health behavior can help us categorize and comprehend these dimensions.

Choosing a Theory of Health Behavior

Several theories of general behavior that are often applied to health contexts. Among others, the theory of reasoned action and its further development, the theory of planned behavior (Fishbein & Ajzen, 2011), or the subjective expected utility theory (Edwards, 1954; Ronis, 1992; Sutton, 1987) are often used in health behavior research to explain prevention and intervention behaviors. The relevant concepts are attitudes toward behavior-relevant aspects, normative beliefs, and subjective norms, as well as perceived behavioral control and the intention to perform the actual behavior.

Other theories focus more explicitly on preventive health behaviors. Continuous models, such as the health belief model (Janz & Becker, 1984; Kirscht, 1988; Rosenstock, 1974; Sheeran & Abraham, 1996), and dynamic stage models, such as the precaution adoption process model (Weinstein, 1988; Weinstein & Sandman, 1992), the transtheoretical

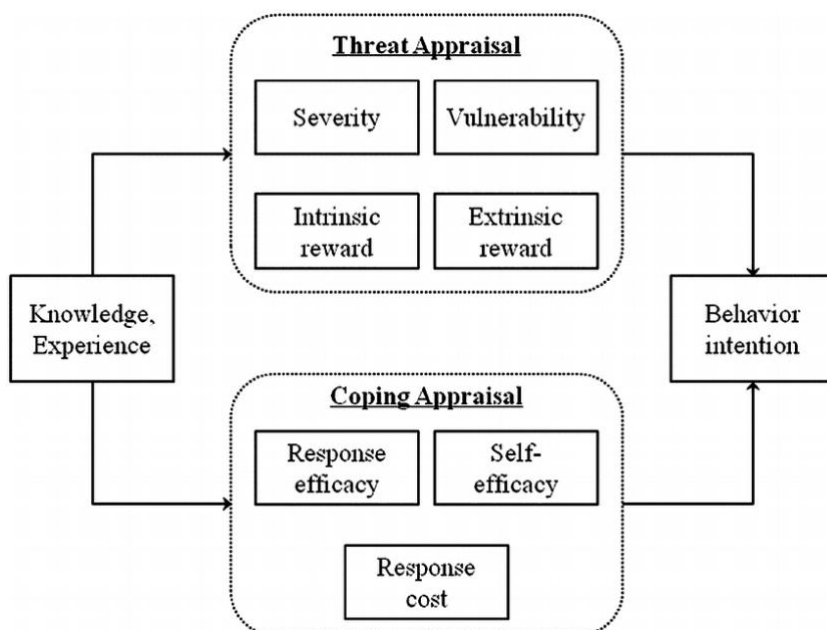
model (Prochaska et al., 1993), and the extended parallel process model (Witte, 1992), or the health action process approach (Schwarzer 1992; Zhang et al., 2019) try to explain why people engage in vaccination, sports, or healthy eating, but do not explain how to change these dimensions explicitly.

Finally, the protection motivation theory (PMT) (Prentice-Dunn & Rogers, 1986; Rogers, 1983) and the information-motivation behavioral skills model (Fisher & Fisher, 2000) both integrate knowledge as a factor that influences determinants of preventive health behavior. Evidence in favor of the concepts of PMT exists in meta-analyses (Milne et al., 2000) and reviews (Floyd et al., 2000). The theoretical concept of the sequelae approach is based on PMT, because it includes the influence of knowledge, risk perception, and coping, and it describes how to change behavioral intentions.

PMT

Knowledge and experience work together as two cognitive mediating processes. A coping appraisal and a threat appraisal influence behavioral intentions, which in turn increase (or decrease) the chances of preventive behaviors.

Figure 1.
Dimensions of PMT (Prentice-Dunn & Rogers, 1986)



Threat Appraisal Components in the Vaccination Decision. Within threat appraisal, the outcomes of maladaptive behaviors are evaluated (Prentice-Dunn & Rogers, 1986). Intrinsic and extrinsic rewards of non-vaccination (e.g., avoiding the fear of vaccination side effects) (Lago, 2013) will be weighed against the perceived severity and probability (Slovic, 2000) of the disease. *Severity* refers to individuals' estimated disease outcomes (the lost quality of life due to the disease) (Brewer et al., 2004). *Susceptibility* or *vulnerability* focuses on the risk of diseases compared to individuals with equal characteristics (Weinstein et al., 1984). The higher the estimation of susceptibility and severity, the higher the intention. The lower the extrinsic and intrinsic rewards for non-vaccination, the lower the intention. Threat appraisal components for vaccination decisions have been a topic of meta-analyses (Brewer et al., 2007) and systematic reviews (Bish et al., 2011; Schmid et al., 2017).

In opposition to fast and experiential risk analysis (affective risk perception including dimensions such as fear and worry), cognitive risk analysis (with dimensions such as severity and vulnerability) relies on reasoning and scientific deliberation (Slovic & Peters, 2006). To improve risk information, studies on risk perception have included severity and vulnerability as dimensions for decades (Slovic, 2000). All aspects cover the general dimension of risk (Brewer et al., 2004).

Greater values in the dimensions of risk perception were associated with an increase in health behavior (such as an increase in vaccine uptake) in the meta-analyses (Brewer et al., 2007). Systematic reviews on influenza vaccination (Schmid et al., 2017) show that an underestimation of risk is an issue even in high-risk groups, such as health care workers and the elderly.

Coping Appraisal Components in the Vaccination Decision. Within the coping appraisal, response efficacy and self-efficacy perceptions are calculated against possible response costs.

In terms of vaccination, this means that the effectiveness of the vaccine to prevent an infection, as well as self-efficacy in scheduling and demanding the vaccine, is in opposition to the perceived costs of vaccination, such as time for making an appointment and monetary costs (e.g., travel expenses for reaching the doctors' office). In vaccination decisions, response costs manifest in the fear of vaccines' adverse events, but the perceived barriers to vaccination (e.g., time to travel to the doctors, scheduling an appointment) also have an effect. There is evidence that fear of adverse events is one of the most important factors in vaccination decisions (Bish et al., 2011). In Milne et al.'s (2000) meta-analyses, dimensions such as response costs and self-efficacy had the strongest correlational relationship with intentions and behavior, even though none of the included research articles covered vaccination as a preventive behavior.

In a recent study, Ling et al. (2019) tested all dimensions of PMT within the scope of seasonal influenza vaccination. Except for response costs, all components were unique predictors of influenza vaccination intentions. Ling et al. (2019) summarized the following:

Individuals are most motivated to engage in protective behavior when encountered by a threatening event when they believe that lack of action poses a threat to themselves (high threat appraisal) and that performing the preventive behavior can reduce that threat (high coping appraisal).

Even though the influences of knowledge and experience are labeled as persuasive information (Floyd et al., 2000), providing evidence-based information about primary and secondary diseases is defined in this study as filling the gaps of missing information within the threat appraisal process.

The intention to perform a behavior results from the threat appraisal and the coping appraisal (Rogers, 1983). If both assessments are large, this is reflected in a higher intention. Even though intention is reliable for predicting current behavior, determinants besides

intention are important for future behavior as well (Milne et al., 2000). For interventions regarding vaccine hesitancy, it is, therefore, crucial to design evidence-based interventions.

Evidence-based Interventions for Vaccine Hesitancy

Evidence-based health interventions (Rossmann, 2015) rely on quality criteria, such as the foundations of theories of health behavior, targeted presentation for a subgroup, such as the elderly, and, most importantly, the content of scientific evidence (Heinemeier et al., 2018). Craig et al. (2008) showed that multi-component interventions are more effective when based on health behavior theory.

The *Vaccination 60+* campaign aimed to increase vaccination knowledge and intentions for pneumococcal and influenza vaccinations in a subgroup of people over 60 years of age in Germany. In the initial data collection, two telephone surveys were initiated to gather evidence of vaccine hesitancy in the regional target group. The 5C-dimension complacency (the underestimation of disease risks) is among the main reasons for vaccine hesitancy in the subgroup of elderly both in Germany and the federal state of Thuringia as an interventional region (Betsch et al., 2018). Given the level of complacency, an evidence-informed educational leaflet was created covering the sequelae approach, among other risk-relevant information.

The Sequelae Approach

In the novel sequelae approach, information about primary infectious diseases (such as influenza) is combined with information about possible late consequences (sequelae, such as sepsis) to increase vaccination intention and behavior. When information about possible sequelae is present, risk perceptions of the primary disease should increase. In turn, the intention to vaccinate against primary diseases should increase as well. In this dissertation, the approach is tested with influenza and sepsis as sequelae. Sepsis is widely unknown to the

public (Rubolotta et al., 2009); however, when an influenza infection taxes the human immune system, the risk of secondary infections increases (Kuiken & Taubenberger, 2008). The most common secondary infections are pneumococcal bacteria causing lung inflammation (Kash & Taubenberger, 2015). If one or both infections attack the immune system, severe sepsis can occur (Florescu & Kalil, 2014). Multiple organ failure is called septic shock and is often fatal (Chousterman et al., 2017). Vaccination against infectious diseases, such as influenza (Nichol et al., 1998), provides the most effective protection against sepsis and septic shocks. This also applies to vaccination against pneumococci and COVID-19 because sepsis also occurs with those diseases (Prescott & Girard, 2020).

The sequelae approach can be explained along several dimensions of PMT. Knowledge about sequelae will increase risk perceptions of infectious diseases, resulting in a greater threat appraisal. Consequently, the intention to vaccinate will increase. Using the example in this dissertation, influenza is a disease with a risk that is systematically underestimated. By learning about potential complications, individuals learn about the risk of disease and gain knowledge of the reasons for hospitalization with or after influenza. An aspect that is not covered in this dissertation is the efficacy of the vaccine. By learning about the possibility of preventing severe complications of influenza, the vaccine can be perceived as more effective, even if people generally know that the effectiveness of the influenza vaccination varies from year to year.

Psychological Obstacles: Health Literacy and Reactance

When health information is optimized for a target group, one must always ensure that there are no unwanted effects. If the health communication strategy does not produce any effects (i.e., greater intentions), the reason for such a result should be understood. This dissertation examines two possible confounding dimensions. First, due to the complexity of information, the effects of health literacy must be monitored closely. Different surface features, such as

factual text versus narrative, can help make information more accessible and understandable. The benefits of different formats and the strategy as a whole need to be evaluated for people with low health literacy skills. Second, health communication is always at risk of reactance effects because the behavioral recommendation favors one option (vaccination) over the other (non-vaccination). If this is too obvious or too forcing, people could perceive the recommendation as a restriction in their freedom of choice and chose the non-favorable option. The worst possible outcome of the strategy would therefore be a boomerang effect due to high reactance. As a result from high reactance, people are less willing to vaccinate than before.

Health Literacy

Health literacy refers to “the knowledge and competences of a person to meet the complex demands of health in modern society” (Sørensen et al., 2012, p.1). More precisely, it is the degree to which people are able to access, understand, appraise, and communicate information in order to engage with the demands of different health contexts so as to promote and maintain health across the life course (Koops van’t Jagt et al., 2016). In the individual definition, this refers to the skill of an individual to “function as a patient.” To date, two studies have focused on the distribution of health literacy skills in Germany (HLS-GER) (Schaeffer et al., 2021) and the EU (HLS-EU) (Sørensen et al., 2015). In the European data, 11.3% of participants showed inadequate health literacy, and 35.5% were classified as having problematic health literacy skills. Among the elderly in the EU, 58.2% of people between 66 and 75 years of age and 60.8% of people over 75 years of age have low health literacy skills. In Germany, the number of people with low health literacy is a bit smaller (39.7% for people between 66 and 75 years of age and 53.9% for people over 75 years of age); however, low health literacy remains a characteristic of a significant number of elderly people (Sørensen et

al., 2015). In 2021, after the onset of the COVID-19 pandemic, health literacy decreased even further. A total of 58.8% of the public has low health literacy. In people over 65 years of age, almost two-thirds have low health literacy values (65.1%) (Schaeffer et al., 2021). With advanced age, basic cognitive functions that are needed to apply health literacy skills, such as perceptual speed, memory, and verbal fluency, decline (Singer et al., 2003).

Low levels of health literacy are associated with a greater number of visits to the emergency unit (Berkman et al., 2011). People with lower health literacy also show and less preventive behavior during the COVID-19 pandemic than people with higher health literacy (Do et al., 2020; Schaeffer et al., 2021). Interestingly, compared to high health literacy, people with low health literacy are on sick leave less, but visit their general practitioner more often, which could indicate a greater number of chronic diseases in the latter group (Schaeffer et al., 2021).

Health literacy can also be defined as a social and cultural practice (Chinn, 2011; Nutbeam, 2008), where institutions and healthcare professionals are responsible for making communication accessible for patients of all health literacy levels (Rootman & Ronson, 2005). When information offered by services and individuals' health literacy match, the interaction with the health system is perceived as successful by the individual (Jordan et al., 2010). In the future, health care will develop, and health care systems will become more complex (Sturmberg & Martin, 2009). Compared to today, there will either be more options to consider when making a health decision (e.g., between different options of treatment) or more health decisions to make in total (e.g., with more available vaccines and multiple chronic conditions). This means that health literacy will become even more important than it is today (Berkman et al., 2010). In sum, when health information informs large groups of the public, such as the elderly in Germany, it should be beneficial for individuals with different

levels of health literacy. Otherwise, the information cannot be processed, and important groups are missed.

Reactance

In psychological reactance theory, reactance is “the tendency to act counter to restrictions or pressure (or recommendations) as to protect or restore a freedom of choice and control” (Brehm & Brehm, 2013, p.4). Reactance can be the reason for unintended effects in health interventions, often described as counter persuasion (Quick et al., 2013), resulting in so-called *boomerang effects* (Hart, 2013). When people know about their freedom of action, emotion, or attitude and perceive the ability to decide accordingly, any information that favors one option over another can work as a threat. Especially when the decision and its consequences are important for an individual (Brehm & Brehm, 2013), the arguments of others can feel as if one’s decisional process is becoming obsolete. Individuals then aim for their restoration of freedom by behaving contrary to restrictions or recommendations (Brehm, 1993). Besides “doing the forbidden act” (Quick et al., 2013, p.172), reactance leads to several other negative results, such as: a) an increased positive attitude toward the threatened choice (Hammock & Brehm, 1966; Reynolds-Tylus, 2019), b) the derogation of the source or the system (Kohn & Barnes, 1977; Reiss et al., 2020), c) the denial of the threats’ existence (Worchel & Andreoli, 1974), or d) by using a related freedom (such as denying other vaccines) to regain feelings of control (Betsch & Böhm, 2016; Brehm & Brehm, 2013). Psychological reactance is one of the most dangerous obstacles to health interventions (Hornik, 2002; Richards & Banas, 2015). Applied to the sequelae approach, reactance could occur because the prevention of sequelae is a strong argument in favor of vaccination. Especially for people with low confidence in the safety of vaccines, favoring non-vaccination as the desired outcome, information about sequelae, and long-lasting consequences can increase reactance.

Focus of the Paper—Research Question of the Dissertation

The primary research question of this dissertation is whether and how information about secondary diseases may increase influenza vaccination intentions and behavior in the target group of seniors.

Binding together theories of cognitive psychology, health psychology, and health communication, science can help us understand how information must be structured and presented to cause longitudinal effects on knowledge, risk perception, vaccination intention, and behavior. The three research papers used to examine this research question are presented below. First, a representative survey was used to determine the lack of information about secondary diseases. Then, a set of experiments evaluated the most effective formats to increase knowledge, risk perception, and intention. Finally, a longitudinal experimental study of the sequelae approach within a flyer that ties together different interventional modules was used to test the external validity and long-term effects on behavior. The results are discussed with regard to health behavior theories, replication, and their transferability to COVID-19 vaccines. The goal of this dissertation is to establish the examined approach as a new instrument within the toolbox for evidence-based health interventions.

Article 1

Determinants of sepsis knowledge

A representative survey of the elderly population in Germany.

Published article in Critical Care

Eitze, S., Fleischmann-Struzek, C., Betsch, C., & Reinhart, K. (2018). Determinants of sepsis knowledge: a representative survey of the elderly population in Germany. *Critical Care*, 22(1), 1-11. <https://doi.org/10.1186/s13054-018-2208-5>

Article 2

Rain on the parade of vaccine hesitancy.

Currently under review in the Journal of Health Communication

Eitze, S., & Betsch, C. (under review). Rain on the Parade of Vaccine Hesitancy: Evaluating the Sequelae Information Approach in Three Experimental Studies. Currently under review in the Journal of Health Communication.

Article 3
Decreasing vaccine hesitancy with
extended health knowledge.
Evidence from a longitudinal randomized
controlled trial.

Published article in Health Psychology

Eitze, S., Heinemeier, D., Schmid-Küpke, N. K., Betsch, C., & Vaccination60+ Study Group.

(2021). Decreasing vaccine hesitancy with extended health knowledge: Evidence from a longitudinal randomized controlled trial. *Health Psychology, 40*(2), 77–88.

<https://doi.org/10.1037/hea0001045>

General Discussion

Summary of Results

The research question of my dissertation consists of the distribution and impact of knowledge about the sequelae of vaccine-preventable diseases. The three articles presented here show how sequelae knowledge can increase vaccination intentions in the short and long term. Sepsis is a severe complication of infectious diseases that is widely unknown in the general population and in elderly generations (Article 1). When information about sepsis was combined with information about the primary diseases in the sequelae approach, several benefits emerged. Accordingly, both knowledge about influenza and knowledge about sepsis increased in the internal meta-analyses (Article 2), and sepsis knowledge increased longitudinally (Article 3).

Article 1

In a representative telephone survey of the elderly in Germany and Thuringia, I measured knowledge about sepsis as a sequela of influenza. Thirty-nine percent of respondents failed to define sepsis correctly, even though 88.6% of respondents had been aware of the term sepsis before. The participants underestimated the mortality of sepsis when compared to other prominent diseases. In addition, the majority of participants did not know that sepsis could be caused by influenza and pneumococcal bacterial infections. Brochures, physicians, nurses, and the media as health information sources did not contribute to increased sepsis knowledge. Therefore, the glaring knowledge gap is a suitable starting point for the sequelae approach.

Article 2

In three consecutive online experiments in German and US samples, the sequelae approach was evaluated. When exposed to the relationship between influenza and sepsis, knowledge about sepsis and the intention to vaccinate increased. Even though people with low confidence in the influenza vaccine experienced greater reactance after they were

exposed to the sequelae approach, this did not lower intentions in any of the experiments. Health literacy was also not found to be a crucial moderator of the sequelae approach. By explaining the relationship between primary diseases, such as influenza, and severe sequelae, such as sepsis, people with all levels of health literacy benefit with regard to their vaccination intentions. This phenomenon is effective in German and American online samples. An alternative sequelae presentation with myocardial infarctions that are less common (Fleischmann et al., 2016) but better known to the general public proved to be equally useful.

Article 3

In an online experiment, an educational leaflet covering the sequelae approach (and two control flyers) was shown at the beginning of the influenza season. After three months, I measured knowledge, risk perception, intention, and self-reported behavior in a follow-up study. Even when the sequelae approach was embedded in an educational leaflet and combined with significant additional information about influenza, myth debunking techniques, and herd immunity, the increase in knowledge and vaccination intention was substantial over three months.

Discussion

The results of the four experimental studies show that the sequelae approach is effective in increasing relevant knowledge and the intention to vaccinate. Even though the size of the effect on intention is small and further research is needed, the concept should be added to the toolbox of educational interventions (Jarrett et al., 2015). Despite this general effectiveness, some unexpected results emerged, which are discussed below.

The sequelae approach was hypothesized to increase the risk perception for influenza as a vaccine-preventable disease. Consequently, the intention to vaccinate was hypothesized to increase as well. However, the results of the internal meta-analyses in Article 2 showed that risk perception did not increase with the presentation of sequelae information compared to information about influenza alone. There are two possible alternative explanations for why

the increase in intention was nevertheless successful. The first explanation derives from the theoretical underpinnings of the theories of health behavior. By providing information that the influenza vaccine not only protects against influenza but also against sequelae that pose a substantial threat to an individual's wellbeing and life, the vaccine might be perceived as more effective against illness than before. Future research should add measurements of response efficacy and self-efficacy to cover all aspects of PMT (Prentice-Dunn & Rogers, 1986). The second explanation for why risk perception is not influenced in the short term derives from the fact that risk perception is increased in longitudinal measurements (Article 3). The information about sequelae might need a phase of consolidation (days or weeks) that is longer than provided by post-experimental measurement immediately after the presentation (Born & Wilhelm, 2012) so that knowledge can effectively transfer into risk perception. Especially for emotional information, a longer consolidation phase (days or weeks) increased memory performance in previous studies unrelated to disease knowledge (Lewis et al., 2011). Nevertheless, further experimental results of the sequelae approach favor the response efficacy explanation. The intention to vaccinate increased immediately after the sequelae approach was applied. Theories of health behavior, such as PMT, assume that risk perceptions and response efficacy are causal for intentions (Prentice-Dunn & Rogers, 1986).

The sequelae approach provided a successful learning situation in the short term (Article 2) and long term (Article 3) that needs to be further understood. In particular, the effects of memory structure (Collins & Loftus, 1975) and the focus of attention (Cowan, 1999) on the effects of the sequelae approach should be further elaborated to better predict and further improve the results. Memory and cognitive performance are important dimensions in the elderly subgroup.

An interdisciplinary experimental approach with a cognitive psychological focus could help shed light on the matter. Theories of semantic network structures (Collins & Loftus, 1975) might provide a theoretical foundation to guide future research on the effects of

memory structure; information (e.g., about an infection) is represented in nodes, which can be connected via links to other nodes (e.g., knowledge about the influenza vaccination).

Together, the related nodes form a concept (e.g., influenza). With advanced age and learning, the persistence of nodes and links in concepts is diminished (Naveh-Benjamin, 2000). If network structure is a crucial requirement for the success of the sequelae approach, then this should be confirmed in experiments that use methods such as the measurement of associative strength (Deese, 1959). On the other hand, the theory of fluid and crystallized intelligence (Horn & Cattell, 1966) proposed that crystallized intelligence, the manifestation of what is learned from the environment, is stable until old age. Taken together and applied to the sequelae approach, combining already stable and existing nodes or concepts, such as influenza, with new information about sequelae might be the most successful combination for educational interventions for the target group of the elderly.

Even though increased intentions did not translate into vaccination behavior three months later (Article 3), increasing knowledge about severe and unknown sequelae might still improve individuals' health. Sepsis is the most severe threat to populational health worldwide (Fleischmann et al. 2016). The urgency for emergency care and the correct diagnosis of sepsis can prevent septic shock, reduce long phases of rehabilitation, and save lives.

Limitations and Future Research

Even though the three papers present a variety of samples, methods, and analyses, limitations have to be discussed. This dissertation mainly used online samples. Especially in the target group of the elderly, this might have forced a self-selection bias (Weber et al., 2020) and could pose a serious threat to the study's external validity. It can be assumed that, in the future, the general population will become more similar to our samples, as more and more older people adapt to using the internet (Macdonald & Hülür, 2021). Right now, the generalizability to people who do not use the internet might be limited. Older people who do not use the internet also tend to be less educated and in poorer health than those who do

(Cresci et al, 2010; König et al, 2018). This is a strong indicator that health literacy could become an issue if the sequelae approach experiments are replicated with laboratory or field studies. Moreover, the samples in all the articles were collected in Western, educated, industrialized, rich, and democratic countries. Consequently, replications are needed in different cultural settings (Henrich et al., 2010).

The first success of the sequelae approach speaks to its further critical proof of concept. In light of the replication crisis in psychology and other disciplines, the results should be understood as initial evidence that requires further testing (Open Science Collaboration, 2015). These replications should be direct, and conceptual replications should extend to other data collection methods and collect additional variables to include all concepts of the PMT (Prentice-Dunn & Rogers, 1986). Afterward, the transfer to other infectious diseases, especially where an underestimation of risk is the evaluated antecedent for vaccine hesitancy with other possible sequelae, needs to be evaluated with experimental research. When it comes to vaccination against measles, the sequela of subacute sclerosing panencephalitis (SSPE) is a serious health threat to unvaccinated children and adults. Due to the substantial differences in individual vaccination decisions and parental vaccination decisions (Bödeker et al., 2015; Leask et al., 2012), reactance could be a more important measure than in individual vaccination decisions.

In the current COVID-19 pandemic, several sequelae, such as long-COVID, sepsis, and a greater risk of strokes, are already being researched. The sequelae approach could prove to be a valuable concept for COVID-19 as well. Vaccinations could be perceived as more effective than before, as they provide substantial protection for societies, especially the in the elderly (Hyams et al., 2021). As a final and crucial test, sequelae knowledge should decrease mortality after infectious diseases in the general public, or at least in the target group. If the sequelae approach is presented repeatedly with memory-enhancing formats such as testing (Rowland, 2014) or spacing (Latimier et al., 2021), knowledge should increase even more,

and, consequently, people should be able to apply this knowledge. This should result in a better diagnosis and earlier emergency treatment, which is related to lower mortality rates after infectious diseases (Fleischmann et al., 2016).

Practical Implications

In the current COVID-19 pandemic and its co-occurring infodemic (Zarocostas, 2020), we need to evaluate evidence-based strategies to target fake news-based vaccine hesitancy. Medically relevant information about sequelae might target an important gap. The strategy might improve health in two ways—by increasing vaccine intentions and decreasing knowledge-related delays in medical treatment. Looking beyond the pandemic, changes in behavior, low trust in institutions and science, and changes in attitudes about social norms and herd immunity are only a few factors that might affect vaccine hesitancy in the future. To this day, there is no evidence that the pandemic has resulted in a higher influenza vaccine demand in the subgroup of the elderly in Europe. However, there is evidence that during the first year of the pandemic, about 40% of all vaccination appointments were postponed (Schmid-Küpke et al., 2021). Therefore, from a public health perspective, knowledge about vaccination against infectious diseases and its importance to societies and cultures might be more prevalent than ever. At least, important factors such as trust in institutions (Sturgis et al., 2021), communication about COVID-19 vaccine side effects (Giesler et al., under review), and discussions about mandatory vaccination (Sprengholz et al., 2021) might have torpedoed vaccine demand longitudinally.

Based on the latest empirical evidence, the relationship between climate change and emerging and well known infectious diseases shows that there is an urgent need for new solutions regarding vaccine hesitancy. Liu et al. (2020) demonstrated that with increasing weather variability, infectious diseases will spread more successfully in urban areas.

Conclusion

The sequelae approach combines information about primary diseases (influenza) and secondary diseases (pneumonia and sepsis); it is an effective way to increase vaccination intention in the short and long term. In addition, people benefit from increased knowledge about these sequelae, as their rapid diagnosis and subsequent professional medical care can be life critical. There is no evidence in the results of this dissertation that health literacy affects the success of the sequelae approach. The results of the experimental studies showed small effects when comparing the sequelae approach to information about influenza alone. Based on the findings presented, it seems advisable for subsequent research to replicate the studies for different primary diseases, as well as late effects, in other target groups. From a health communication perspective, it is recommended that the sequelae approach should be linked to other effective messages and features (e.g., framing) as a lever for informed vaccination decision-making to achieve optimal results.

General References

- Berkman, N. D., Davis, T. C., & McCormack, L. (2010). Health Literacy: What Is It? *Journal of Health Communication, 15*(sup2), 9–19.
<https://doi.org/10.1080/10810730.2010.499985>
- Berkman, N. D., Sheridan, S. L., Donahue, K. E., Halpern, D. J., & Crotty, K. (2011). Low Health Literacy and Health Outcomes: An Updated Systematic Review. *Annals of Internal Medicine, 155*(2), 97. <https://doi.org/10.7326/0003-4819-155-2-201107190-00005>
- Betsch, C., & Böhm, R. (2016). Detrimental effects of introducing partial compulsory vaccination: Experimental evidence. *The European Journal of Public Health, 26*(3), 378–381. <https://doi.org/10.1093/eurpub/ckv154>
- Betsch, C., Rossmann, C., Pletz, M. W., Vollmar, H. C., Freytag, A., Wichmann, O., Hanke, R., Hanke, W., Heinemeier, D., Schmid, P., Eitze, S., Weber, W., Reinhardt, A., Küpke,

Supplement to Article 3

- N. K., Forstner, C., Fleischmann-Struzek, C., Mikolajetz, A., Römhild, J., Neufeind, J., ... Reinhart, K. (2018). Increasing influenza and pneumococcal vaccine uptake in the elderly: Study protocol for the multi-methods prospective intervention study Vaccination60+. *BMC Public Health*, *18*(1). <https://doi.org/10.1186/s12889-018-5787-9>
- Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PloS One*, *13*(12), e0208601.
- Bish, A., Yardley, L., Nicoll, A., & Michie, S. (2011). Factors associated with uptake of vaccination against pandemic influenza: A systematic review. *Vaccine*, *29*(38), 6472–6484. <https://doi.org/10.1016/j.vaccine.2011.06.107>
- Bödeker, B., Betsch, C., & Wichmann, O. (2015). Skewed risk perceptions in pregnant women: The case of influenza vaccination. *BMC Public Health*, *15*(1), 1308. <https://doi.org/10.1186/s12889-015-2621-5>
- Born, J., & Wilhelm, I. (2012). System consolidation of memory during sleep. *Psychological Research*, *76*(2), 192–203. <https://doi.org/10.1007/s00426-011-0335-6>
- Brehm, J. W. (1993). Control, Its Loss, and Psychological Reactance. In G. Weary, F. Gleicher, & K. L. Marsh (Eds.), *Control Motivation and Social Cognition* (pp. 3–30). Springer New York. https://doi.org/10.1007/978-1-4613-8309-3_1
- Brehm, S. S., & Brehm, J. W. (2013). *Psychological reactance: A theory of freedom and control*. Academic Press.
- Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*, *26*(2), 136.
- Brewer, N. T., Weinstein, N. D., Cuite, C. L., & Herrington, J. E. (2004). Risk perceptions and their relation to risk behavior. *Annals of Behavioral Medicine*, *27*(2), 125–130.
- Buda, S., Prahm, K., Dürrwald, R., Biere, B., Schilling, J., Buchholz, U., & Haas, W. (2018).

Bericht zur Epidemiologie der Influenza in Deutschland Saison 2017/18.

- Cameron, C. (1996). Patient compliance: Recognition of factors involved and suggestions for promoting compliance with therapeutic regimens. *Journal of Advanced Nursing*, 24(2), 244–250.
- Chinn, D. (2011). Critical health literacy: A review and critical analysis. *Social Science & Medicine*, 73(1), 60–67. <https://doi.org/10.1016/j.socscimed.2011.04.004>
- Chousterman, B. G., Swirski, F. K., & Weber, G. F. (2017). Cytokine storm and sepsis disease pathogenesis. *Seminars in Immunopathology*, 39(5), 517–528. <https://doi.org/10.1007/s00281-017-0639-8>
- Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, 82(6), 407–428. <https://doi.org/10.1037/0033-295X.82.6.407>
- Cowan, N. (1999). An Embedded-Processes Model of Working Memory. In A. Miyake & P. Shah (Eds.), *Models of Working Memory* (1st ed., pp. 62–101). Cambridge University Press. <https://doi.org/10.1017/CBO9781139174909.006>
- Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: The new Medical Research Council guidance. *BMJ*, a1655. <https://doi.org/10.1136/bmj.a1655>
- Cresci, M. K., Yarandi, H. N., & Morrell, R. W. (2010). Pro-Nets Versus No-Nets: Differences in Urban Older Adults' Predilections for Internet Use. *Educational Gerontology*, 36(6), 500–520. <https://doi.org/10.1080/03601270903212476>
- Deese, J. (1959). Influence of Inter-Item Associative Strength upon Immediate Free Recall. *Psychological Reports*, 5(3), 305–312. <https://doi.org/10.2466/pr0.1959.5.3.305>
- Do, B. N., Tran, T. V., Phan, D. T., Nguyen, H. C., Nguyen, T. T. P., Nguyen, H. C., Ha, T. H., Dao, H. K., Trinh, M. V., Do, T. V., Nguyen, H. Q., Vo, T. T., Nguyen, N. P. T., Tran, C. Q., Tran, K. V., Duong, T. T., Pham, H. X., Nguyen, L. V., Nguyen, K. T., ... Duong, T. V. (2020). Health Literacy, eHealth Literacy, Adherence to Infection

- Prevention and Control Procedures, Lifestyle Changes, and Suspected COVID-19 Symptoms Among Health Care Workers During Lockdown: Online Survey. *Journal of Medical Internet Research*, 22(11), e22894. <https://doi.org/10.2196/22894>
- Dubé, E., Gagnon, D., Nickels, E., Jeram, S., & Schuster, M. (2014). Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon. *Vaccine*, 32(49), 6649–6654.
- Dubé, E., & MacDonald, N. E. (2020). How can a global pandemic affect vaccine hesitancy? *Expert Review of Vaccines*, 19(10), 899–901.
- Edwards, W. (1954). The theory of decision making. *Psychological Bulletin*, 51(4), 380.
- European Centre for Disease Prevention and Control. (2018). *Seasonal influenza vaccination and antiviral use in EU/EEA Member States*. ECDC.
- Fine, P., Eames, K., & Heymann, D. L. (2011). “Herd Immunity”: A Rough Guide. *Clinical Infectious Diseases*, 52(7), 911–916. <https://doi.org/10.1093/cid/cir007>
- Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavior: The reasoned action approach*. Psychology press.
- Fisher, J. D., & Fisher, W. A. (2000). Theoretical approaches to individual-level change in HIV risk behavior. In *Handbook of HIV prevention* (pp. 3–55). Springer.
- Fleischmann, C., Scherag, A., Adhikari, N. K. J., Hartog, C. S., Tsaganos, T., Schlattmann, P., Angus, D. C., & Reinhart, K. (2016). Assessment of Global Incidence and Mortality of Hospital-treated Sepsis. Current Estimates and Limitations. *American Journal of Respiratory and Critical Care Medicine*, 193(3), 259–272.
<https://doi.org/10.1164/rccm.201504-0781OC>
- Florescu, D. F., & Kalil, A. C. (2014). The complex link between influenza and severe sepsis. *Virulence*, 5(1), 137–142. <https://doi.org/10.4161/viru.27103>
- Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A Meta-Analysis of Research on Protection Motivation Theory. *Journal of Applied Social Psychology*, 30(2), 407–429.

<https://doi.org/10.1111/j.1559-1816.2000.tb02323.x>

Giesler, P., Eitze, S., Shamsrizi, P., Addo, M. M., & Betsch, C. (under review). The Impact of New Vaccine Types, Myth Debunking, and Critical Events in Vaccine Trials on Confidence, Vaccination Intention, and Willingness to Participate in a Vaccine Trial: Experimental Evidence Using the Example of COVID-19. *European Journal of Health Communication*.

Hammock, T., & Brehm, J. W. (1966). The attractiveness of choice alternatives when freedom to choose is eliminated by a social agent¹. *Journal of Personality*, 34(4), 546–554. <https://doi.org/10.1111/j.1467-6494.1966.tb02370.x>

Hart, P. S. (2013). Boomerang effects in risk communication. In *Effective risk communication* (pp. 330–344). Routledge.

Heinemeier, D., Meißner, C., & Betsch, C. (2018). Was bedeutet Evidenzbasierung / Evidenzinformierung in der Gesundheitskommunikation? Eine Befragung während der 2. Jahrestagung der Fachgruppe Gesundheitskommunikation der DGPK. In P. Stehr, D. Heinemeier, & C. Rossmann (Eds.), *Evidenzbasierte / evidenzinformierte Gesundheitskommunikation* (pp. 45–60). Nomos Verlagsgesellschaft mbH & Co. KG. <https://doi.org/10.5771/9783845291963-45>

Heinemeier, D., Schmid, P., & Betsch, C. (in prep.). *Influenza and pneumococcal vaccine hesitancy in the elderly population: Results from two representative surveys in germany and thuringia*.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Beyond WEIRD: Towards a broad-based behavioral science. *Behavioral and Brain Sciences*, 33(2–3), 111–135. <https://doi.org/10.1017/S0140525X10000725>

Horn, J. L., & Cattell, R. B. (1966). Refinement and test of the theory of fluid and crystallized general intelligences. *Journal of Educational Psychology*, 57(5), 253–270. <https://doi.org/10.1037/h0023816>

- Hornik, R. C. (2002). Introduction public health communication: Making sense of contradictory evidence. In *Public health communication* (pp. 17–36). Routledge.
- Hyams, C., Marlow, R., Maseko, Z., King, J., Ward, L., Fox, K., Heath, R., Tuner, A., Friedrich, Z., Morrison, L., Ruffino, G., Antico, R., Adegbite, D., Szasz-Benczur, Z., Garcia Gonzalez, M., Oliver, J., Danon, L., & Finn, A. (2021). Effectiveness of BNT162b2 and ChAdOx1 nCoV-19 COVID-19 vaccination at preventing hospitalisations in people aged at least 80 years: A test-negative, case-control study. *The Lancet Infectious Diseases*, *21*(11), 1539–1548. [https://doi.org/10.1016/S1473-3099\(21\)00330-3](https://doi.org/10.1016/S1473-3099(21)00330-3)
- Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education Quarterly*, *11*(1), 1–47.
- Jarrett, C., Wilson, R., O’Leary, M., Eckersberger, E., & Larson, H. J. (2015). Strategies for addressing vaccine hesitancy – A systematic review. *Vaccine*, *33*(34), 4180–4190. <https://doi.org/10.1016/j.vaccine.2015.04.040>
- Jordan, J. E., Buchbinder, R., & Osborne, R. H. (2010). Conceptualising health literacy from the patient perspective. *Patient Education and Counseling*, *79*(1), 36–42. <https://doi.org/10.1016/j.pec.2009.10.001>
- Kash, J. C., & Taubenberger, J. K. (2015). The Role of Viral, Host, and Secondary Bacterial Factors in Influenza Pathogenesis. *The American Journal of Pathology*, *185*(6), 1528–1536. <https://doi.org/10.1016/j.ajpath.2014.08.030>
- Kirscht, J. P. (1988). The health belief model and predictions of health actions. In *Health behavior* (pp. 27–41). Springer.
- Kohn, P. M., & Barnes, G. E. (1977). Subject variables and reactance to persuasive communications about drugs. *European Journal of Social Psychology*, *7*(1), 97–109. <https://doi.org/10.1002/ejsp.2420070108>
- König, R., Seifert, A., & Doh, M. (2018). Internet use among older Europeans: An analysis

based on SHARE data. *Universal Access in the Information Society*, 17(3), 621–633.

<https://doi.org/10.1007/s10209-018-0609-5>

- Koops van 't Jagt, R., Hoeks, J. C. J., Jansen, C. J. M., de Winter, A. F., & Reijneveld, S. A. (2016). Comprehensibility of Health-Related Documents for Older Adults with Different Levels of Health Literacy: A Systematic Review. *Journal of Health Communication*, 21(2), 159–177. <https://doi.org/10.1080/10810730.2015.1049306>
- Kuiken, T., & Taubenberger, J. K. (2008). Pathology of human influenza revisited. *Vaccine*, 26, D59–D66. <https://doi.org/10.1016/j.vaccine.2008.07.025>
- Lagoe, C. (2013). *An Exploration of the Influence that Source Credibility and Fear have on MMR Vaccination Intentions*.
- Latimier, A., Peyre, H., & Ramus, F. (2021). A Meta-Analytic Review of the Benefit of Spacing out Retrieval Practice Episodes on Retention. *Educational Psychology Review*, 33(3), 959–987. <https://doi.org/10.1007/s10648-020-09572-8>
- Leask, J., Kinnersley, P., Jackson, C., Cheater, F., Bedford, H., & Rowles, G. (2012). Communicating with parents about vaccination: A framework for health professionals. *BMC Pediatrics*, 12(1), 154. <https://doi.org/10.1186/1471-2431-12-154>
- Lewis, P. A., Cairney, S., Manning, L., & Critchley, H. D. (2011). The impact of overnight consolidation upon memory for emotional and neutral encoding contexts. *Neuropsychologia*, 49(9), 2619–2629. <https://doi.org/10.1016/j.neuropsychologia.2011.05.009>
- Ling, M., Kothe, E. J., & Mullan, B. A. (2019). Predicting intention to receive a seasonal influenza vaccination using Protection Motivation Theory. *Social Science & Medicine*, 233, 87–92. <https://doi.org/10.1016/j.socscimed.2019.06.002>
- Liu, Q., Tan, Z.-M., Sun, J., Hou, Y., Fu, C., & Wu, Z. (2020). Changing rapid weather variability increases influenza epidemic risk in a warming climate. *Environmental Research Letters*, 15(4), 044004.

- Macdonald, B., & Hülür, G. (2021). Internet Adoption in Older Adults: Findings from the Health and Retirement Study. *Cyberpsychology, Behavior, and Social Networking*, 24(2), 101–107. <https://doi.org/10.1089/cyber.2019.0736>
- MacDonald, N. E. & SAGE Working Group on Vaccine Hesitancy. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, 33(34), 4161–4164. <https://doi.org/10.1016/j.vaccine.2015.04.036>
- Mereckiene, J. (2018). *European Centre for Disease Prevention and Control. Seasonal influenza vaccination and antiviral use in EU/EEA Member States—Overview of vaccine recommendations for 2017–2018 and vaccination coverage rates for 2015–2016 and 2016–2017 influenza seasons. Ecdc.*
- Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and Intervention in Health-Related Behavior: A Meta-Analytic Review of Protection Motivation Theory. *Journal of Applied Social Psychology*, 30(1), 106–143. <https://doi.org/10.1111/j.1559-1816.2000.tb02308.x>
- Naveh-Benjamin, M. (2000). Adult age differences in memory performance: Tests of an associative deficit hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 26(5), 1170–1187. <https://doi.org/10.1037/0278-7393.26.5.1170>
- Nichol, K. L., Wuorenma, J., & von Sternberg, T. (1998). Benefits of Influenza Vaccination for Low-, Intermediate-, and High-Risk Senior Citizens. *Archives of Internal Medicine*, 158(16), 1769. <https://doi.org/10.1001/archinte.158.16.1769>
- Nutbeam, D. (2008). The evolving concept of health literacy. *Social Science & Medicine*, 67(12), 2072–2078. <https://doi.org/10.1016/j.socscimed.2008.09.050>
- Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, 349(6251), aac4716. <https://doi.org/10.1126/science.aac4716>
- Prentice-Dunn, S., & Rogers, R. W. (1986). Protection motivation theory and preventive health: Beyond the health belief model. *Health Education Research*, 1(3), 153–161.

- Prescott, H. C., & Girard, T. D. (2020). Recovery From Severe COVID-19: Leveraging the Lessons of Survival From Sepsis. *JAMA*, *324*(8), 739.
<https://doi.org/10.1001/jama.2020.14103>
- Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, *51*(3), 390–395.
- Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1993). In search of how people change: Applications to addictive behaviors. *Addictions Nursing Network*, *5*(1), 2–16.
- Quick, B. L., Shen, L., & Dillard, J. P. (2013). Reactance theory and persuasion. *The SAGE Handbook of Persuasion: Developments in Theory and Practice*, 167–183.
- Reiss, S., Franchina, V., Jutzi, C., Willardt, R., & Jonas, E. (2020). From anxiety to action—Experience of threat, emotional states, reactance, and action preferences in the early days of COVID-19 self-isolation in Germany and Austria. *PLOS ONE*, *15*(12), e0243193. <https://doi.org/10.1371/journal.pone.0243193>
- Reynolds-Tylus, T. (2019). Psychological Reactance and Persuasive Health Communication: A Review of the Literature. *Frontiers in Communication*, *4*, 56.
<https://doi.org/10.3389/fcomm.2019.00056>
- Richards, A. S., & Banas, J. A. (2015). Inoculating Against Reactance to Persuasive Health Messages. *Health Communication*, *30*(5), 451–460.
<https://doi.org/10.1080/10410236.2013.867005>
- Rieck, T., Feig, M., Wichmann, O., & Siedler, A. (2017). *Impfquoten der Rotavirus-, Masern-, HPV-und Influenza-Impfung in Deutschland*.
- Ritvo, P., Irvine, J., Klar, N., Wilson, K., Brown, L., Bremner, K. E., Rinfret, A., Remis, R., & Krahn, M. D. (2003). A Canadian national survey of attitudes and knowledge regarding preventive vaccines. *Journal of Immune Based Therapies and Vaccines*, *1*(1), 1–9.

- Rogers, R. W. (1983). Cognitive and psychological processes in fear appeals and attitude change: A revised theory of protection motivation. *Social Psychophysiology: A Sourcebook*, 153–176.
- Ronis, D. L. (1992). Conditional health threats: Health beliefs, decisions, and behaviors among adults. *Health Psychology*, 11(2), 127.
- Rootman, I., & Ronson, B. (2005). Literacy and Health Research in Canada: Where Have We Been and Where Should We Go? *Canadian Journal of Public Health*, 96(S2), S62–S77. <https://doi.org/10.1007/BF03403703>
- Rosenstock, I. M. (1974). The Health Belief Model and Preventive Health Behavior. *Health Education & Behavior*, 2(4), 354–386. <https://doi.org/10.1177/109019817400200405>
- Rossmann, C. (2015). Strategic health communication. Theory-and evidence-based campaign development. *Routledge Handb. Strateg. Commun New York*, 409–423.
- Rowland, C. A. (2014). The effect of testing versus restudy on retention: A meta-analytic review of the testing effect. *Psychological Bulletin*, 140(6), 1432–1463. <https://doi.org/10.1037/a0037559>
- Rubulotta, F. M., Ramsay, G., Parker, M. M., Dellinger, R. P., Levy, M. M., & Poeze, M. (2009). An international survey: Public awareness and perception of sepsis*: *Critical Care Medicine*, 37(1), 167–170. <https://doi.org/10.1097/CCM.0b013e3181926883>
- Schaeffer, D., Berens, E.-M., Gille, S., Griese, L., Klinger, J., de Sombre, S., Vogt, D., & Hurrelmann, K. (2021). *Gesundheitskompetenz der Bevölkerung in Deutschland vor und während der Corona Pandemie: Ergebnisse des HLS-GER 2*.
- Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M.-L. (2017). Barriers of influenza vaccination intention and behavior—a systematic review of influenza vaccine hesitancy, 2005–2016. *PloS One*, 12(1), e0170550.
- Schmid-Küpke, N. K., Matysiak-Klose, D., Siedler, A., Felgendreff, L., Wieler, L., Thaiss, H. M., & Betsch, C. (2021). Cancelled routine vaccination appointments due to COVID-19

pandemic in Germany. *Vaccine: X*, 8, 100094.

<https://doi.org/10.1016/j.jvacx.2021.100094>

Schwarzer, R. (1992). Self-efficacy in the adaptation and maintenance of health behaviors:

Theoretical approaches and a new model. *R.Schwarzer (Ed)*, 217–243.

Sheeran, P., & Abraham, C. (1996). The health belief model. *Predicting Health Behaviour*, 2, 29–80.

Singer, T., Verhaeghen, P., Ghisletta, P., Lindenberger, U., & Baltes, P. B. (2003). The fate of cognition in very old age: Six-year longitudinal findings in the Berlin Aging Study (BASE). *Psychology and Aging*, 18(2), 318–331. <https://doi.org/10.1037/0882-7974.18.2.318>

Slovic, P. E. (2000). *The perception of risk*. Earthscan publications.

Slovic, P., & Peters, E. (2006). Risk Perception and Affect. *Current Directions in Psychological Science*, 15(6), 322–325. <https://doi.org/10.1111/j.1467-8721.2006.00461.x>

Sørensen, K., Pelikan, J. M., Röthlin, F., Ganahl, K., Slonska, Z., Doyle, G., Fullam, J., Kondilis, B., Agraftotis, D., Uiters, E., Falcon, M., Mensing, M., Tchamov, K., Broucke, S. van den, & Brand, H. (2015). Health literacy in Europe: Comparative results of the European health literacy survey (HLS-EU). *The European Journal of Public Health*, 25(6), 1053–1058. <https://doi.org/10.1093/eurpub/ckv043>

Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., Brand, H., & (HLS-EU) Consortium Health Literacy Project European. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health*, 12(1), 80. <https://doi.org/10.1186/1471-2458-12-80>

Sprengholz, P., Betsch, C., & Böhm, R. (2021). Reactance revisited: Consequences of mandatory and scarce vaccination in the case of COVID-19. *Applied Psychology: Health and Well-Being*, 13(4), 986–995. <https://doi.org/10.1111/aphw.12285>

- Sturgis, P., Brunton-Smith, I., & Jackson, J. (2021). Trust in science, social consensus and vaccine confidence. *Nature Human Behaviour*, 5(11), 1528–1534.
<https://doi.org/10.1038/s41562-021-01115-7>
- Sturmberg, J. P., & Martin, C. M. (2009). Complexity and health—Yesterday’s traditions, tomorrow’s future. *Journal of Evaluation in Clinical Practice*, 15(3), 543–548.
<https://doi.org/10.1111/j.1365-2753.2009.01163.x>
- Sutton, S. (1987). Social-psychological Approaches to Understanding Addictive Behaviours: Attitude-behaviour and decision-making models. *British Journal of Addiction*, 82(4), 355–370.
- Weber, W., Reinhardt, A., & Rossmann, C. (2020). Lifestyle Segmentation to Explain the Online Health Information–Seeking Behavior of Older Adults: Representative Telephone Survey. *Journal of Medical Internet Research*, 22(6), e15099.
<https://doi.org/10.2196/15099>
- Weinstein, N. D. (1984). Why it won’t happen to me: Perceptions of risk factors and susceptibility. *Health Psychology*, 3(5), 431.
- Weinstein, N. D. (1988). The precaution adoption process. *Health Psychology*, 7(4), 355.
- Weinstein, N. D., & Sandman, P. M. (1992). A model of the precaution adoption process: Evidence from home radon testing. *Health Psychology*, 11(3), 170.
- WHO. (2019). *Ten threats to Global Health in 2019*. <https://www.who.int/emergencies/ten-threats-to-global-health-in-2019>
- Wilson, S. L., & Wiysonge, C. (2020). Social media and vaccine hesitancy. *BMJ Global Health*, 5(10), e004206.
- Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communications Monographs*, 59(4), 329–349.
- Worchel, S., & Andreoli, V. A. (1974). Attribution of causality as a means of restoring behavioral freedom. *Journal of Personality and Social Psychology*, 29(2), 237–245.

Supplement to Article 3

<https://doi.org/10.1037/h0036012>

Zarocostas, J. (2020). How to fight an infodemic. *The Lancet*, 395(10225), 676.

[https://doi.org/10.1016/S0140-6736\(20\)30461-X](https://doi.org/10.1016/S0140-6736(20)30461-X)

Zhang, C.-Q., Zhang, R., Schwarzer, R., & Hagger, M. S. (2019). A meta-analysis of the health action process approach. *Health Psychology*, 38(7), 623.