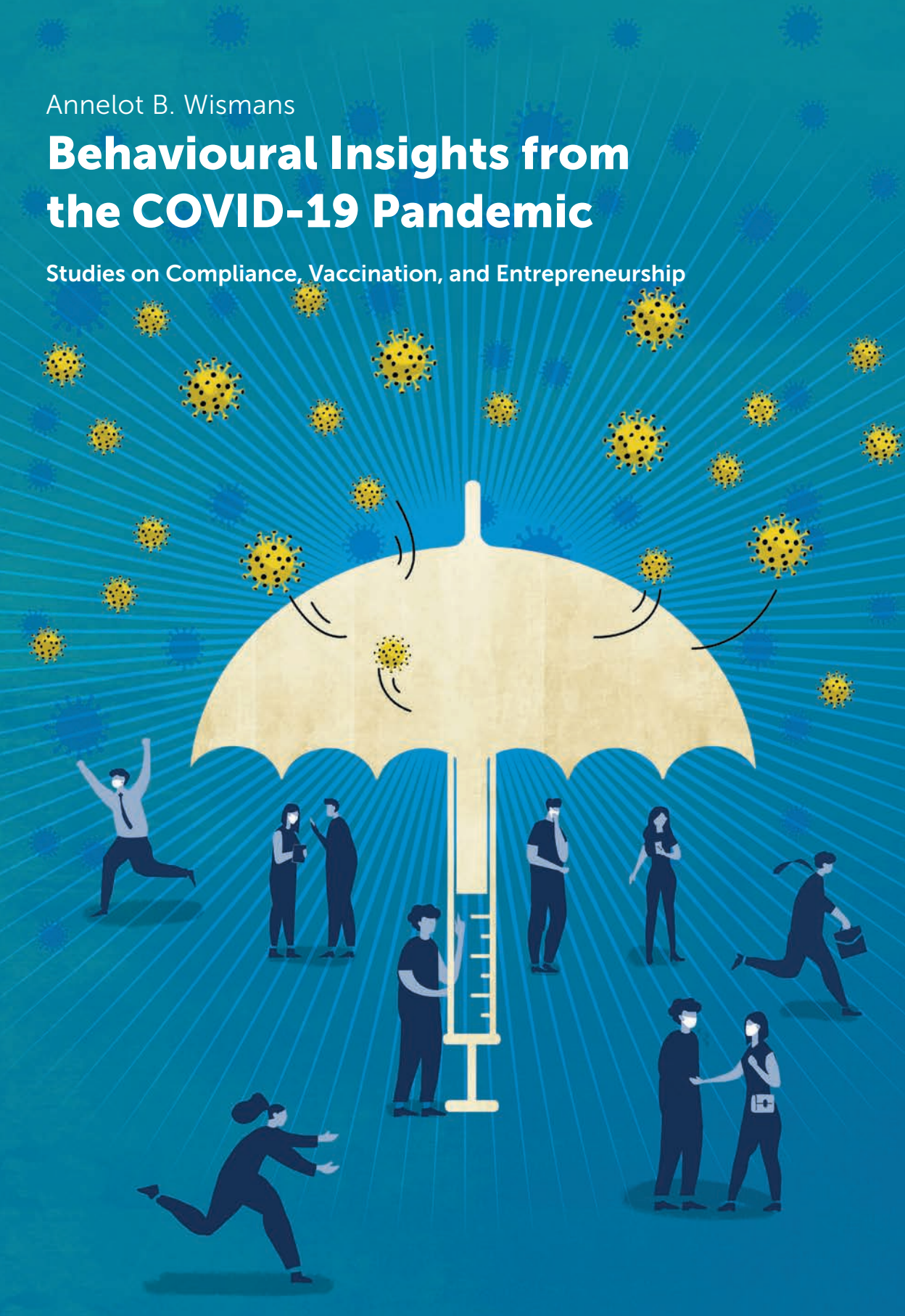
Annelot B. Wismans

Behavioural Insights from the COVID-19 Pandemic

Studies on Compliance, Vaccination, and Entrepreneurship



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Studies on Compliance, Vaccination, and Entrepreneurship

Gedragsinzichten voortkomend uit de COVID-19 Pandemie

Studies over Naleving, Vaccinatie en Ondernemerschap

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born in Rotterdam.

Erasmus University Rotterdam

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"The COVID-19 pandemic is as much about psychology as biology and hence that if we are to deal with the pandemic effectively, it is as important for us to understand how people behave as it is to understand how the virus behaves." - Jetten et al. (2020)

Acknowledgements

When I started my PhD four years ago, I was motivated by the prospect of combining my interests in psychology and economics by studying the psychology behind entrepreneurship. At that time no one could have guessed that a global pandemic was coming, let alone that it would eventually become the topic of this dissertation. A little more than one year into my PhD the acute societal relevance of studying real-time behaviour during a global pandemic sparked my enthusiasm. I am therefore probably one of the few PhDs that will argue that the pandemic also had a positive impact on their research. While I was worried during the pandemics' early days that the studies in this dissertation would have lost their present-day relevance by the time I would defend, unfortunately we now know better. My PhD has been an inspiring and challenging period in which I had the opportunity to meet and work with many wonderful people. As this dissertation would not have been possible without those that have directly or indirectly supported me, I want to take this opportunity to thank some of them in particular.

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Annelot Wismans,
October 2022

Table of Contents

List of Tables

List of Figures

1

Chapter 1

Introduction

Abstract

The COVID-19 pandemic has had an enormous global impact with consequences on all levels. Among governments' tools to curb a pandemic are the installation of preventive public health regulations and recommendations - related to increasing social distancing and improving hygiene - and widespread vaccination. Both these tools are only effective if collectively complied with and effectively adopted. Hence, strategies to halt the pandemic heavily relied on human behaviour. It was therefore quickly acknowledged that the field of social and behavioural sciences had a vital role to play in its approach. Research to understand how people and societies behave and make decisions during the COVID-19 pandemic was desperately needed. This also sparked the initiation of the Erasmus University Rotterdam International COVID-19 Student Survey, which forms the basis of many chapters of this thesis. This thesis consists of six studies aiming to understand individual behaviour in the context of a global pandemic. The chapters in this thesis can be broadly divided under three themes. Part 1 is about compliance with COVID-19 measures. Part 2 focuses on COVID-19 vaccination. Finally, Part 3 deals with entrepreneurship during the COVID-19 pandemic. This first chapter gives background information on the relevance of studying behaviour during the COVID-19 pandemic, and specifically the relevance of the three parts is discussed. Finally, it provides an overview of the studies included in this thesis.

1.1 The COVID-19 pandemic

In December 2019, cases of a novel viral infection with unknown cause were detected in Wuhan, China. A novel coronavirus (SARS-CoV-2) was later identified as the cause of this outbreak and the disease caused by the virus was officially named coronavirus disease 2019 (COVID-19)[1]. Despite a lockdown of the 18 million inhabitants of Wuhan, the virus quickly spread across the globe. At the end of January 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 a Public Health Emergency of International Concern, and subsequently it was classified as a pandemic on March 11th, 2020. At that time, it was unknown how long the COVID-19 pandemic would disrupt global life. Due to multiple novel variants of the virus emerging over time, it has had a long-lasting and unprecedented impact in the two years that followed (Gómez et al., 2021).

The impact and consequences of the pandemic have been felt on all levels. First and foremost, causing a global health crisis with considerable consequences for morbidity and mortality (Ioannidis, 2020b; Islam et al., 2021). At the time of writing (October 2022), the virus has caused over 622 million infections and over 6.6 million deaths globally (Dong et al., 2020). In fact, these numbers are even higher as not everyone that is infected

[1] In this thesis, for simplified terminology, we will also use COVID-19 (the name of the disease) when referring to SARS-CoV-2 (the virus causing the disease).

with COVID-19 or dies while infected with COVID-19 gets tested (The Economist, 2022). Second, due to the pandemic governments had to impose multiple regulations, such as (semi)-lockdowns and closure of certain industries, which had far-reaching effects on businesses and the global economy. While the economic impact was cushioned by fiscal support of governments to some extent, the pandemic triggered an economic downturn with a GDP drop of 6.5% in Europe in 2020 and rises in unemployment and business failures (ILO Monitor, 2021; Muggenthaler et al., 2021; Pak et al., 2020). Finally, next to its impact on physical health and the economy, the pandemic severely affected mental health and wellbeing, with studies reporting higher levels of depression, anxiety, loneliness, and suicidal thoughts (O'Connor et al., 2021; Pierce et al., 2020; Wang et al., 2020).

As there was no effective medication or vaccine to treat or prevent the spread of COVID-19 in the beginning of the pandemic, governments quickly installed a range of measures to stop and limit its transmission (Sebhatu et al., 2020; World Health Organization, 2020a). Initially, most countries started with containment strategies, aimed at stopping the transmission from infected to non-infected people. This included measures like early case identification, rapid testing, isolation, contact tracing and quarantining of contacts. Yet, as in many countries outbreaks quickly grew more numerous and larger, outpacing containment, governments shifted to mitigation strategies. These strategies aim at preventing an outbreak from growing bigger to minimise effects on vulnerable groups and avoid health systems to get overwhelmed (Lai et al., 2020; Walensky & del Rio, 2020). Mitigation relies on installing non-pharmaceutical interventions (NPI's), which mostly consist of actions that people can take to limit the spread of the virus. As COVID-19 is spread through human-to-human transmission, these NPI's primarily focused on increasing 'social distancing'[2] and improving hygiene (Anderson, Heesterbeek, et al., 2020; Hale et al., 2021). Specifically, social distancing is a set of measures related to increasing the physical distance between people and reducing the number of people one comes in physical contact with. Hygiene measures target the minimization of contact with viruses and for example focus on increasing hand washing and avoiding face touching. Moreover, many countries installed regulations related to the use of face masks (Howard et al., 2021; World Health Organization, 2020b). The stringency of these regulations was divergent across countries and ranged from advising or recommending behaviour to mandating behaviour and stringent lockdowns (Hale et al., 2021). Following the ups and downs in infection numbers, governments increased and relaxed the stringency of their measures over time during the pandemic (Hale et al., 2021).

Another tool in the toolbox to curb a pandemic is vaccination. Shortly after the outbreak, it was recognized that global and widespread vaccination would be one of the most promising means to protect people from COVID-19 and control the pandemic.

[2] Also known as physical distancing. In this dissertation, the term social distancing will be used.

Therefore, scientists worldwide directly started with the development of a vaccine against COVID-19 (Le et al., 2020). Before the COVID-19 pandemic, the fastest any vaccine had previously been developed was four years. However, amongst others due to previous research on related viruses, immense funding, and officials moving quickly, COVID-19 vaccines were developed and approved within less than a year (Cleve, 2021). This was followed by large-scale vaccination campaigns to ensure the majority of the public got vaccinated.

1.2 Importance of social & behavioural science in the response to the COVID-19 pandemic

From the onset of the pandemic, the fields of virology, epidemiology and medicine obviously played an important role in the fight against the pandemic. However, whilst not always fully recognized, the field of social and behavioural science has a vital role to play in the approach of pandemics (Taylor, 2019). Both for NPI's and vaccination to be an effective strategy to regulate or halt the pandemic human behaviour is the critical factor (Taylor, 2019; West et al., 2020). Public health regulations imposed by governments required people to change their daily routines and behaviours practically overnight. Collective compliance with these measures is considered to be crucial for the effectiveness of this approach (Alagoz et al., 2021; Chang et al., 2020). Moreover, as soon as vaccines became available, it was critical that people were willing to get vaccinated. Estimated percentages of people that should get vaccinated to achieve herd immunity[3] ranged from 67% to 95% (Anderson, Vegvari, et al., 2020; Mills et al., 2020; Randolph & Barreiro, 2020). Both strategies to curb the pandemic therefore relied heavily on human behaviour.

Policy makers frequently assume that knowledge and its rational assessment are enough to drive and change behaviour (Kelly & Barker, 2016; Putters, 2022). Even if compliance with regulations and getting vaccinated are seen as rational behaviours during a pandemic, we know that in fact people do not always behave accordingly. People are greatly affected by other factors amongst which emotions, norms, habits, and individual characteristics (Kahneman, 2011; Kelly & Barker, 2016). The significance of understanding drivers of human behaviour during the COVID-19 pandemic was therefore soon acknowledged by groups of researchers, who advocated the need of gaining and applying insights from social and behavioural sciences in the response to the COVID-19 pandemic (Betsch, 2020; Bonell et al., 2020; van Bavel et al., 2020; West et al., 2020). As mentioned

[3] The importance of achieving herd (or population) immunity has been stressed throughout the pandemic. It is defined as follows: '*herd immunity works through achieving a threshold immunity at the population level that is able to theoretically cut the transmission chain of a given infectious disease, be it obtained through natural infection or vaccination. This may not mean that a given individual is fully protected at all times or situations. It is the threshold immunity that, when high enough, can protect most if not all in a population in a given geographical area for a certain time interval.*' (Kadkhoda, 2021)

by Jetten et al. (2020), "*The COVID-19 pandemic is as much about psychology as biology and hence that if we are to deal with the pandemic effectively, it is as important for us to understand how people behave as it is to understand how the virus behaves"*. Along the course of the pandemic, this message grew stronger and was more widely embraced. For example, in July 2020 the WHO convened a Technical Advisory Group on Behavioural Insights and Sciences for Health. WHO's Director-General then stated that: "*The COVID-19 pandemic has taught the world that public health agencies and experts need a better understanding of how people and societies behave and make decisions in relation to their health*" (World Health Organization, 2020d, 2020c).

To increase our understanding of how people and societies behave and make decisions during the COVID-19 pandemic, collecting and analysing empirical data on individual behaviour during the pandemic was believed to be essential. While the COVID-19 pandemic was not the first pandemic to shock the world, its global and severe socioeconomic impact is unparalleled in recent history (He et al., 2020; Liang et al., 2021). Little recent data was available that was directly applicable to the present situation. Also, the exceptional situation provided a unique situation –a 'natural experiment'- to study behaviour in times of crisis. Sparked by its acute relevance, behavioural scientists worldwide initiated research projects. Online global repositories keeping track of data and projects examining the societal and behavioural impact of the pandemic show the immense amount of research that has been conducted in a short time (Daly et al., 2020; WRPN, 2022). Many of these projects focus on individual behaviour, allowing to disentangle what characteristics, motives and policies are important for behavioural choices and outcomes during the pandemic (Daly et al., 2020). Also on country level, governmental organizations started analysing the response of the public to COVID-19, for example by periodically conducting surveys among their inhabitants to monitor COVID-19 related behaviour and attitudes (RIVM, 2022). To disseminate this knowledge, scientific journals also emphasized the importance of COVID-19 publications, prioritizing the review of COVID-19 related studies and direct (open-access) publication of papers (Besançon et al., 2021; Palayew et al., 2020). Altogether, the pandemic set in motion a big wave of research in the field of social science. The potential value of this research is considerable given that findings can be used to inform current and future public health campaigns and interventions, for example, aimed at increasing compliance with NPI's and vaccination uptake.

1.3 Erasmus University Rotterdam International COVID-19 Student Survey (EURICSS)

The project of my PhD study is the result of an interdisciplinary research initiative called the Erasmus University Rotterdam Institute for Behaviour and Biology (EURIBEB). EURIBEB's main aim is to link health and biological measures with social

scientific outcomes in economics and psychology. While my dissertation initially would focus on increasing the understanding of the characteristics of the entrepreneur, amongst others focussing on the role of ADHD and personality, I decided to change this focus at the start of 2020. Not long after that, while I was thinking about new research ideas, COVID-19 spread to the Netherlands. Just like the large group of scientists, as described in section 1.2, I was immediately interested in the behavioural side of the pandemic and enthusiastic to study this due to its novelty and relevance.

Soon after the start of the pandemic, together with my thesis directors and their network (in particular that of entrepreneurship scholars), we initiated the Erasmus University Rotterdam International COVID-19 Student Survey (EURICSS). The EURICSS is an international study on behaviour of university students across different countries during the COVID-19 pandemic. Our aim was to acquire insights on individual differences and pandemic related behaviour, or behaviour affected by the pandemic, such as compliance with public health regulations, COVID-19 vaccination and – my initial PhD-topic – entrepreneurship. Both at the beginning of the pandemic, and eight months later in the middle of the pandemic, we distributed two online surveys to collect data. Before the initiation of both waves of data collection, we received approval from the Internal Review Board of the Erasmus School of Economics for our studies.

The population we surveyed as part of the EURICSS consisted solely of university students. We focused on collecting data of students for three reasons. First, our network and function within the academic environment made it easier to collect a large amount of data in a relatively short time with a limited budget. Especially during the first wave of data collection, we assumed that we were under time pressure to collect relevant data making it impossible to acquire funding to approach other demographic groups. Second, in studying behaviour during the pandemic, students are a relevant demographic group. It was soon recognized that younger people are in general less at risk of suffering from negative health consequences of COVID-19 infection (Brandén et al., 2020; Götzinger et al., 2020; Ioannidis et al., 2020; Swann et al., 2020; Zhou et al., 2020). At the same time this group may have to give up a lot in terms of social life when following COVID-19 measures. It is therefore interesting to investigate pandemic-related behaviours of this group for whom motives, and antecedents of this behaviour might be different compared to the general population. Third, during later phases of the pandemic, reports suggested students to be at the centre of new infection peaks across Europe and the US (The Economist, 2020), again underlining the relevance of studying the behaviour of students.

The first data collection took place in the early days of the COVID-19 pandemic, between late April and the beginning of May 2020 (weeks 17-19). We collected data from students in Belgium, Colombia, France, Germany, India, Ireland, Italy, the Netherlands, Portugal, Spain, and Sweden. For the data collection we worked together with Prof. Janssen, Prof Dejardin (both Belgium), Prof. Barrientos Marín (Colombia), Prof. Torrès (France), Prof. Block (Germany), Dr. Mukerjee (India), Prof. Burke (Ireland), Prof.

Santarelli (Italy), Prof. Thurik, Prof. Franken (both the Netherlands), Rui Baptista (Portugal), Prof. Millán (Spain), Dr. Letina, and Prof Wennberg (both Sweden). The survey was translated in four languages: English, French, Spanish and Dutch. The general aim of this first data collection was to investigate how students perceive and which students comply with COVID-19 measures set by governments. Data were collected on a broad range of COVID-19 related behaviours and attitudes. Moreover, data on personality, personal characteristics and entrepreneurial aspirations were collected. In total, we surveyed 7,403 students.

Since the consequences of the coronavirus persisted to impact daily lives, a new wave of data was collected eight months later, in December 2020 (weeks 51-52). The second survey was distributed among university students from three countries: Belgium, the Netherlands and Portugal. For the data collection we worked together with Prof. Janssen, Prof. Dejardin (both Belgium), Prof. Thurik, Prof. Franken (both the Netherlands), and Rui Baptista (Portugal). The students that were invited to take part also participated in the survey during the first wave. At this stage, it was clear that vaccinations against COVID-19 would soon become available. In the second survey, next to repeating a range of questions that were part of the first survey, we added new questions primarily on the topic of vaccinations. In total, 1,137 students were surveyed during this follow-up survey.

The COVID-19 pandemic sparked the start of the EURICSS, which became the base of many of my studies. Consequently, I changed the topic of my dissertation to studying individual differences in relation to COVID-19 related behaviour. Chapter 2 to 6 are based on EURICSS data, while other datasets are used in Chapter 7. In the next section, the thesis' outline and aims are discussed.

1.4 Thesis outline & aims

The aims of the current thesis are multiple. The shared aim of the studies presented is to add to the understanding of which individual characteristics and attitudes are important for behavioural choices and outcomes during a global pandemic.

The chapters in this thesis can be broadly divided under three themes. Part 1, containing Chapter 2 to 4, is about 'Compliance with COVID-19 measures'. Part 2 focuses on 'COVID-19 Vaccination' and consists of two chapters, Chapter 5 and 7. Finally, Part 3 is about 'Entrepreneurship and the COVID-19 pandemic' and contains both Chapter 6 and Chapter 7. Note that Chapter 7 fits under both Part 2 and Part 3 and will be discussed as final study of this thesis in Part 3. The themes and division of chapters is shown in Figure 1.1.

Chapter 2, 3, 4 and 6 are based on data collected during the first wave of the EURICSS. Chapter 5 is based on data collected during both waves of the EURICSS. Finally, in Chapter 7, we make use of three open access datasets containing individual data related to the COVID-19 pandemic.

In the next section, the aims of the three different parts and a description of the accompanying chapters are presented. Some of the paragraphs in these sections are based on text from the related chapters. Results and implications of these chapters are given in the discussion in Chapter 8.

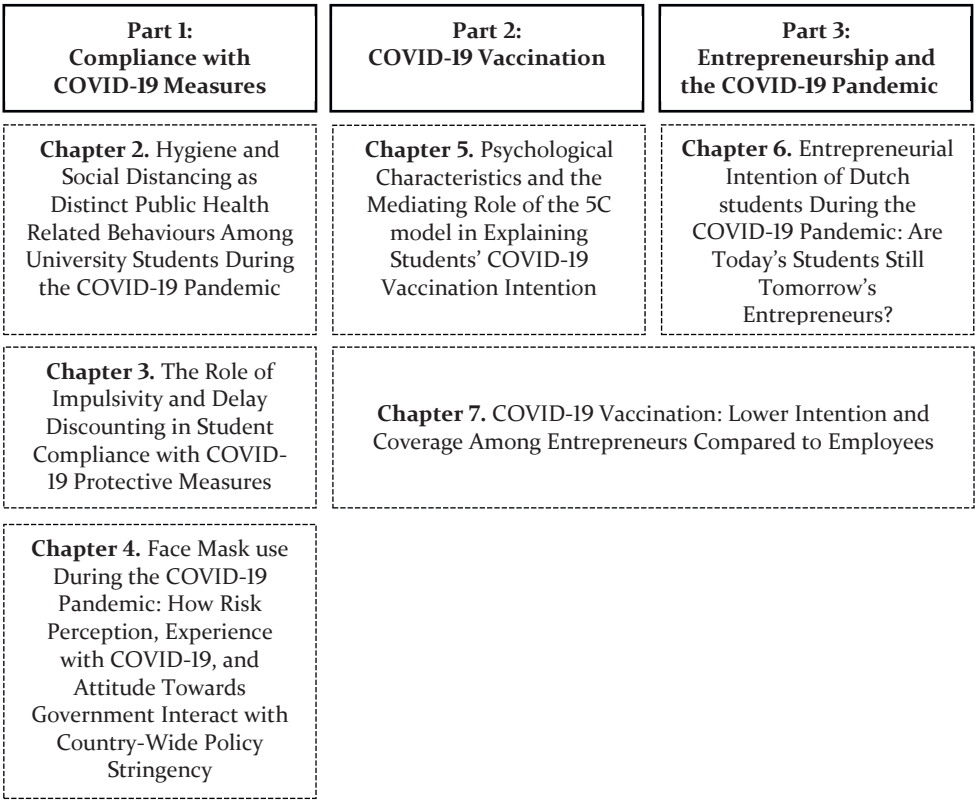

Figure 1.1 Overview themes and chapters included in this thesis

Part 1: Compliance with COVID-19 Measures

Part 1 deals with compliance with COVID-19 related public health measures. This part contains three Chapters (2-4).

As indicated earlier in this introduction, governments were quick to instal multiple regulations (NPI's) to curb the spread of COVID-19. The importance of collective compliance with these measures was presented by Chang et al. (2020). In their study, they used epidemiological data on COVID-19 and agent-based modelling to simulate different scenarios to evaluate the effectiveness of multiple NPI's with respect to different levels of compliance in the Australian population. Figure 1.2 shows part of their results on the

effectiveness of population-wide social distancing for 13 weeks (grey area). The Figure shows that with low compliance levels (<70%), social distancing is fully inadequate in reducing the prevalence of COVID-19 in the time frame studied. This shows that NPI's are useless without high levels of compliance. To reach the necessary levels of compliance, it is important to understand underlying drivers of compliance.

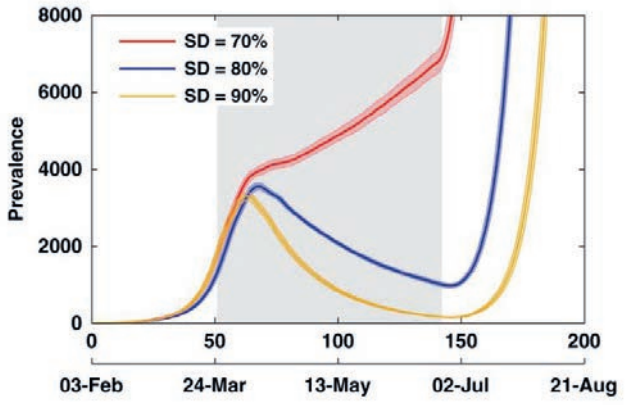

Figure 1.2 Modelling of the effects of different levels of Social Distancing (SD) compliance (70-90%) of 13 weeks (grey area) on the prevalence of COVID-19

Note: Figure 2b from "Modelling transmission and control of the COVID-19 pandemic in Australia" by Chang et al., 2020, *Nature Communications*, *11*(1), 5170. CC-BY-4.0. Modifications: 'b' was removed from the original Figure and the legend originally presented in Figure 2d in the paper was included in this Figure.

In research unrelated to pandemics, compliance behaviours have been extensively studied, for example in connection to medical recommendations for the chronically ill (for a review, see DiMatteo, 2004), or with respect to health-related recommendations and required behavioural changes (e.g., physical activity, sex behaviour, drinking, smoking) in health psychology. Studies on these behaviours show the importance of individual attitudes, beliefs, norms, and characteristics, with important theories in this respect being the Health Belief Model and Theory of Planned Behaviour (Ajzen, 1991; Conner et al., 2002; Doganis et al., 1995; Janz & Becker, 1984). While compliance with COVID-19 measures does revolve around health behaviours, there are three important differences between the health-related recommendations typically studied and COVID-19 recommendations. First, COVID-19 regulations apply to everyone and not exclusively to specific subpopulations, even though certain groups are at higher risk (Brandén et al., 2020; A. Clark et al., 2020; Hashim et al., 2020; Mueller et al., 2020; Williamson et al., 2020; Zhou et al., 2020). Second, studies of health-related behaviours usually focus on one type of behaviour (e.g., smoking or drinking) or a range of closely related behaviours (e.g., eating habits). COVID-19 related recommendations cover more diverse types of behaviours not necessarily closely related, such as keeping physical

distance and washing hands frequently (Alwan et al., 2020; Chu et al., 2020; Ioannidis, 2020a; Rundle et al., 2020). Third, as mentioned earlier, while previously studied behaviours have direct personal benefits, this is not the case for COVID-19 recommendations. This is specifically the case for students who have a minute risk of developing negative health consequences. Given these differences, studies specifically focused on compliance with COVID-19 related behaviours were required after the outbreak of the pandemic.

Based on this literature, one of the aims of this thesis, specifically of the three chapters in Part I, is to acquire insight into factors associated with compliance during the COVID-19 pandemic. First, in Chapter 2, we investigate the extent to which compliance with certain COVID-19 measures correlates with compliance with other COVID-19 measures. We investigate whether it is problematic that early research on compliance with COVID-19 measures mostly focused on composite measures, in which compliance with multiple types of behaviours is assessed at the same time. Second, taking into account the outcomes of Chapter 2, we analyse how different personality traits, attitudes and policies relate to compliance with specific measures in Chapter 2, Chapter 3 (both focused on social distancing and hygiene) and Chapter 4 (focused on face mask use). By gaining insights into the relationship between students' individual differences and compliance with COVID-19 measures, these outcomes could be used to inform policy makers in designing public health campaigns and to target groups with suboptimal levels of compliance.

Short summaries of these three chapters are given below. Their outcomes are summarized in the discussion chapter.

Chapter 2. Hygiene and Social Distancing as Distinct Public Health Related Behaviours Among University Students' During the COVID-19 Pandemic

Prevailing research on individuals' compliance with public health related behaviours during the COVID-19 pandemic tends to study composite measures of multiple types of behaviours, without distinguishing between different types of behaviours or public health measures. This may be problematic since adjustment concerning a range of different daily behaviours may not be simply understood as a sole behavioural construct. In this study, we seek to explain students' public health related compliance behaviours during the COVID-19 pandemic by examining the underlying components of such behaviours using a Principal Components Analysis. Subsequently, we investigate how components found in this study relate to individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics using regression analyses. We use data of the EURICSS from 7,403 university students in ten countries regarding these behaviours.

Chapter 3. The Role of Impulsivity and Delay Discounting in Student Compliance with COVID-19 Protective Measures

The recommendations and restrictions set by governments gave rise to new situations that require residents to deliberate and respond nonautomatically. For highly impulsive individuals, dealing with these situations may be harder, as they tend to deliberate less about the consequences of their behaviours. In this study, we therefore investigate the relationship between impulsivity and delay discounting on the one hand and compliance with COVID-19 restrictions on the other hand. We distinguish between compliance with social distancing measures and compliance with hygiene measures. We conduct regression analyses using data from 6,759 students from seven European countries part of the EURICSS.

Chapter 4. Face Mask use During the COVID-19 Pandemic: How Risk Perception, Experience with COVID-19, and Attitude Towards Government Interact with Country-Wide Policy Stringency

Of all regulations imposed by governments to protect public health during the COVID-19 pandemic, the (mandatory) use of face masks has been one the most contentious subjects. The appropriateness and effectiveness of face mask regulations has been widely discussed, as is also apparent from the divergent measures taken across and within countries over time, including mandating, recommending, and discouraging their use. In this study, we analyse how country-level policy stringency and individual-level predictors associate with face mask use during the early stages of the global COVID-19 pandemic. First, we study how (self and other-related) risk perception, (direct and indirect) experience with COVID-19, attitude towards government and policy stringency shape face mask use. Second, we study whether there is an interaction between policy stringency and the individual-level variables. We conduct multilevel analyses exploiting variation in face mask regulations across countries and use data from the first wave of the EURICSS consisting of approximately 7,000 students in ten countries.

Part 2: COVID-19 Vaccination

The second part of this dissertation centres around COVID-19 vaccination and consists of two papers on this subject: Chapter 5 and Chapter 7, of which the latter will be discussed under Part 3.

Less than a year after COVID-19 was officially classified as a pandemic, the first vaccines against COVID-19 were approved and entered the market. As indicated, the initial estimated percentage of people that should get vaccinated to create herd immunity ranged from 67% to 95% (Anderson, Vegvari, et al., 2020; Mills et al., 2020; Randolph & Barreiro, 2020). Given that COVID-19 vaccines were completely new, little was known about the acceptance and motivation behind COVID-19 vaccination preceding and during its initial roll-out.

Importantly, even before the pandemic general vaccine acceptance had been the subject of global concern. In 2019, the WHO declared 'vaccine hesitancy' as one of the ten biggest threats to global health (World Health Organization, 2019). Vaccine hesitancy is defined as the refusal or reluctance of getting vaccinated despite the availability of a vaccination (MacDonald, 2015). Over the last decades, vaccine hesitancy has become more problematic (Dubé et al., 2013), with European countries showing highest levels of scepticism (Larson et al., 2016).

Pre-pandemic literature identifies potential barriers to vaccine acceptance at different levels (Schmid et al., 2017), ranging from the political and sociocultural levels to the individual level. At the country level, in addition to factors such as the availability and cost of vaccines (MacDonald, 2015), trust in health officials, the media and governments play an important role in vaccination intention (Dubé et al., 2013). At the individual level, studies have shown the relevance of psychological theories of behaviour for vaccine acceptance, like the Theory of Planned Behaviour (Betsch et al., 2015; Gerend & Shepherd, 2012; Xiao & Wong, 2020). Several models have been developed to integrate previous literature on vaccination behaviour, such as the 3C (MacDonald, 2015), 4C (Betsch et al., 2015) and 5C models (Betsch et al., 2018). Grounded in previous theoretical models, the 5C model aimed at providing a tool useful for both research and practice, reflecting a broad scope of predictors of vaccination intention and behaviour (Betsch et al., 2018). The model includes five psychological antecedents of vaccination, of which the first one, Confidence, relates to trust in the effectiveness and safety of vaccines, in the system that delivers these and in the motivations of policymakers. Secondly, Complacency reflects the perceived risk and perceived level of threat of vaccine-preventable diseases. Thirdly, Constraints reflects the structural psychological and physical barriers, such as those related to geographical accessibility, ability to understand (language and health literacy), and affordability. Fourthly, Calculation relates to individuals' engagement in extensive information searching, which can lead to lower vaccination willingness due to the high availability of anti-vaccination information. Finally, Collective responsibility reflects one's willingness to protect others by getting vaccinated by means of herd immunity (Betsch et al., 2018). It was shown that the pattern of the most important Cs within the 5C model varies across vaccines, target groups and countries (Betsch et al., 2018), making it relevant to study how this model relates to the acceptance of new vaccines, such as the COVID-19 vaccine.

While there is a large literature on existing vaccines, the COVID-19 vaccines differ from previous vaccines in many respects, such as development speed, innovativeness of the techniques used, uncertainty regarding the magnitude and extent of its effectiveness, and potential side effects. As vaccination willingness is context-, time-, place-, and vaccine-dependent (Dubé et al., 2014), research on COVID-19 vaccination intention and its antecedents was needed, preferably across a variety of target groups and countries.

Based on this literature, the goal of Part 2 of this thesis - and the second wave of data collection of the EURICSS - was therefore to acquire insights into the relation between individual differences and COVID-19 vaccination acceptance. More specifically, Part 2 has two aims. First, in Chapter 5, we aim to get a better understanding of students' intention to get vaccinated against COVID-19, and how this relates to the 5C model and underlying psychological characteristics. Second, in Chapter 7 (see Part 3), we aim to get a better understanding of a potential difference in COVID-19 vaccination intention and behaviour of two demographic groups: entrepreneurs and employees.

A short summary of Chapter 5 is given below. Its outcomes are summarized in the discussion chapter.

Chapter 5. Psychological Characteristics and the Mediating Role of the 5C Model in Explaining Students' COVID-19 Vaccination Intention

Chapter 5 is both based on the 5C model of Betsch et al. (2018) (discussed above) and on a study by Murphy et al. (2021) showing the relevance of psychological characteristics for the willingness to get vaccinated against COVID-19. In this chapter, we study COVID-19 vaccination intention using data from the first and second wave of the EURICSS, consisting of university students from three countries, the Netherlands, Belgium, and Portugal. The study has three goals. First, we assess the intention to get vaccinated on a scale ranging from completely resistant to completely acceptant. Second, we use the 5C model to study which antecedents are most important in explaining COVID-19 vaccination intention of students. Third, we investigate which psychological variables, including COVID-19 vaccine-related and COVID-19-related attitudes and personality traits, affect vaccination intention through the 5Cs. In this way, we aim to understand for which groups reaching desirable levels of these 5Cs and, thereby, vaccination intention may be more problematic.

Part 3: Entrepreneurship and the COVID-19 Pandemic

Part 3 of this thesis takes a different angle and focuses on entrepreneurship and entrepreneurs during the COVID-19 pandemic. This part consists of both Chapter 6 and 7.

The regulations taken by governments to curb the spread of COVID-19 have had a considerable impact on the global economy, specifically hurting businesses and business owners (Belitski et al., 2022). Nationwide lockdowns forced businesses to remain closed for many consecutive months, resulting in a substantial increase in economic uncertainty (Altig et al., 2020). According to Statistics Netherlands, the pandemic resulted in the highest economic downturn in the Netherlands in 2020 (GDP drop of -3.8% compared to 2019) since World War II. Moreover, the unemployment rate in the Netherlands rose from 2.9% to 4.6% between March and August 2020 (Statistics Netherlands, 2021). While multiple governmental support measures have limited negative consequences to a large

extent and employment rates and economic growth recovered faster than expected (OECD, 2022; Woloszko, 2020), the COVID-19 pandemic revealed the specific risks associated with being a business owner. Especially showing how external factors outside entrepreneurs' control impact their businesses. In a survey among small and medium-sized enterprise (SME) owners in 23 countries conducted during the pandemic in 2020, 61% of business owners indicated that the existence of their business was under threat due to the pandemic (Stephan, Zbierowski, Pérez-Luño, Klausen, et al., 2021a). Moreover, Kuckertz et al. (2020) reported that the growth and innovation potential of start-ups are at risk due to the pandemic and the measures taken by governments. Finally, it was shown that self-employed workers were affected more strongly than wage workers by the financial insecurities caused by the pandemic in terms of psychological distress (Backman et al., 2021; Patel & Rietveld, 2020), and that they had increased levels of burnout (Torrès, Benzari, et al., 2021; Torrès et al., 2022).

As entrepreneurship is documented as helping economies recover from economic slowdowns (Koellinger & Thurik, 2012), it is important to study how the COVID-19 pandemic has affected the behaviour of (future) entrepreneurs. Hence, the first aim of this part is to study whether the consequences of the COVID-19 pandemic may also shape the future of entrepreneurship by altering entrepreneurial intentions and the profile of the future entrepreneur (Chapter 6). Second, given the severe consequences of the pandemic for many entrepreneurs and vaccination being portrayed as the most promising way out of the pandemic, one might expect entrepreneurs to be more willing to get vaccinated than those employed by a company. However, two studies showed entrepreneurs to be less willing to get vaccinated than employees (Nguyen et al., 2022; Valckx et al., 2022). We therefore aim to study this relationship and provide explanations using representative data of employees and entrepreneurs in Chapter 7.

A short summary of these chapters is given below. Their outcomes are summarized in the discussion chapter.

Chapter 6. Entrepreneurial Intention of Dutch Students During the COVID-19 Pandemic: Are Today's Students Still Tomorrow's Entrepreneurs?

In this chapter, we assess the development of students' entrepreneurial intention during the beginning of the COVID-19 pandemic in the Netherlands. This study is the first to investigate whether and in which direction entrepreneurial intention has changed during the COVID-19 pandemic. On the one hand, the pandemic may lower entrepreneurial intentions due to the high levels of economic uncertainty and exposure to the adverse consequences of the pandemic on businesses. On the other hand, it may strengthen entrepreneurial intention through increases in necessity entrepreneurship – due to the unpredictability of the job market - and increases in opportunity entrepreneurship – due to changed consumption patterns and the growth of certain sectors. In this chapter we also study how a set of COVID-19-related, context-related, and

demographic variables are connected to self-reported changes in entrepreneurial intention. We use data from the first wave of the EURICSS consisting of approximately 1,000 students from Erasmus University Rotterdam.

Chapter 7: COVID-19 Vaccination: Lower Intention and Coverage Among Entrepreneurs Compared to Employees

As indicated, to date, two studies have shown that, compared to employees, entrepreneurs indicate a lower willingness to get vaccinated against COVID-19 (Nguyen et al., 2022; Valckx et al., 2022). In this chapter, we try to replicate the difference in COVID-19 vaccination willingness between entrepreneurs and employees. Second, we study whether the difference persists when controlling for three aspects: key demographics, vaccination attitudes and COVID-19 context, including the financial impact of the pandemic, wellbeing, and government attitude. Third, we study whether there are differences in how the context of the pandemic relates to vaccination willingness for entrepreneurs and employees. We make use of three datasets. To start with, we study COVID-19 vaccination coverage of entrepreneurs and employees in a large 27-country sample (N>13,500) from the Flash Eurobarometer launched by the European Commission in all European Union member states. This dataset serves as a first step to establish whether there is a robust difference in vaccination coverage. Second, we use two datasets in which we study the three aspects discussed. In the dataset derived from the Dutch LISS (Longitudinal Internet studies for the Social Sciences) panel administered by CentERdata (Tilburg University, The Netherlands) (Scherpenzeel, 2018), we focus on COVID-19 vaccination intention assessed before COVID-19 vaccines became available. In the second dataset, derived from the Understanding Coronavirus in America ("Covid") survey from the Understanding America Study (UAS) (Kapteyn et al., 2020), we focus on COVID-19 vaccination status during a later phase of the pandemic.

1.5 Individual contributions & publication status per chapter

Table 1.1 gives an overview of the publication status of the chapters in this thesis and other work that I have conducted during my PhD. In this section I discuss my contributions to each chapter in the present thesis. Of all chapters included in this dissertation (2 to 7), I am the first author and of all chapters currently published (2 to 6) I am the corresponding author. The current chapter (1), I wrote independently, whilst receiving feedback on drafts from my supervisors.

For Chapter 2 we used data from the first wave of the EURICSS. Data was collected in ten countries by all co-authors of this chapter. After the data was collected, a smaller working group was created to keep things organized. For Chapter 2, I formed a 'data team' together with Dr. Letina from Linköping University (currently University of

Glasgow). While thinking about ideas for an initial paper, Dr. Letina and I worked closely together with Prof. Thurik, Prof. Franken, and Prof. Wennberg (then Linköping University, currently Stockholm School of Economics). After several brainstorms and discussing initial ideas, soon we came up with the idea for Chapter 2: investigating whether compliance with different COVID-19 regulations clusters together. The data analysis was performed by Dr. Letina and me. The original first draft of this paper was written by Prof. Wennberg, Dr. Letina, and me. During the process Prof. Thurik and Prof. Franken critically gave feedback on each new version. Finally, the co-authors involved in the data collection all revised final drafts of the manuscript.

Chapter 3 is also based on the data collected during the first COVID-19 survey. I had the idea for Chapter 3 in mind when designing the survey. I finalized the idea together with Prof. Franken. I started with the initial setup of the paper together with Prof. Franken. At a later stage, I worked closely together with the same 'working group' from Chapter 2 formed by Dr. Letina, Prof. Wennberg, Prof. Franken, Prof. Thurik, and me. I took most of the data analysis and writing upon me. Dr. Letina assisted in data analysis. Moreover, Prof. Wennberg, Prof. Thurik and Prof. Franken critically reviewed and revised the manuscript. Finally, the rest of the co-authors were involved in later rounds of review of the manuscript.

Chapter 4 is also based on first wave of data from the EURICSS. Prof. Thurik and I came up with the idea to investigate the use of face masks, which became the basis of Chapter 4. I had some discussions with Dr. Mukerjee about potential directions for this project. Prof. Thurik and I initially saw the variability in face mask regulations across the countries in our sample as a problem. However, in the end, the variability in policy stringency became the basis of the paper. We approached Dr. van der Zwan (University of Leiden), given his experience with multilevel analyses. He was excited about joining our team and took the lead in the data analysis. I took the lead in writing the first draft. Prof. Thurik took a supervisory role. Prof. Wennberg helped to critically revise the paper. Prof. Thurik, Dr. Mukerjee and Prof. Franken also took part in improving the first drafts of the manuscript. The other co-authors were involved in reviewing later versions of the paper.

Chapter 5 was created based on data collected during both the first and the second wave of the EURICSS. Therefore, we worked with the group that was involved in both data collections: Prof. Thurik, Prof. Franken, Prof. Janssen, Prof. Dejardin and Prof. Baptista. The idea of Chapter 5 was based on two earlier papers. The paper by Murphy et al. (2020) that showed the importance of psychological characteristics for COVID-19 vaccination behaviour and the paper by Betsch et al. (2018) that showed the importance of the 5C scale and recommended further research on the psychological profiles related to the 5C's. In the second wave of EURICSS we included the 5C scale by Betsch et al. (2018). I was primarily responsible for the data analysis and writing of the manuscript. Prof. Thurik and Prof. Franken helped in developing the idea, text, and structure of the

paper. Moreover, Prof. Janssen, Prof. Dejardin and Prof. Baptista gave feedback on and revised several versions of the manuscript.

This chapter resulted from an invitation Prof. Thurik received to propose a chapter for the book: "*The COVID-19 Crisis and Entrepreneurship*". Chapter 6 was created together with Mr. Lodder and Prof. Thurik. When writing his master thesis, Mr. Lodder made use of data that we collected from Dutch students during our first COVID-19 survey. His thesis inspired us to pursue with an idea that Prof. Thurik and I were already discussing, investigating (self-reported) differences in entrepreneurial intention during the pandemic. I conducted the data analysis and most of the writing. Mr. Lodder and Prof. Thurik gave feedback on and revised the manuscript.

Dr. van der Zwan and Prof. Thurik came up with the idea for the study presented in Chapter 7, investigating vaccination intention of entrepreneurs and employees. Soon I joined the project and together we decided to use open access databases to study vaccination behaviour in representative samples. Both Dr. van der Zwan and I were involved in the data analysis, at first Dr. van der Zwan was in the lead, after which I took over. Finally, I took up the initiative to write the first draft of the manuscript. Prof. Thurik and Dr. van der Zwan shared their suggestions and comments. We regularly met to discuss updates and next steps.

Table 1.1 Publication status of the chapters and other papers (October 2022)

Ch.	Title	Authors	Publication status
		Papers part of this thesis	
2	Hygiene and Social Distancing as Distinct Public Health Related Behaviours Among University Students During the COVID-19 Pandemic	Wismans, Letina, Thurik, Wennberg, Franken, Baptista, Barrientos Marín, Block, Burke, Dejardin, Janssen, Mukerjee, Santarelli, Millán, & Torrès	Published in special issue *"Psychosocial Functioning During the COVID-19 Pandemic"* in *Social Psychological Bulletin* in 2020
3	The Role of Impulsivity and Delay Discounting in Student Compliance with COVID-19 Protective Measures	Wismans, Letina, Wennberg, Thurik, Baptista, Burke, Dejardin, Janssen, Santarelli, Torrès, & Franken	Published in *Personality and Individual Differences* in 2021
4	Face Mask use During the COVID-19 Pandemic: How Risk Perception, Experience with COVID-19, and Attitude Towards Government Interact with Country-Wide Policy Stringency	Wismans, van der Zwan, Wennberg, Franken, Mukerjee, Baptista, Barrientos Marín, Burke, Dejardin, Janssen, Letina, Millán, Santarelli, Torrès, & Thurik	Published in *BMC Public Health* in 2022
5	Psychological Characteristics and the Mediating Role of the 5C Model in Explaining Students' COVID-19 Vaccination Intention	Wismans, Thurik, Baptista, Dejardin, Janssen, & Franken	Published in *PLOS One* in 2021
6	Entrepreneurial Intention of Dutch Students During the COVID-19 Pandemic: Are Today's Students Still Tomorrow's Entrepreneurs?	Wismans, Lodder, & Thurik	Published in the book: "*The COVID-19 Crisis and Entrepreneurship: Perspectives and Experiences of Researchers, Thought Leaders, and Policymakers"* in 2022, Springer International Publishing AG.
7	COVID-19 Vaccination: Lower Intention and Coverage Among Entrepreneurs Compared to Employees	Wismans, Van der Zwan, & Thurik	Manuscript to be submitted
		Papers not part of this thesis	
N/A	Attention-Deficit Hyperactivity Disorder Symptoms and Entrepreneurial Orientation: A Replication Note	Wismans, Thurik, Verheul, Torrès, & Kamei	Published in *Applied Psychology: an International Review* in 2020
N/A	The Link Between Attention-Deficit Hyperactivity Disorder Symptoms and Entrepreneurial Orientation in Japanese Business Owners.	Wismans, Kamei, Thurik, & Torrès	Published in *Management Review Quarterly* in 2021
N/A	Seeking the Roots of Entrepreneurship: Childhood and Adolescence Extraversion Predict Entrepreneurial Intention in Adults	Wismans, Jansen, Thurik, Prinzie, & Franken	Manuscript submitted
N/A	Measuring Play & Play in Entrepreneurship	Mukerjee, Wismans, Thurik, & Torrès	Work in progress

I

PART I

Compliance with COVID-19 Measures

2

Chapter 2

Hygiene and Social Distancing as Distinct Public Health Related Behaviours among University Students' During the COVID-19 Pandemic

Annelot Wismans, Srebrenka Letina, Roy Thurik, Karl Wennberg, Ingmar Franken, Rui Baptista, Jorge Barrientos Marín, Joern Block, Andrew Burke, Marcus Dejardin, Frank Janssen, Jinia Mukerjee, Enrico Santarelli, José María Millán, Olivier Torrès

This chapter has been published as: Wismans, A., Letina, S., Thurik, R., Wennberg, K., Franken, I., Baptista, R., Marín, J. B., Block, J., Burke, A., Dejardin, M., Janssen, F., Santarelli, E., & Torrès, O. (2020). Hygiene and social distancing as distinct public health related behaviours among university students during the COVID-19 pandemic. S*ocial Psychological Bulletin*, 15(4), 1-26.

Abstract

Prevailing research on individuals' compliance with public health related behaviours during the COVID-19 pandemic tends to study composite measures of multiple types of behaviours, without distinguishing between different types of behaviours. However, measures taken by governments involve adjustments concerning a range of different daily behaviours. In this study, we seek to explain students' public health related compliance behaviours during the COVID-19 pandemic by examining the underlying components of such behaviours, then investigating how these components relate to individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics. We surveyed 7,403 university students in ten countries regarding these behaviours. Principal Components Analysis reveals that compliance related to hygiene (hand washing, coughing behaviours) are uniformly distinct from social distancing behaviours. Regression analyses predicting Social Distancing and Hygiene lead to differences in explained variance and type of predictors. Our study shows that treating public health compliance as a sole construct obfuscates the dimensionality of compliance behaviours, which risks poorer prediction of individuals' compliance behaviours and problems in generating valid public health recommendations. Affecting these distinct behaviours may require different types of interventions.

2.1 Introduction

To dampen the spread of COVID-19[4], public authorities have taken a range of measures including recommendations or restrictions of behaviours, all of which require adjustments concerning different daily behaviours (Anderson, Heesterbeek, et al., 2020; Hale et al., 2020; Sebhatu et al., 2020). Scholars worldwide have sought to obtain more insights into individuals' compliance with such recommendations or restrictions. Current explanations of individuals' compliance stem from surveys using demographic characteristics such as gender, age, employment status and education (Farias & Pilati, 2022), sometimes combined with political attitudes or personality scales (e.g. Allcott et al., 2020; Blagov, 2021; Clark et al., 2020; Farias & Pilati, 2020). Other studies highlight cognitive and information processing factors as important for social distancing[5] behaviour and compliance (Banerjee et al., 2020; Stanley et al., 2021; Wise et al., 2020).

Yet, most studies focus solely on composite measures assessing compliance with multiple types of behaviours (C. Clark et al., 2020; Harper et al., 2021; Plohl & Musil, 2021) without distinguishing between different types of public health measures or behaviours. This may be problematic since adjustment concerning a range of different daily

[4] In this chapter and in our student survey we refer to 'COVID-19' and 'COVID-19 health recommendations and restrictions' as synonymous with the SARS-CoV-2 virus for the sake of simplicity and readability.

[5] By social distancing behaviours we refer to "a constellation of behaviours that decrease close physical contact among non-household members" (Bourassa et al., 2020; Koo et al., 2020). For details of how we measure social distancing behaviours, see methods and results.

behaviours cannot simply be understood as a sole behavioural construct, as stressed in a pre-COVID review of 26 papers on the determinants of compliance during pandemics (Bish & Michie, 2010). Next to more novel behaviours that require learning (e.g. keeping distance from others), there are established behaviours that only have to be changed in intensity or frequency (e.g. improving hygiene behaviours). Where some behaviours require conscious deliberation (e.g. deciding not to visit family), others are part of natural routines for most people (e.g. hand washing). Some behaviours that need to be stopped are so habitual that they are hard to change, like touching your face (Verplanken & Wood, 2006). Other behaviours go against deep-rooted human desires such as avoiding physical contact with others. There is also a distinction between the degree to which compliance with certain measures can be affected individually. Keeping distance is not independent of the behaviours of proximate others. It is thus likely that predictors of compliance differ across different types of protective behaviours (Bish & Michie, 2010).

In sum, studies that focus on public health compliance as being a sole and coherent construct may obfuscate the potential dimensionality of COVID-19 compliance, and as a result lead to undertheorized models with poor prediction of individuals' compliance, and unvalidated public health recommendations. To address this, we examine the extent to which compliance with key public health measures correlates with compliance with other measures in a large cross-national study of university students' self-reported perception of and self-reported compliance regarding COVID-19 recommendations and restrictions. The importance of cross-national studies is highlighted in a recent review of social and behavioural science's support to COVID-19 pandemic response (van Bavel et al., 2020). We seek to explain students' public health related compliance behaviours during the COVID-19 pandemic by examining the underlying components of such behaviours, then investigating how these components relate to individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics.

Explaining different types of health behaviours

In research unrelated to pandemics, compliance or non-adherence behaviours have been studied in connection to medical recommendations for the chronically ill (for a review see DiMatteo (2004)), while in health psychology, health-related recommendations and required behavioural changes (e.g. physical activity, sex behaviour, drinking, smoking) have been extensively studied. While compliance with COVID-19 measures revolves around health behaviours, there are three important differences between the health-related recommendations typically studied and COVID-19 recommendations. First, recommended COVID-19 related behaviours apply to everyone and not exclusively to specific subpopulations, even though certain groups are at higher risk (Brandén et al., 2020; A. Clark et al., 2020; Hashim et al., 2020; Mueller et al., 2020; Williamson et al., 2020; Zhou et al., 2020). Second, studies of health-related behaviours

usually focus on one type of behaviour (e.g. smoking or drinking) or a range of closely related behaviours (e.g. eating habits). COVID-19 related recommendations cover more diverse types of behaviours not necessarily closely related, such as keeping physical distance and washing hands frequently (Alwan et al., 2020; Chu et al., 2020; Ioannidis, 2020a; N. R. Jones et al., 2020; Rundle et al., 2020). Third, while previously studied behaviours have direct personal benefits, this is not the case for COVID-19 recommendations. For students, following COVID-19 measures means potentially significant changes in daily behaviours entailing giving up a lot in terms of social life, while they are in general less at risk to suffer from negative health consequences of COVID-19 infection (Brandén et al., 2020; Götzinger et al., 2020; Ioannidis et al., 2020; Swann et al., 2020; Zhou et al., 2020). Compliance with such recommendations is thus more about protecting others than oneself, i.e., leading to a social benefit instead of personal one.

The importance of attitudes and descriptive norms

The goal of COVID-19 recommendations is to bring about and maintain a change in individual behaviours that will make people less likely to get infected and infect others. For this to happen, an underlying assumption is that people will perceive these recommendations as appropriate and have favourable attitudes towards following them. Recent studies on attitudes towards COVID-19 recommendations also suggest overall high agreement and adherence with public health guidelines (Czeisler et al., 2020; Selby et al., 2020). The notion that the attitudes towards recommendations influence compliance follows from the research in social and health psychology (e.g. Stroebe, 2011). Eagly and Chaiken (1993, p. 1) define attitudes as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour". The concept of attitudes has been widely used in predicting different health related behaviours (e.g., Doganis et al., 1995), usually as an integral part of wider theoretical frameworks such as the theories of Reasoned Action or Planned Behaviour (Ajzen et al., 2007), or the Health Belief Model (Janz & Becker, 1984). We thus expect more positive attitudes (e.g., the degree to which people take them seriously and think they are appropriate) towards public policy to lead to higher compliance with COVID-19 measures.

In addition to an individual's attitude towards specific behaviours, another central factor in psychological theories of health behaviours is the role of behavioural norms in individuals' social context. Norms are powerful shapers of behaviour (Cialdini & Goldstein, 2004; Sherif, 1936) and individuals are guided by norms in their understanding of and respond to situations, especially during times of uncertainty (Cialdini, 2009). A distinction can be made between injunctive and descriptive norms: Injunctive norms relate to what is seen as (dis)approved by others, i.e. what you perceive others think you ought to do, whereas descriptive norms relate to what is typically done by others, i.e. what you observe others to actually do (Deutsch & Gerard, 1955). Although the two are often correlated, they are conceptually and motivationally different (Cialdini, 2007). Bicchieri

and Xiao (2009) showed that injunctive norms are of importance when in line with the descriptive norm. However, if the two contradict, descriptive norms are more important: people do what they think others would do, even when they believe this is not the behaviour that is approved (Bicchieri & Xiao, 2009; Kallgren et al., 2000; Smith-McLallen & Fishbein, 2008; Stok et al., 2014). When it comes to health-risk behaviours, descriptive norms have been indicated as particularly important (Rivis & Sheeran, 2003; van Bavel et al., 2020). Further, descriptive norms tend to have the strongest effect on behaviour if they stem from people with which an individual identifies, such as family and friends (Abrams et al., 1990). Since non-compliance with COVID-19 measures is a health-risk behaviour, we expect descriptive norms to play an important role for the behaviours we examine. Since the COVID-19 pandemic requires behaviour change from everyone, descriptive norms can easily be formed. Together, we expect descriptive social norms, specifically the degree to which friends and family comply with COVID-19 measures, to play a role in explaining compliance with COVID-19 measures.

The current study

We examine the extent to which compliance with key public health measures correlates with compliance with other measures, and if these behaviours differ across and within student populations in distinct countries. We use Principal Components Analysis (PCA) to examine underlying components of compliance behaviour. Moreover, using the international setting of the dataset we examine how the different compliance components acquired in step one vary across countries. Finally, we study whether a set of individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics are differently related to the compliance components unearthed using multiple regression analysis.

2.2 Methods

Sample

We surveyed 7,403 students from late April to the beginning of May 2020 (week 17 through 19) at twelve universities in ten countries: Belgium, Colombia, France, Germany, India, Ireland, Italy, the Netherlands, Portugal, Spain and Sweden. We used an online survey based on the Qualtrics software, approved in advance by the Internal Review Board of the Erasmus University Rotterdam.

At the time of data collection, all countries had initiated various recommendations and restrictions regarding health-related behaviour. Eight of the countries were in complete lockdown (India, Colombia, Spain, Italy, Portugal, Ireland, Belgium, France), meaning that inhabitants could only go outside if movements could be justified. However, specific regulations differed across countries. Measures were least

strict in Sweden, followed by the Netherlands. For an overview of regulations applicable across countries at the time of data collection see supplementary materials (Table S2.1).

Students have shown to be a key group for studies on compliance behaviours for several reasons: with former general lockdown measures across the world having been relaxed, infection levels have started to rise in late summer of 2020 and in Europe as well as the United States, new cases are mostly found among the younger generation and have been linked to student gatherings and parties (Murillo-Llorente & Perez-Bermejo, 2020; The Economist, 2020; E. Wilson et al., 2020). Students are epidemiologically important in respect to their demographics and social behaviours: most are young, live in shared housing, and meet many others on a daily basis. This makes them susceptible to superspreading events (Lau et al., 2017). The World Health Organisation highlights young people's compliance with COVID-19 related measures 'a priority'(The Economist, 2020). Hence, scientific knowledge of students' health behaviours is crucial, especially given that universities around the world are partly or fully open for study in fall 2020 and early 2021 (Liu et al., 2020).

The survey could be completed in English, Dutch, French or Spanish. Translations were made by a native speaker, reviewed by another native speaker and if necessary adapted after consultation between both translators. A pre-test was conducted with Dutch students[6]. Only fully completed surveys were used for analyses. An informed consent had to be signed at the start of the survey. 44 students did not sign the consent, leading to a total of 7,359 completed questionnaires. Number of missing values was low (0.02%). Therefore, pairwise deletion was used depending on the analyses conducted.

Descriptive sample statistics are presented in supplementary materials (Table S2.2). The sample consists of both undergraduate and graduate (but not postgraduate) students across disciplines (e.g., economics, business, social sciences, humanities, science, engineering, and medicine). Response rates varied between 7% (Belgium) and 31% (France), with an overall response rate of 8.5%, excluding Netherlands and India where exact response rates could not be computed. Average age is 22.8 (Standard deviation (*SD*)= 5.9). More women (61.3%) than men (38.7%) participated in the survey, consistent with the average rate of university studies in most of the countries studied (World Economic Forum, 2020). 54.1% of the students were in a relationship at the time of completing the survey. 12.9% had lived in the country of their university for less than five years, we infer that these are international students. In the Netherlands and Ireland, the percentage of international students was relatively high (NL: 30.5%, IRE: 30.0%).

Measures

In this section we describe all measures used for analyses. Descriptive statistics for all variables and the anticipated outcome variables of the PCA are presented in

[6] When we refer to students from a specific country in this chapter, we mean students studying in that country, e.g., with Dutch students we refer to students that study in the Netherlands.

supplementary materials (Table S2.3) including mean, standard deviations, and correlations.

Compliance

Compliance was measured using nine items revolving around different behaviours related to the recommendations and restrictions by governments. The behaviours investigated are listed in Table 2.1. Items were preceded by the following introductory text: *'In the past two months, which of the following measures did you follow and to which extent? Please indicate to what extent you disagree or agree with these statements.'* Answers were given on a scale of 1 ('Completely disagree') to 5 ('Completely agree'). Due to the novel situation, we were not able to use existing validated questionnaires. The items were constructed ad hoc and reviewed by all authors involved in the study. Simple scales were used to reduce problems with cross-country translation equivalence (Steenkamp & Baumgartner, 1998).

Pearson's correlations of the compliance items are presented for the full dataset in Table 2.1. Inter-item correlations are positive but mostly low, suggesting that investigated compliance behaviours show relatively small covariation. In other words, knowing one student's compliance with one specific behaviour does not allow for a high prediction of compliance with another specific behaviour. Item means in Table 2.1 are relatively high and variability (standard deviations) is small, indicating negatively skewed distributions: More students indicated to (completely) agree than to (completely) disagree to perform the behaviours studied.

Students report complying most with 'not shaking hands' and least with 'avoiding touching their face'. Most variation was present for 'visiting others/having visitors', indicating that students differ most in their agreement with performing this behaviour. Least variation was found for 'not shaking hands', meaning that students answered relatively uniformly for this question.

Independent variables

Attitudes: Attitudes to public health measures is captured by two individual items revolving around the extent to which students report taking measures seriously and how they feel about the amount of measures taken in their country. 'Taking Measures Seriously' was captured by the following question: '*To what extent do you take the Government measures seriously?*'. Students could answer on a 7-point scale (1: 'Not at all' to 7: 'Extremely'). Opinions on the number of measures taken was assessed by the following question: '*Do you think that the Government is taking too few or too many measures to prevent the spread of the coronavirus?*'. Answers could be given on a 7-point Likert scale (1: 'Far too few'; 4: 'Just the right amount'; 7: 'Far too many'). With the initial scoring it was not possible to capture the strength of the relationship of perceiving measures as too few versus as too many. To allow for a different influence of the two (non-linear effects), the variable was recoded to three dummy variables: 'Too Few Measures' (1-

3 = 1; 4-7 = 0), 'Right Amount' (4 = 1; 1-3 = 0; 5-7 = 0), and 'Too Many Measures' (5-7 = 1; 1-4 = 0). 42.75% of the students indicated too few measures were taken, 42.55% indicated the right number of measures were taken, and 14.70% indicated too many measures were taken.

Descriptive norm: The descriptive norm was captured using one item on the degree to which friends and family of students have complied with the measures. The question that had to be answered was as follows: '*To what extent do your family and friends strictly follow the measures related to the coronavirus?*'. Answers were given on a 7-point Likert scale (1: 'They do not follow the measures at all'; 7 'They strictly follow all measures').

Demographic variables

The following demographic variables were included: age (continuous), gender (0 = male, 1 = female) and relationship status (0 = not in a relationship, 1 = in a relationship).

Table 2.1 Correlation table compliance items (total sample, *N*=7,309)

Item	*M*	*SD*	1	2	3	4	5	6	7	8
1. I avoided touching my face	3.17	1.26	-							
2. I coughed and sneezed into my elbow and/or used a handkerchief	4.46	0.84	.27	-						
3. I washed my hands more often and longer	4.23	0.86	.31	.25	-					
4. When not at home I kept the advised distance between myself and others	4.36	0.87	.19	.18	.15	-				
5. I did not meet with others unless it was strictly necessary	4.13	1.07	.11	.03	.04	.31	-			
6. I only went outside if it was strictly necessary	3.91	1.17	.15	.07	.03	.28	.59	-		
7. I did not shake hands	4.76	0.62	.09	.13	.11	.33	.25	.21	-	
8. I did not visit others/have not had visitors	3.82	1.27	.13	.08	.05	.27	.63	.51	.22	-
9. I have not visited elderly people or people who are vulnerable for health reasons	4.56	0.92	.08	.11	.05	.11	.18	.17	.13	.29

Note: compliance was measured at a scale from 1 (lowest agreement) to 5 (highest agreement). All correlations are significant at 1% significance level.

Data analysis

To study the dimensionality of compliance we investigate how the nine compliance behaviours relate to each other and whether it is possible to create composite measures of students' public-health related behaviour. We use PCA to identify orthogonal components explaining most of the variance in the data by reducing dimensions of the original set of items, while preserving as much information as possible. Parallel Analysis is used to determine the number of components that should be retained (Horn, 1965), a

suitable method when 95th-percentile eigenvalues (EVs) are used (Glorfeld, 1995; Hayton et al., 2004). The parallel analyses are based on O'Connor's (2000) syntax, estimated with Monte Carlo simulation, 100 iterations. Components with EVs greater than the randomly generated 95th-percentile EVs are retained (Hayton et al., 2004). These analyses inform which items underlie the extracted dimensions, and therefore these items can be used to construct composite scores which capture the identified dimensions the best.

After obtaining the components of compliance by creating item-average scores, we examine how they correlate and how they vary across countries by studying descriptive statistics (mean and standard deviations).

Finally, we predict each compliance component using multiple regression analyses and the predictors described. The models include country dummies to control for country differences, a method recommended when the number of countries in a sample is low (<50) (Möhring, 2012; Wooldridge, 2010, p. 132).

2.3 Results

Principal Component Analysis

The Kaiser-Mayer-Olkin measure verified the sampling adequacy for the PCA, KMO=.756 (Hutcheson & Sofroniou, 1999). Bartlett's test of sphericity indicated that correlations between items were sufficiently large for PCA, $X^2(36) = 11983.94$, $p<.001$. Parallel analysis indicated that two components should be retained that together explain 47.06% of the variance. Table 2.2 shows the component loadings, those with absolute value greater than .40 (bold printed) are interpreted (Stevens, 2012).

Looking at the items that cluster on the same components in Table 2.2, it is apparent that component 1 represents types of behaviour that are all related to social distancing, e.g., being in physical contact with other people. This component thus seems to well capture Social Distancing compliance[7]. Items that load on component 2 all seem to be related to hygiene behaviour (washing hands, coughing in the elbow, and not touching the face). Therefore, we suggest that this component captures Hygiene compliance. Social Distancing comprises items 4-9 of Table 2.2, and Hygiene comprises items 1-3. In the rest of this chapter, we will refer to Social Distancing and Hygiene to indicate compliance with behaviours that these components capture. It is important to note that by "Hygiene" in this chapter we refer only to compliance with the hygiene behaviours described in three items used to measure it, that is, to 'washing hands', 'touching one's face', and 'coughing/sneezing in the elbow'.

[7] It should be noted that Social Distancing has and can be used interchangeably with Physical Distancing. In this chapter we refer to Social Distancing, because of its extensive use in literature and media and to avoid confusion that physical distancing only refers to "keeping the advised distance between self and others".

Table 2.2 Component matrix Principal Components Analysis of compliance behaviours

Item	Component 1 Social Distancing	Component 2 Hygiene
1. I avoided touching my face	.37	**.58**
2. I coughed and sneezed into my elbow and/or used a handkerchief	.30	**.62**
3. I washed my hands more often and longer	.26	**.67**
4. When not at home I kept the advised distance between myself and others	**.59**	.17
5. I did not meet with others unless it was strictly necessary	**.77**	-.35
6. I only went outside if it was strictly necessary	**.72**	-.29
7. I did not shake hands	**.50**	.10
8. I did not visit others/have not had visitors	**.76**	-.30
9. I have not visited elderly people or people who are vulnerable for health reasons	**.40**	-.03

We also conducted PCA's on the separate country samples. In eight out of ten countries, parallel analysis confirms that two factors should be retained. In two countries, the parallel analysis indicates that one component should be retained: Spain and Ireland. Looking closely at these country sub-group samples, our interpretation is that the one-factor structure arises in the Spanish sample due to Spanish students indicating high compliance on both social distancing and hygiene items, meaning that all items load highly (>.40) on the first component. For Ireland, the interpretation is less clear since all items except avoiding 'touching one's face' and 'washing hands' load highly (>.40) on the first component. These two hygiene-related items load highly on the second component, which seems to hint at a two-factor structure. The somewhat divergent pattern in the Irish sub-sample may be caused by the relatively small sample size of Irish students (*N*=100).

To check whether compliance behaviours can be understood as a similar two-dimensional construct across countries, we compared item loadings on the first two principal components of each country with the pattern of loadings extracted for the whole sample. This is done by following the procedure advised by researchers dealing with evaluation of degree of cross-cultural replication (McCrae et al., 1996; van de Vijver & Leung, 1997). The procedure involves orthogonal Procrustes rotation, followed by computation of congruence coefficients which quantifies in which degree components are replicated. Values on the diagonal of the resulting matrix are known as Tucker's phi coefficient of agreement (van de Vijver & Leung, 1997). The results presented in Table 2.3 indicate high cross-cultural equivalence. The structure was equal for all countries (>.95, good similarity), except for the second component in the Irish sample (>.85, fair similarity), and the loadings of both components in the Spanish sample (<.85, no similarity) (Lorenzo-Seva & ten Berge, 2006). The latter finding is in line with the one-dimensional structure found in Spain using Horn's parallel analysis. Component matrices per country are presented as supplementary material (Table S2.4).

Table 2.3 Tucker's Phi coefficients

Country	Component 1 Social Distancing	Component 2 Hygiene
BE	1.00	1.00
COL	.98	.99
ESP	.76	.43
FR	1.00	.96
IND	.98	.99
IRL	.97	.90
IT	.99	.99
NL	.99	.99
PRT	.98	.98
SWE	.99	.99

Using the outcomes of the PCA, composite continuous scores can be created by taking the average of the items that belong to each component. By doing so we created two composite measures of different types of compliance: Social Distancing (item 4-9) and Hygiene (item 1-3). Internal consistency of items included in the Social Distancing construct was good (α=.73) while internal consistency of the Hygiene construct was weaker (α=.52). This lower reliability likely results from the small number of items related to Hygiene included in the survey.

Relating the item-average composite measures of Social Distancing and Hygiene to each other strongly supports these are two distinct behaviours that are only weakly correlated (*r*=.21).

Social Distancing and Hygiene across countries

Using the measures of students' average compliance with Social Distancing and Hygiene obtained from the PCA, we examine how these behaviours vary between students in different countries. Finally, we calculate how much of the variation in compliance is dependent on the country that the student lives in.

To compare the extent to which students comply with measures in each country we compare the average scores of Social Distancing and Hygiene among all students in a country in Figure 2.1, with average Hygiene on the Y-axis and average Social Distancing on the X-axis, and country means and standard deviations provided in the table below. The figure reveals several groupings of countries with similar compliance. This suggests that student populations across countries cannot simply be placed on a continuum of compliance with both Social Distancing and Hygiene, but that compliance with each type of behaviour is distinct across countries. The right corner of Figure 2.1 however shows that for students in Spain, high levels of Social Distancing are correlated with high levels of Hygiene, in line with the one-factor structure of the compliance measure found in this sample. We observe a cluster of countries where students report similar scores on both behaviours: Colombia, France, Ireland, India, and Portugal. Sweden and the Netherlands

are both 'outliers' in terms of a relatively lower Social Distancing. Students in Sweden exhibit on average a higher level of Hygiene compared to students in all other countries except Spain. Students in Italy and Belgium comply strictly with Social Distancing, but more weakly with Hygiene. Results of one-way ANOVA tests of the mean differences between countries are present in supplementary materials (Table S2.5).

Figure 2.1 Visualization average Social Distancing (axis x) and Hygiene (axis y) across countries

Component		Total	BE	COL	ESP	FR	IND	IRE	IT	NL	PRT	SWE
Social Distancing	*M*	4.26	4.31	4.41	4.61	4.27	4.47	4.33	4.5	3.8	4.44	3.65
	SD	0.66	0.61	0.59	0.53	0.69	0.54	0.65	0.51	0.69	0.57	0.72
Hygiene	*M*	3.96	3.84	4.06	4.24	4.09	4.10	4.10	3.87	4.00	4.10	4.15
	SD	0.72	0.74	0.71	0.71	0.69	0.72	0.56	0.78	0.66	0.65	0.59

We calculated the intraclass correlation coefficient (ICC) to gauge the variance in students' self-reported behaviour that can be attributed to the different country clusters, as opposed to variation between individual students regardless of country of residence[8]. Using Maximum Likelihood, the ICC of countries for Hygiene is only .024. For Social Distancing the ICC is much higher: .18. This indicates that country residence explains more of the variation in compliance with Social Distancing than with Hygiene.

[8] We note that ICC estimates may be unreliable due to the low number of countries in our sample (Bryan & Jenkins, 2016).

Two plausible reasons for this are (i) cross-national differences in regulations mainly differ regarding Social Distancing, not regarding Hygiene, and (ii) in our data, items related to Hygiene exhibited smaller variability and higher values in general.

Explaining Social Distancing and Hygiene

Table 2.4 presents results of multiple regression predicting Social Distancing (Models 1 and 2) and Hygiene (Models 3 and 4)[9]. Models 1 and 3 are based on all variables except compliance with the other type of behaviour, which is added in models 2 and 4, respectively. All models include country dummies (not displayed), with Dutch students as the reference group. The coefficients for 'Too Few Measures' and 'Too Many Measures' are estimated against the reference category 'Right Amount of Measures'.

We find 'Taking measures seriously' to be positively related to both Social Distancing (B=0.26, p<.001) and Hygiene (B=0.17, p<.001). Students that feel that 'Too few measures' are being taken to decrease the spread of COVID-19 are more likely to comply with both Social Distancing (B=0.12, p<.001) and Hygiene (B=0.07, p<.001), compared to students reporting 'Right Amount of Measures'. Students that report 'Too many measures' have been taken are slightly less compliant when it comes down to Social Distancing (B=-0.02, p=.047), compared to students reporting 'Right Amount of Measures'. However, this result becomes insignificant when adding Hygiene as a control variable to the model predicting Social Distancing (B=-0.02, p=.062). With respect to Hygiene, perceiving that too many measures are taken compared to the right amount of measures does not affect compliance.

We also find that students reporting higher descriptive social norms in one's environment (having friends and family more strictly following the measures) are more likely to comply with Social Distancing (B=0.15, p<.001) and Hygiene (B=0.08, p<.001).

Regarding the control variables, we find students' Age to be positively related to both Social Distancing (B=0.11, p<.001) and Hygiene (B=0.11, p<.001), as is being female (Social Distancing: B=0.05, p<.001, Hygiene: B=0.11, p<.001). Students in a relationship are somewhat less likely to comply with Social Distancing (B=-0.04, p<.001) but more likely to comply with Hygiene (B=0.09, p<.001).

By adding Hygiene and Social Distancing as control variables in models 2 and 4 of Table 2.4, we observe that both types of compliance are positive and significant predictors of each other but that the direction and strength of the relationships of the other predictor variables do not change much. Adjusted R^2 shows only a small increase for both models after adding the alternative type of compliance: from .273 to .287 for the Social Distancing model, and from .116 to .134 for the Hygiene model. The small increase in adjusted R^2 again suggests that the two types of behaviours are distinct.

[9] The same models estimated without international students were all but identical, except for the coefficient 'Too Many Measures' in model 2 (B=-0.03, p=.025 when excluding international students, B=-0.02, p=.062 in the full sample).

Table 2.4 Multiple regression analyses explaining Social Distancing and Hygiene

Dependent Variable	Model 1 Social Distancing			Model 2 Social Distancing			Model 3 Hygiene			Model 4 Hygiene		
	B	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*
Age	0.11	0.001	<.001	0.09	0.001	<.001	0.11	0.001	<.001	0.10	0.001	<.001
Female	0.05	0.01	<.001	0.04	0.01	<.001	0.11	0.02	<.001	0.10	0.02	<.001
Relationship	-0.04	0.01	<.001	-0.05	0.01	<.001	0.09	0.02	<.001	0.10	0.02	<.001
Taking Measures Seriously	0.26	0.01	<.001	0.24	0.01	<.001	0.17	0.01	<.001	0.13	0.01	<.001
Too Few Measures (=1)	0.12	0.01	<.001	0.11	0.01	<.001	0.07	0.02	<.001	0.05	0.02	<.001
Too Many Measures (=1)	-0.02	0.02	.047	-0.02	0.02	.062	-0.02	0.02	.203	-0.01	0.03	.305
Descriptive Norm	0.15	0.01	<.001	0.14	0.01	<.001	0.08	0.01	<.001	0.06	0.01	<.001
Social Distancing										0.15	0.01	<.001
Hygiene				0.13	0.01	<.001						
Adjusted R^2	0.27			0.29			0.12			0.13		
N	7217			7201			7221			7201		

Note: Country dummies included but not shown. Dutch students that perceive the right amount of measures are taken serve as a reference group. *B* is standardized beta.

2.4 Discussion

Summary of findings

We used a continuous measure of compliance with multiple behaviours and showed that compliance with public health measures set by authorities during the COVID-19 pandemic consists of two clearly distinct components: Social Distancing and Hygiene. Despite the differences in the restrictive measures and prevalence of COVID-19 among ten countries studied, our findings point towards high commonalities in regard to the dimensionality of compliance. The two types of behaviours are only weakly correlated with each other, and differently predicted by individual attitudes towards public health measures, descriptive norms among friends and family, and key demographics. In other words: Social Distancing does not necessarily go hand in hand with Hygiene. This means that one cannot simply rank students as 'more or less compliant with COVID-19 measures' (e.g. Harper et al., 2020; Plohl & Musil, 2021). Moreover, we reveal significant variability among students in Social Distancing and Hygiene across countries. Country-samples cannot be placed on a continuum of compliance with both measures since high average levels of either Social Distancing or Hygiene do not necessarily imply a high average level of the other type of behaviour. We also show that the country of residence explains more of the variation in Social Distancing than in Hygiene. Finally, a selection of commonly used variables - attitudes and descriptive norms - were predictive of both behaviours, but more strongly related to Social Distancing. In line with previous studies, being male and being younger is negatively related to Social Distancing and especially Hygiene (Bish & Michie, 2010; Farias & Pilati, 2022). Finally, we found that being in a relationship is negatively related to Social Distancing, but positively related to Hygiene. These results

indicate that compliance with public health related measures during the COVID-19 pandemic cannot be reduced to one single composite measure, and that doing so may lead to poorer prediction of individuals' compliance and problems in generating valid public health recommendations.

Scientific contributions

The contributions of this study are multiple. First, we show that Social Distancing and Hygiene are two distinct types of behaviours during the COVID-19 pandemic, and potentially also during other infectious diseases. With this finding we hope to inspire future research to study the behaviours separately and develop stronger predictive models for each behaviour. Assuming that compliance is unidimensional and/or mostly composed of behaviours related to "social" distancing is wrong and can result in missed opportunity to correctly identify possibly different antecedents of these different behavioural dimensions. Our findings show that compliance with public health measures is best viewed as a multidimensional construct and this directly implies that both dimensions should be taken into account to design effective strategies, and when investigating, theorizing, and modelling compliance (and pandemic related outcomes) (Aleta et al., 2020; Bahl et al., 2021). Once identified, it is important to recognize that behaviours captured by each dimension are likely different in many aspects: Social Distancing behaviours require more conscious deliberation, while Hygiene behaviours are generally more automatic. Further, our analyses show these behaviours to be differently related to theoretically relevant predictors. While we show that Social Distancing and Hygiene levels are independent, the combination of these behaviours on individual level affects the individual exposure and infection risk differently. Ideally, both Social Distancing and Hygiene should be high, and one cannot compensate for the lack of the other. High Social Distancing but low Hygiene still puts a person at risk for an infection since it is unrealistic that people can completely and absolutely distance themselves from others for prolonged periods of time. Importantly, while we can assume individuals have a high control over Hygiene by performing certain behaviours, their "social" distance depends not only on their own behaviours but also on the behaviours of people they have contact with. For example, if a student A with a high Social Distancing comes across a student B with a low Social Distancing, this dyadic interaction will likely result in a less than optimal "social" distance between the two. The co-dependent nature of "achieved" Social Distancing in difference with Hygiene – people do not affect each other's hygiene directly – implies that while both behaviours will affect the spread of infection, their effect will be different and argues for more nuanced models of infection spread. Therefore, showing that compliance is "made up" by two behaviours gives important inputs for modelling the spread of disease.

Second, we show that attitudes towards public policy and descriptive norms are more predictive of Social Distancing than for Hygiene. Given that Hygiene related

behaviours are less salient (less visible) than behaviours related with Social Distancing, more routinized (automatic), and less problematized and discussed in the media, it is not surprising that they showed to be less strongly connected with attitudes and norms. It is highly possible that thinking about the recommendations and restrictions related to COVID-19 is dominated by behaviours related with "social" distancing, and therefore reported attitudes and descriptive norms are more closely related with these behaviours than with Hygiene. Social distancing behaviours are more easily (and correctly) observable. In contrast, Dickie et al.(2018) for example showed that college students consistently believed that they washed their hands more frequently than their peers. However, higher predictability of Social Distancing could partly be a result of the more reliable measurement of this construct in comparison with Hygiene (in terms of number of items and alpha coefficient). These differences underline the importance of distinguishing between the types of compliance. Further research could study whether injunctive social norms (the perception of what one ought to do) has a similar effect on both types of compliance, since this is unaffected by the visibility of the behaviours as performed by others. Further, our findings that Social Distancing and Hygiene are distinct types of compliance motivates further research regarding the descriptive norms about each type of compliance. Psychological models should seek to identify stronger antecedents in terms of attitudes, behavioural norms towards these behaviours, for example by relying on established health psychological research examining attitudes, behavioural norms and intentions related to e.g., alcohol abstaining (Conner et al., 1999), healthy eating (Conner et al., 2002) or condom use (Montanaro & Bryan, 2014). With the need for compliance continuing to exist, attitudes and descriptive norms are likely to shift over time; e.g., students become fatigued with the measures and see compliance of their peers decreasing. For both future research and public authorities, it would be fruitful to monitor attitudes and descriptive norms towards the measures as an important proxy and predictor of compliance. Public authorities should focus on creating interventions to improve attitudes, e.g., by using attitudinal argumentation (Ajzen et al., 2007), and descriptive norms, e.g., by stressing in their communication that the majority of the population is compliant instead of focusing on non-compliant groups. Our results should make public health authorities aware of the fact that they require inhabitants to change multiple types of behaviour that may require distinct interventions (Michie et al., 2011; Verplanken & Wood, 2006). Moreover, they tentatively suggest that interventions aimed at enhancing Social Distancing benefit more from influencing attitudes and descriptive norms than interventions aimed at enhancing Hygiene.

Third, our study is based on a rather large sample compared to existing samples previously conducted on compliance during the COVID-19 pandemic. We found a stable distinction between Social Distancing and Hygiene both in the overall sample as well as when examining the specific country-samples. It should be mentioned that for two countries (Ireland and Spain) one component emerged from the PCA, indicating that

Social Distancing and Hygiene are more related for students in these countries. This is likely explained by high levels of both Social Distancing and Hygiene in Spain and by a relatively small sample size (*N*=100) in Ireland, as the component loadings of the Irish sample do show fair similarity to that of the total sample. In general, also on a country-level we can conclude that the Social Distancing-Hygiene distinction is present and similar. Taken together, our findings provide cues to scholars and public health officials interested in modelling the individual compliance and the spread of the disease and devising applicable interventions to uphold prescribed recommendations and restrictions.

Limitations and future research

Results of our study should be interpreted acknowledging the timing of data collection. The end of April 2020 was still in the early phase of the COVID-19 pandemic. Public health behaviours related to Hygiene and Social Distancing may change over time, while we implicitly model Social Distancing and Hygiene in this study as stable traits. We recognize that in reality these are dynamic behaviours, showing even daily fluctuations. Future research should investigate the temporal stability of both dimensions, using not only self-reported behaviours - which are likely affected by social desirability to a certain degree - but also measures of actual behaviours. Such approach would also reduce the common method bias of a single survey being used to measure all variables of interest self-reported by the participants at the same point in time (Podsakoff et al., 2003). Finally, we did not collect data on the place of residence of students, e.g., whether they live in a large city or small town. Future research should investigate whether there are differences in compliance between students living in rural versus urban areas.

A strength of this study comes from the fact that we collected data on samples of students in ten different countries at a simultaneous relevant point in time. Yet, we were not able to avoid self-selection bias, which probably led to low compliance students being underrepresented. While we assume that their underrepresentation did not affect the findings about the dimensionality of compliance in any substantial degree, it is possible that due to the range restriction in our dependent variable the investigated predictor variables could have been compromised. Future data collection efforts should try to secure the participation of students such that those who are not complying highly are incentivised to participate.

We identified two distinct dimensions of compliance and investigated them using attitudes and descriptive norm variables. We hope that future research will build on our findings and use more elaborate models of behaviours of interest distinguishing between Social Distancing and Hygiene. A logical step would be to validate key constructs from central theories of health behaviours such as perceived behavioural control as in the Theory of Planned Behaviour (Ajzen et al., 2007), belief in the compliance effectiveness and beliefs about personal COVID-19 threat as in the Health Belief Model (Janz & Becker,

1984). Future research should also go beyond internal beliefs and intentions towards also considering unconscious priming and situational cues in changing automatic and habitual behaviours (Stroebe, 2011). Measuring the behaviour or attitudes of close social contacts would also allow more precise insights about the mechanism of social influence in compliance behaviours. Finally, there are opportunities in widening the theoretical framework by incorporating other relevant theories from the field of social psychology (e.g., social identity theory and COVID-19 (Jetten et al., 2020) for psychological science to make valuable contributions in understanding and addressing the challenges arising from the pandemic.

2.5 Supplementary material

Table S2.1 Overview of COVID-19 regulations across countries

	Avoiding touching your face	Coughing into elbow and/or use a handkerchief	Washing hands more often and longer	Keep a distance from others when not at home	Only go outside if strictly necessary	Do not shake hands	Not allowed to have visitors/visit others	Not visit elderly people or people who are vulnerable for health reasons
Belgium	x	x	x	x	x	x	x	x
Colombia	x	x	x	x	x	x	x	x
France	x	x	x	x	x	x		
India	x	x	x	x	x	x	x	
Ireland	x	x	x	x	x	x	x	
Italy	x	x	x	x	x	x	x	x
Netherlands	x	x	x	x		x		x
Portugal	x	x	x	x	x	x	x	x
Spain	x	x	x	x	x	x	x	x
Sweden	x	x	x	x		x		x

Note: 'x' indicates that the measure was taken by the country to lower the spread of COVID-19. Information is applicable to the period the survey was online (week 17-19, 2020)

Table S2.2 Descriptive statistics: total sample

		NL	BE	PRT	ESP	IND	FR	SWE	IT	IRE	COL	Total
		% /M (SD)	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*	*% /M (SD)*
Sample Size		1,090	3,645	1275	157	201	209	247	193	100	286	7,403
Response rate (%)		n/a	7.0	14.2	12.8	n/a	31.0	9.9	17.6	7.9	8.2	8.6[a]
Gender (%)	*Male*	42.46	31.92	52.72	33.12	55.73	28.29	42.68	46.8	36.0	38.6	38.66
	Female	57.54	68.08	47.28	66.88	44.27	71.71	57.32	53.2	64.0	61.4	61.34
Age (years)		20.76 (2.81)	23.24 (6.51)	22.79 (5.83)	23.20 (4.85)	21.81 (5.14)	20.56 (2.16)	25.73 (5.77)	22.62 (2.69)	24.38 (7.03)	25.12 (8.21)	22.84 (5.93)
Subject Study (%)	*Economics /Business*	77.53	15.49	16.45	83.97	8.33	93.27	8.13	60.94	98.00	89.16	33.23
	Psychology	16.67	6.49	0.16	1.28	3.65	0.00	5.28	0.00	0.00	1.75	6.06
	Law	0.64	9.53	0.08	1.28	2.60	0.00	1.63	0.00	0.00	0.35	4.97
	Philosophy, Arts & Letters	0.18	10.52	0.32	0.64	3.65	0.00	3.66	0.00	0.00	0.00	5.50
	Medicine	0.09	15.52	0.16	0.00	3.65	0.48	17.89	0.00	0.00	0.35	8.41
	Sciences	2.30	12.56	10.57	0.64	30.21	0.00	8.13	20.31	0.00	1.75	10.02
	Agronomy	0.09	3.31	0.24	0.64	0.00	0.00	0.00	0.00	0.00	0.35	1.72
	Engineering	0.00	9.50	58.03	0.00	20.83	0.48	21.54	0.00	0.00	1.40	15.95
	Computer sciences	0.18	2.29	10.73	0.00	15.10	0.00	10.98	1.04	1.00	0.35	3.81
	Other	2.30	14.80	3.26	11.54	11.98	5.77	22.76	17.71	1.00	4.50	10.33
International student (%)	*No*	69.52	89.73	91.51	97.44	97.42	92.31	91.46	94.30	65.00	99.65	87.72
	Yes	30.48	10.27	8.49	2.56	2.58	7.69	8.54	5.70	35.00	0.35	12.28
Relationship (%)	*No*	59.67	51.64	57.20	45.16	71.35	52.88	44.90	49.74	56.00	55.59	54.13
	Yes	40.33	48.36	42.80	54.84	28.65	47.12	55.10	50.26	44.00	44.41	45.90
Government Trust	(1-10)[b]	7.28 (1.64)	5.55 (2.13)	6.44 (1.99)	4.09 (2.55)	6.22 (2.53)	5.55 (2.07)	7.11 (2.26)	5.53 (2.22)	6.99 (1.80)	3.71 (2.30)	5.95 (2.24)

Note: [a] Excluding India and the Netherlands, [b] Government trust was rated on a scale of 1 (lowest trust) to 10 (highest trust)

Table S2.3 Descriptive statistics variables regression analyses – total sample

	M	*SD*	1	2	3	4	5	6	7	8	9
1. Age	22.84	5.93	-								
2. Female	0.61	0.49	-.03***	-							
3. Relationship (1=yes)	0.46	0.50	.17***	.09***	-						
4. Taking Measures Seriously	6.11	1.03	-.001	.10***	.001	-					
5. Too Few Measures (=1)	0.43	0.49	-.01	.07***	.02	-.01	-				
6. Too Many Measures (=1)	0.15	0.35	.06**	-.05***	-.02	-.19***	-.36***	-			
7. Social Norm	5.58	1.11	.04***	.02	-.02*	.20***	-.03***	-.04***	-		
8. Social Distancing	4.25	0.66	.12***	.09***	-.01	.31***	.12***	-.10***	.24***	-	
9. Hygiene	3.95	0.72	.12***	.11***	.11***	.21***	.06***	-.07***	.13***	.21***	-

Note: ***: $p<.01$; **: $p<.05$; *: $p<.10$

Table S2.4 Component matrices Principal Component Analysis per country

	NL		BE		PRT		ESP		IND		FR		SWE		IT		IRE		COL	
Items	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
1. I avoided touching my face	**.42**	**.46**	.37	**.59**	.34	**.62**	**.59**	.32	**.49**	**.58**	.11	**.72**	**.44**	**.47**	**.43**	**.65**	.27	**.64**	**.57**	**.46**
2. I coughed and sneezed into my elbow and/or used a handkerchief	.32	**.61**	.31	**.62**	**.40**	**.41**	**.53**	.21	**.59**	**.52**	.11	**.70**	.35	**.49**	**.49**	**.55**	**.43**	.15	**.47**	**.50**
3. I washed my hands more often and longer	.38	**.61**	.29	**.63**	.30	**.62**	**.48**	.32	**.48**	**.59**	.00	**.46**	.36	**.69**	.32	**.74**	.23	**.69**	**.46**	**.59**
4. When not at home I kept the advised distance between myself and others	**.64**	.12	**.57**	.19	**.55**	.24	**.53**	**-.65**	**.60**	-.08	**.53**	.35	**.66**	.16	**.57**	.09	**.57**	.03	**.62**	.21
5. I did not meet with others unless it was strictly necessary	**.74**	**-.42**	**.75**	**-.39**	**.72**	-.35	**.56**	-.03	**.71**	-.35	**.83**	-.11	**.75**	**-.41**	**.73**	**-.45**	**.72**	-.13	**.60**	-.38
6. I only went outside if it was strictly necessary	**.71**	-.31	**.70**	-.27	**.64**	-.32	**.51**	.15	**.58**	-.38	**.77**	-.20	**.72**	-.34	**.63**	-.36	**.65**	-.30	**.64**	-.33
7. I did not shake hands	**.50**	.18	**.45**	.11	**.53**	.23	**.61**	**-.59**	**.73**	-.13	**.45**	.23	**.66**	.07	**.44**	-.09	**.55**	**.42**	**.63**	-.03
8. I did not visit others/have not had visitors	**.72**	**-.41**	**.74**	-.31	**.71**	-.32	**.63**	.07	**.62**	-.31	**.80**	-.14	**.75**	-.29	**.70**	-.39	**.75**	-.39	**.68**	-.36
9. I have not visited elderly people or people who are vulnerable for health reasons	.32	.12	**.40**	-.08	**.52**	-.26	**.65**	.24	**.45**	-.16	**.48**	-.17	.19	-.04	**.40**	.05	**.59**	-.11	**.52**	-.37

Note: component loadings with absolute value greater than .04 bold printed. Gray colour indicates distinction made between items based on PCA on entire sample. C1= component one, C2 = component two.

Table S2.5 One-way ANOVA's testing mean-differences in compliance between countries

Country		Mean difference Social Distancing	Mean difference Hygiene
NL	BE	-0.51***	0.16***
	PRT	-0.64***	-0.10***
	ESP	-0.81***	-0.24***
	IND	-0.67***	-0.10
	FR	-0.47***	-0.09
	SWE	0.15**	-0.15*
	IT	-0.70***	0.13
	IRE	-0.53***	-0.10
	COL	-0.61***	-0.06
BE	PRT	-0.12***	-0.26***
	ESP	-0.29***	-0.40***
	IND	-0.15**	-0.26***
	FR	0.04	-0.25***
	SWE	0.67***	-0.31***
	IT	-0.19***	-0.03
	IRE	-0.02	-0.26**
	COL	-0.09	-0.22***
PRT	ESP	-0.17**	-0.14
	IND	-0.03	0.01
	FR	0.16**	0.01
	SWE	0.79***	-0.05
	IT	-0.07	0.24***
	IRE	0.11	0.00
	COL	0.03	0.04
ESP	IND	0.14	0.14
	FR	0.33***	0.15
	SWE	0.96***	0.08
	IT	0.10	0.37***
	IRE	0.28**	0.14
	COL	0.20**	0.17
IND	FR	0.19*	0.01
	SWE	0.82***	-0.06
	IT	-0.04	0.23*
	IRE	0.14	0.00
	COL	0.06	0.03
FR	SWE	0.63***	-0.07
	IT	-0.23***	0.22*
	IRE	-0.06	-0.01
	COL	-0.13	0.02
SWE	IT	-0.86***	0.28***
	IRE	-0.68***	0.05
	COL	-0.76***	0.09
IT	IRE	0.17	-0.23
	COL	0.10	-0.20
IRE	COL	-0.08	0.04

Note: ***: $p<.01$; **: $p<.05$; *: $p<.10$

2.6 Data availability

Research data that was used for the study and a codebook explaining all variables in this data can be found online via https://doi.org/10.23668/psycharchives.4412.

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3

Chapter 3

The Role of Impulsivity and Delay Discounting in Student Compliance With COVID-19 Protective Measures

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Abstract

During the 2020 COVID-19 pandemic, governments set recommendations and restrictions that have given rise to new situations that require residents to deliberate and respond nonautomatically. For highly impulsive individuals, dealing with these situations may be harder, as they tend to deliberate less about the consequences of their behaviours. In this study, we investigate the relationship between impulsivity and delay discounting on the one hand and compliance with COVID-19 restrictions on the other hand. We distinguish between compliance with social distancing measures and compliance with hygiene measures. Regression analyses of an international sample of 6,759 students from seven European countries reveal that the self-reported personality construct of impulsivity is negatively related to both types of compliance behaviour. However, and unexpectedly, we also find a weak positive association between the discount rate—as measured by a behavioural task—and compliance. Our study highlights the importance of individual differences in impulsivity in regard to compliance with public health measures during a pandemic.

3.1 Introduction

During the 2020 COVID-19 pandemic, governments have imposed measures to protect public health[10] that require individuals to engage in behaviour changes, e.g., maintaining a physical distance between oneself and others and limiting the number of one's social contacts (Sebhatu et al., 2020; Wismans et al., 2020). These new situations have required individuals to engage in deliberation and to respond nonautomatically, for example, when making decisions between the suddenly risky action of seeing friends or staying at home. While meeting friends leads to the immediate benefit of a social reward, staying at home leads to the long-term benefit of staying healthy and contributing to 'flattening the curve'. For impulsive individuals, making health-conscious decisions could be harder, as they tend to respond automatically and deliberate less about behavioural consequences than most people of equal ability (Dalley et al., 2011; Dickman, 1990). Moreover, highly impulsive individuals are more easily distracted (Stanford et al., 2009) and so are more likely to forget to wash their hands or to avoid touching their face, making it more difficult for them to comply with the required changes to hygiene behaviours.

Impulsivity covers a wide range of behaviours and actions that lack forethought, are overly risky or prematurely expressed, and often lead to unwanted outcomes (Evenden, 1999). Impulsivity is seen as a complex concept that is both part of standard individual differences in personality, as well as more dysfunctional and pathological behaviours (Dickman, 1990). Impulsive behaviours may at times be adaptive for individuals as well as groups (J. Williams & Taylor, 2006). However, impulsivity is also

[10] Throughout this chapter we use the term 'measures' to describe the set of restrictions and recommendations imposed by governments during the 2020 COVID-19 pandemic.

related to risky behaviours and negative outcomes such as high-risk sexual behaviour, obesity, substance abuse and gambling (Butler & Montgomery, 2004; Slutske et al., 2005). A concept related to impulsivity is 'delay discounting', which relates to preferences for immediately available rewards over larger rewards that are available later (Ainslie, 1975). Delay discounting is often measured using behavioural tasks (B. Reynolds, 2006) that capture individuals' tendencies to devalue temporally distant rewards even though they are more valuable than the immediately available benefits (Madden & Bickel, 2010). The personality construct of impulsivity is often gauged using self-report measures such as the Barratt Impulsiveness Scale (BIS) (Barratt, 1959; Patton et al., 1995). Both delay discounting and impulsivity are associated with a lack of foresight and with ignoring the future consequences of behaviour, and as such, delay discounting is often regarded as an aspect of impulsivity. However, prior studies have found little overlap between self-reported impulsivity and behavioural tasks that assess delay discounting (Bernoster et al., 2019; B. Reynolds, 2006). This suggests that delay discounting represents an associated but distinct aspect of impulsivity.

During widespread pandemics such as the COVID-19 pandemic, a lack of deliberation and a tendency toward risky behaviours could lead to impulsive persons being more likely to violate governmental measures. The same could be true for people with higher discount rates who place a higher value on immediately available rewards. For example, such individuals may place a higher value on socialization obtained through noncompliance than on the potential long-term reward of fewer restrictions obtained through collective compliance. Consequently, more impulsive individuals and those with higher discount rates could be more likely to violate public health measures and therefore be more prone to becoming infected with and spreading the COVID-19 virus.

Given the novelty of the situation, there is hardly any evidence on the relationship between impulsivity and compliance with COVID-19 measures. Three studies (two of which non peer reviewed) have been conducted studying the link between self-reported impulsivity and compliance, all showing a strong negative association (Alper et al., 2021; Kuiper et al., 2020; van Rooij et al., 2020). While Kuiper et al. (2020) and Van Rooij et al. (2020) focused solely on social distancing and stay-at-home measures, Alper et al. (2021) focused on a composite measure of several types of restrictions. In all three studies, impulsivity was not the main variable of interest, and the results were based on relatively small samples from a single country.

Several studies indirectly support our expectations of a negative relationship between impulsivity and compliance. Studies have shown that psychopathy and ADHD, both associated with high levels of impulsivity, are related to lower compliance with the measures and with risk of COVID-19 infection. For example, Merzon et al. (2021) found that untreated ADHD is a risk factor for COVID-19 infection, which could be driven by a lower ability to comply with COVID-19 measures due to the characteristics associated with ADHD. Other studies have linked higher levels of psychopathy to low compliance

with the measures and even an intent to knowingly expose others to risk (Blagov, 2021; Nowak et al., 2020; O'Connell et al., 2021). Finally, Miguel et al. (2021) showed that people who followed all types of measures exhibited fewer traits related to antisocial personality disorder than people who followed none of the measures.

Delay discounting has been used to explain many of the contradictory choices that people make. Specifically, time preferences play a role in choices that involve behaviours with delayed (long-term) benefits and immediate (short-term) costs, for example, the choice to resist the instant gratification of smoking another cigarette in exchange for the long-term benefit of staying healthy. Higher discount rates have been used to explain a range of maladaptive behaviours, such as substance use, overeating, problem gambling and low treatment adherence (Bickel & Marsch, 2001; Stoianova et al., 2018; Weller et al., 2008).

These choice dilemmas are closely related to the situation surrounding the 2020 COVID-19 pandemic. Not complying with the COVID-19 measures provides short-term benefits (such as being able to go outside and seeing friends) and eliminates the short-term costs of compliance but leads to adverse long-term consequences (such as becoming infected and spreading the virus) and eliminates long-term rewards (such as staying healthy and contributing to flattening the curve). Nese et al. (2022)—using hypothetical compliance decisions over time—showed that compliance follows a hyperbolic-like curve, decreasing over time, with steeper discounting rates when the stated likelihood of contracting COVID-19 is lower. Relatedly, Van Hulsen et al. (2020) showed that consideration of future consequences is positively related to compliance with measures related to COVID-19 in the Netherlands.

The current study

Our study uses a large international sample of university students. As the health consequences of COVID-19 infections for younger individuals are in general much less severe (Wu & McGoogan, 2020), evidence on students' compliance behaviour is important. Young people may need to think more about the consequences of their behaviour for the older people surrounding them than about the consequences for themselves. The increase in infections traced back to younger individuals at the start of the second wave across Europe and in the United States (The Economist, 2020) also makes students a relevant demographic group to study.

Generally, the recommendations and restrictions set by governments can be divided into measures related to *hygiene* and measures related to *social distancing*. While previous studies on compliance tend to construct composite measures of these behaviours, recent papers have shown that when studying compliance with public health restrictions surrounding pandemics, it is important to distinguish between compliance with measures related to social distancing and hygiene. This is because the level and

antecedents of compliance with social distancing measures and compliance with hygiene measures are found to be different (Bish & Michie, 2010; Wismans et al., 2020).

In this study, we therefore investigated the link between self-reported impulsivity and delay discounting on the one hand and compliance with social distancing and hygiene measures on the other among university students. Based on the literature presented above, we formulated the following four hypotheses concerning compliance with governmental measures during the first wave of the 2020 COVID-19 pandemic:

H1a: Self-reported impulsivity is negatively related to compliance with social distancing measures.

H1b: Self-reported impulsivity is negatively related to compliance with hygiene measures.

H2a: The temporal discount rate is negatively related to compliance with social distancing measures.

H2b: The temporal discount rate is negatively related to compliance with hygiene measures.

3.2 Methods

Participants

In the early phase of the COVID-19 pandemic (week 17-19 2020), an online questionnaire was distributed among university students in ten countries. The current study uses data on students in seven of these countries[11]: Belgium, France, Ireland, Italy, the Netherlands, Sweden, and Portugal. Our sample consisted of 6,759 graduate and undergraduate students. The survey was approved by the Internal Review Board of Erasmus University Rotterdam in advance and was shared with the target group for 13 consecutive days using the online survey software Qualtrics. Students could choose to complete the survey in English, Dutch or French, and translations were made by two native speakers per language. All students signed an informed consent form at the start of the survey.

On average, respondents were 22.76 years old (standard deviation, SD, 5.84). A total of 61.7 percent were female, in line with the gender distribution at these universities and at nontechnical European universities in general. Information on country samples is presented in supplementary material (Table S3.2).

[11] We do not use the data from students in Spain, Colombia, or India due to (i) a translation mistake in the Spanish version (Spain and Colombia) of the delay discounting task and (ii) the large difference in discount rates between Indian and European students (likely due to differences in currency and the perceived value of money).

Measures

Compliance with social distancing and hygiene measures

Compliance behaviour was measured using 9 items. Prior research using principal component analysis has shown that these items are best divided into two types of behaviour: social distancing compliance and hygiene compliance (Wismans et al., 2020). The social distancing measure consisted of 6 items, and the hygiene measure consisted of 3 items. Students had to indicate to what extent they (dis)agreed with the statements on a scale of 1 (completely disagree) to 5 (completely agree). Examples of social distancing statements are *'I only went outside if it was strictly necessary'* and *'When outside I kept the advised distance between me and others'*. The three hygiene statements are *'I coughed and sneezed into my elbow and/or used a handkerchief', 'I washed my hands more often and longer'* and *'I avoided touching my face'*. The reliability of the social distancing measure was good (α=.71), although the reliability of the hygiene measure was relatively low (α=.52), likely because it consisted of only three items. See Wismans, Letina, et al. (2020) for further validation of these two constructs.

Barratt Impulsiveness Scale-Brief (BIS-Brief)

Impulsivity was assessed using the BIS-Brief by Steinberg et al. (2013), a shorter unidimensional version of the BIS-11 (Patton et al., 1995) consisting of 8 items. Steinberg et al. (2013) demonstrated the internal consistency, construct validity and concurrent validity of the 8-item impulsivity measure and concluded that the BIS-Brief reduces the burden on participants without loss of information. Answers were given on a 4-point scale ranging from 'Rarely/Never' (1) to 'Almost Always/Always' (4). Half of the items were reverse coded. Items from validated translations of the BIS-11 were used for the French (Bayle et al., 2000) and Dutch (Lijffijt & Barratt, 2005) versions of the survey. The reliability of the instrument in our sample was good (α=.74).

5-Trial Adjusting Delay Discounting Task

To measure the discount rate in a fast and accurate manner, we used the 5-trial adjusting delay discounting task (Koffarnus & Bickel, 2014). The discount rate obtained using this task correlates to that obtained from lengthier tasks (Koffarnus & Bickel, 2014) and was validated by Cox and Dallery (Cox & Dallery, 2016). In this task, students make five consecutive hypothetical choices between receiving €1000 after a delay and €500 now. The task starts with a delay of 3 weeks, and the delay is increased or decreased based on previous choices made until reaching the 'indifference delay', which is used to calculate the discount rate (k). We use a natural log transformation of the discount rate (Koffarnus & Bickel, 2014; Yoon & Higgins, 2008). For more information on the mathematical procedure, see supplementary material S3.1 (or see Koffarnus & Bickel, 2014).

Control variables

We controlled for students' age and gender, as these relate to both impulsivity and compliance with protective health behaviours (Bish & Michie, 2010; Chamorro et al., 2012). Age was measured as a continuous variable and gender as a binary variable (0: male, 1: female). We also controlled for the degree to which students reported that friends and family members followed the public health measures. Social norms are powerful shapers of behaviour (Cialdini & Goldstein, 2004), and studies have shown that they play an important role in explaining compliance with COVID-19 measures (van Rooij et al., 2020). The social norm was measured with the question '*To what extent do your family and friends strictly follow the measures related to the coronavirus?'* with a 7-point Likert scale (1='They do not follow the measures at all' – 7='They strictly follow all measures'). Missing data were below 1.5 percent for all major variables included in the below models[12].

3.3 Results

We present descriptive statistics, Cronbach's alpha values and correlations in Table 3.1. Information on the country samples is presented in the supplementary material (Table S.3.2). In general, student compliance with COVID-19 measures in our sample was high, especially for social distancing behaviours. Self-reported impulsivity as measured by the BIS-Brief correlated negatively with both social distancing and hygiene compliance, whereas the discount rate correlated positively with social distancing and hygiene compliance. Impulsivity and the discount rate were not statistically related, in line with prior studies (McLeish & Oxoby, 2007; B. Reynolds, 2006).

Table 3.1 Descriptive statistics, Cronbach's alphas and correlations of total sample (*N*=6,759)

	M	*SD*	*α*	1	2	3	4	5	6
1. Social distancing	4.23	0.66	.71	-					
2. Hygiene	3.94	0.72	.52	.18	-				
3. BIS-Brief Impulsivity	1.99	0.46	.74	-.12	-.15	-			
4. Discount rate - ln(*k*)	-5.82	1.85	-	.07	.05	-.02	-		
5. Age	22.76	5.84	-	.12	.11	-.12	.03	-	
6. Gender (1=female)	0.62	0.49	-	.09	.12	.01	.07	-.03	-
7. Social norm	5.56	1.10	-	.23	.12	-.10	.04	.04	.03

Note: correlations in excess of |0.02| are statistically significant at the 5% level. α=Cronbach's alpha

To test our hypotheses, we conducted regression analyses with social distancing compliance (Table 3.2) and hygiene compliance as the dependent variables (Table 3.3). All models controlled for country differences using dummy variables (omitted from the

[12] Regressions on 50 imputed datasets based on all the main variables in the final model were conducted. The average values of the pooled estimates and regression coefficients were almost identical to the results from the nonimputed dataset.

regression tables). We first estimated the models without control variables (model 1), then included age and gender (model 2), and finally included social norms (model 3). We based our conclusions on the final model (model 3, Tables 3.2 and 3.3).

Confirming our first two hypotheses, 1a and 1b, we found that self-reported impulsivity is negatively related to both social distancing compliance (B=-0.10, p<.001) and hygiene compliance (B=-0.12, p<.001). However, in contrast to hypotheses 2a and 2b, the discount rate is positively—though weakly—related to both social distancing compliance (B=0.03, p=.004) and hygiene compliance (B=0.03, p=.008).

Table 3.2 Results regression analyses with social distancing as dependent variable

	Model 1 Social Distancing		Model 2 Social Distancing		Model 3 Social Distancing	
	B (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*
BIS-Brief Impulsivity	-0.13 (0.02)	<.001	-0.12 (0.02)	<.001	-0.10 (0.02)	<.001
Discount rate - ln(*k*)	0.05 (0.004)	<.001	0.04 (0.004)	<.001	0.03 (0.004)	.004
Age			0.09 (0.001)	<.001	0.08 (0.001)	<.001
Gender			0.09 (0.02)	<.001	0.09 (0.02)	<.001
Social norm					0.19 (0.01)	<.001
N	6,686		6,598		6,593	
Adjusted R^2	0.15		0.16		0.19	

Note: B is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

Table 3.3 Results regression analyses with hygiene as dependent variable

	Model 1 Hygiene		Model 2 Hygiene		Model 3 Hygiene	
	B (SE)	*p*	*B (SE)*	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.15 (0.02)	<.001	-0.13 (0.02)	<.001	-0.12 (0.02)	<.001
Discount rate - ln(k)	0.05 (0.005)	<.001	0.03 (0.005)	.004	0.03 (0.005)	.008
Age			0.11 (0.002)	<.001	0.11 (0.002)	<.001
Gender			0.15 (0.02)	<.001	0.14 (0.02)	<.001
Social norm					0.09 (0.01)	<.001
N	6,688		6,601		6,595	
Adjusted R^2	0.05		0.08		0.09	

Note: B is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

Robustness and sensitivity checks

To further investigate the results, robustness and sensitivity checks were conducted which are discussed and presented in the supplementary material. We conducted subsample analyses by country (S3.3), gender (S3.4), nationality (international versus domestic students) (S3.5), and age groups (S3.6). Moreover, we tested whether the relationships hold when using follow-up data (S3.7), when transforming the skewed dependent variables (S3.8) and when using different – but related – dependent variables (S3.9). Overall, the results show that the impulsivity compliance is robust across analyses. Moreover, we generally confirm the positive relationship between discount rate and

compliance with COVID-19 measures in most analyses, although in some subgroup analyses (with smaller *N*) the result is not present or statistically significant at conventional *p*-value levels.

3.4 Discussion

In our international sample of university students, we found that the self-reported personality construct impulsivity is negatively related to compliance with both social distancing and hygiene measures. Moreover, we found a positive but weak association between the discount rate and compliance with both types of COVID-19 measures.

The negative association between self-reported impulsivity and both compliance behaviours confirm our hypotheses (H1a and H1b): more impulsive students are more likely to show decreased compliance with social distancing and hygiene measures (Alper et al., 2021; Kuiper et al., 2020; van Rooij et al., 2020). Our paper provides novel empirical insights by showing that self-reported impulsivity is negatively related not only to compliance with social distancing and stay-at-home measures but also to compliance with hygiene behaviours. We found trait impulsivity to be related to lower compliance, extending studies that have related ADHD and psychopathy to COVID-19 infection (Merzon et al., 2021) and to decreased compliance with COVID-19 measures (Blagov, 2021; Nowak et al., 2020; O'Connell et al., 2021). Multiple sensitivity tests indicated that the relationship between impulsivity and compliance was robust. Follow-up data, collected nine months after the main data collection, also showed that impulsivity was not only related to compliance in the initial phase of the pandemic but was also negatively associated with prolonged compliance.

Contrary to our hypotheses (H2a and H2b), we found a positive—albeit small—link between the discount rate and social distancing and hygiene compliance, indicating that students with a higher discount rate (i.e., more impatient, and more strongly present-biased students) were more likely to comply with both types of COVID-19 public health measures. This surprising result motivated us to analyse the robustness of the relationship using sensitivity tests. While the association was not always statistically significant in the subgroup analyses, it was predominantly positive and never statistically significant in the theoretically expected direction. Our relatively large sample provided statistical power to detect this small but robust deviation from prior theory. Below, we discuss the possible theoretical mechanisms and methodological issues that may underlie this finding. These explanations are not mutually exclusive.

COVID-19 induced stress. Previous literature showed that higher stress levels are related to greater delay discounting (Malesza, 2019). It is thus possible that stress induced by the COVID-19 crisis affected the relationship found, causing both greater delay discounting and higher compliance with COVID-19 measures. The choice for a monetary discount rate may have strengthened this effect, as from the early days of the COVID-19

crisis, it was recognized that the pandemic was likely to cause a financial crisis for many people. Hence, increased COVID-19 related stress may have affected both compliance and negative expectations related to COVID-19-induced financial insecurity. Consequently, students with more worries could be more inclined to forsake a larger financial gain in the future for a smaller gain in the present[13].

Long-term versus short-term benefits. Given the uniqueness of the COVID-19 pandemic, it was surrounded by a lot of uncertainty regarding its duration. It is possible that students did not perceive compliance to have benefits only in the long run but rather on a more short-term. As governments put emphasis on the short-term benefits of compliance in their communication (e.g., 'The more we comply with the measures, the sooner we will be out of the pandemic') students could have had the idea that the objectives would be reached soon. If the benefits of compliance were perceived to occur rather sooner than later, this would mean that they were to be discounted less.

Statistical artifact(s). While the analyses conducted on the subgroups within our sample did not provide a strong indication of the existence of opposite relationships within groups, something which is known as Simpson's paradox (Simpson, 1951), there could be other unobserved factors that affect the relationship between compliance and discount rate in different subgroups in our data. There could for example be an unmeasured country-level variable related to public health, standards of living or culture that moderates the relationship between the discount rate and compliance (Strimling et al., 2018). Finally, since our sample was not random or representative, but relied on a voluntary participation, the existence of a (self) selection in respect to one or more variables is possible, which in turn could have distorted observed associations (sometimes referred as collider bias, for more details see Griffith et al. (2020)).

While this study is, to the best of our knowledge, the first to study the role of impulsivity and delay discounting in compliance with COVID-19 measures in a large sample of students, it has limitations. The data were collected using an online survey with self-reported measures, which elicits social desirability bias among respondents. While anonymity was emphasized and the data were collected in an online environment, students could have overreported their compliance with public health measures. Finally, the task that we used to assess the discount rate differs from the decision to comply with COVID-19 measures in three ways. First, we used a money-related instead of a health-related discounting task (Bleichrodt et al., 2016). This may be problematic as discount rates for money and health have not always been found to be universal (Attema, 2012). As compliance could be seen as a preventive health-behaviour, a health-related discount rate could have been better at describing time preferences related to compliance. Second, the discount rate task assessed decisions in the individual domain, while the decision to

[13] In unreported regression models, we included a control variable capturing 'How did/does the current coronavirus crisis affect your financial security?' (Likert scale, 1-5), which was negatively correlated to the discount rate (r=-.12). However, all results remained almost identical when controlling for changes in financial security.

comply with COVID-19-related measures entail trade-offs between an individual's own benefits and the societal benefits, a classical collective action dilemma. Studies show that dilemmas containing a social element decrease individuals' discount rates (Bickel et al., 2012; Charlton et al., 2013). Third, studies have shown an asymmetry in discount rates between gains and losses (Khwaja et al., 2007). In our study, we assessed discounting in the gains domain while the trade-off surrounding compliance involves potential losses. Future research could shed light on this issue by using tasks that involve domains and contexts more similar to the pandemic situation, such as health-related delay discounting tasks (Bleichrodt et al., 2016) or tasks involving a social element (Bickel et al., 2012; Charlton et al., 2013).

In conclusion, we found a consistent negative link between the personality trait of impulsivity and compliance with COVID-19 measures. Contrary to our hypotheses, we also found a positive but weak link between the discount rate and compliance, which warrants further research. These opposing results underline the fact that self-reported impulsivity and delay discounting are distinct concepts and should not be used interchangeably. Policy makers could take these findings into account to communicate messages in a more tailored and targeted manner. As more impulsive individuals rarely engage in extensive forethought, emphasizing the consequences of noncompliance or facilitating alternative outlets for impulses (e.g., physical activity) may be warranted to decrease the increased risk of high-impulsivity individuals to engage in risky behaviour during widespread pandemics.

3.5 Supplementary material

S3.1 - 5-Trial Adjusting Delay Discounting Task

To measure the discount rate, we used the 5-trial adjusting delay discounting task (Koffarnus & Bickel, 2014). As stated, in this task, students make five consecutive hypothetical choices between receiving €1000 after a delay and €500 now. The task starts with a delay of 3 weeks, and the delay is increased or decreased based on previous choices made until reaching the 'indifference delay', which is used to calculate the discount rate (k). At this indifference delay, the subjective value of both rewards is approximately equal. This is used as a measure of the 'effective delay 50' (ED_{50}). At this point, the larger reward has lost half of its subjective value (Koffarnus & Bickel, 2014). To derive estimates of the discount rate, a hyperbolic discounting model is used (Mazur, 1987):

$$V = \frac{A}{(1 + kD)}$$

V is the current value of the delayed reward (discounted value), A is the reward amount, D is the delay, and k is a parameter that reflects the discount rate. Higher values of k reflect a faster devaluation of the delayed reward and thus greater impulsivity.

ED_{50} is thus the delay (D) at which the current value (V) is half of its nominal amount (A). The indifference point (ED_{50}) that is elicited by the task is used to estimate k by taking its inverse ($1/ED_{50}$). We use a natural log transformation of the discount rate (Koffarnus & Bickel, 2014; Yoon & Higgins, 2008).

S3.2 - Information on country samples

Table S3.2 Descriptive statistics country samples

	Total (*N*=6,759)		NL (*N*=1,090)		BE (*N*=3,556)		PRT (*N*=1,275)		FR (*N*=209)		SWE (*N*=247)		IT (*N*=193)		IRE (*N*=100)	
	M/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*
Social distancing	4.23	0.66	3.80	0.69	4.31	0.61	4.44	0.57	4.27	0.69	3.65	0.72	4.50	0.51	4.33	0.65
Hygiene	3.94	0.72	4.00	0.66	3.84	0.74	4.10	0.65	4.09	0.69	4.15	0.59	3.87	0.78	4.10	0.56
BIS-Brief Impulsivity	1.99	0.46	1.95	0.46	2.02	0.45	1.94	0.47	2.05	0.45	1.96	0.43	1.85	0.39	2.02	0.48
Discount rate - ln(*k*)	-5.82	1.85	-6.03	1.56	-5.89	1.90	-5.64	1.88	-4.96	1.76	-5.97	1.72	-5.27	1.94	-5.41	1.96
Age	22.76	5.84	20.76	2.81	23.24	6.51	22.79	5.83	20.56	2.16	25.73	5.77	22.62	2.69	24.38	7.03
Gender - *Male* (%)	38.3		42.46		31.92		52.72		28.29		42.68		46.84		36.00	
Gender - *Female (%)*	61.7		57.54		68.08		47.28		71.71		57.32		53.16		64.00	
Social norm	5.56	1.10	5.46	1.11	5.54	1.09	5.68	1.05	5.86	1.14	5.17	1.20	5.92	1.05	5.85	1.02

S3.3 - Regression analyses on country samples

We conducted the same regression analyses as in Tables 3.2 and 3.3 on the seven country subsamples. The results are detailed in Tables S3.3.1 to S3.3.7 below and show that the results obtained with the country subsamples are overall in line with the main results. Due to the smaller sample sizes, only some relationships exhibited p-values below .05.

The association between impulsivity and social distancing compliance was negative in all country subsamples, with p-values below .05 in four out of the seven samples, and most pronounced in the French sample (*B*=-0.28, *SE*=0.10, *p*<.001). The impulsivity-hygiene compliance relationship was likewise negative in all country samples, with *p*-values below .05 in four out of the seven country subsamples. These results underline the robustness of the relationship between impulsivity and both social distancing and hygiene compliance.

With respect to the discount rate, we found a positive relationship between the discount rate and social distancing compliance (*p*<.05) in four out of the seven country subsamples. The range of the effect sizes was broad and much stronger in the Swedish (*B*=0.19, *SE*=0.03, *p*<.01) and Irish subsamples (*B*=0.21, *SE*=0.03, *p*=.04) than in the overall sample or in the other subsamples. The direction of the coefficient in two of the subsamples was negative but small (*p*>.10). The relationship between the discount rate and hygiene compliance was less pronounced in the country subsamples than in the overall sample, with only the Belgian subsample exhibiting a *p*-value below .05 (*B*=0.04, *SE*=0.01, *p*=.03). This indicates that the relationship between the discount rate and compliance with COVID-19 measures is overall much weaker than the relationship between impulsivity and compliance and that it is also sensitive to sample size.

Table S3.3.1 Regression analyses – sample: the Netherlands

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.12 (0.04)	<.001	-0.03 (0.04)	.40
Discount rate - ln(*k*)	0.09 (0.01)	<.001	0.04 (0.01)	.19
Age	0.06 (0.01)	.002	0.04 (0.01)	.24
Gender	0.16 (0.04)	.06	0.17 (0.04)	<.001
Social norm	0.27 (0.02)	<.001	0.14 (0.02)	<.001
N	1,067		1,069	
R^2	0.14		0.05	

Note: *B* is standardized beta.

Table S3.3.2 Regression analyses – sample: Belgium

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.10 (0.02)	<.001	-0.16 (0.03)	<.001
Discount rate - ln(*k*)	0.03 (0.01)	.04	0.04 (0.01)	.03
Age	0.11 (0.002)	<.001	0.13 (0.002)	<.001
Gender	0.08 (0.02)	<.001	0.15 (0.03)	<.001
Social norm	0.18 (0.01)	<.001	0.10 (0.01)	<.001
N	3,558		3,561	
R^2	0.07		0.09	

Note: *B* is standardized beta.

Table S3.3.3 Regression analyses – sample: Portugal

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.08 (0.03)	.041	-0.10 (0.04)	<.001
Discount rate - ln(*k*)	-0.04 (0.01)	.14	0.03 (0.01)	.26
Age	0.06 (0.003)	.04	0.12 (0.003)	<.001
Gender	0.07 (0.03)	.02	0.12 (0.04)	<.001
Social norm	0.20 (0.02)	<.001	0.04 (0.02)	.16
N	1,235		1,231	
R^2	0.06		0.04	

Note: *B* is standardized beta.

Table S3.3.4 Regression analyses – sample: France

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.28 (0.10)	<.001	-0.10 (0.10)	.15
Discount rate - ln(*k*)	0.02 (0.03)	.81	0.002 (0.03)	.98
Age	0.06 (0.02)	.35	-0.17 (0.02)	.01
Gender	-0.01 (0.10)	.92	0.15 (0.10)	.03
Social norm	0.24 (0.04)	<.001	0.19 (0.04)	.01
N	204		203	
R^2	0.16		0.11	

Note: *B* is standardized beta.

Table S3.3.5 Regression analyses – sample: Sweden

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.07 (0.11)	.24	-0.15 (0.09)	.02
Discount rate - ln(*k*)	0.19 (0.03)	.003	-0.02 (0.02)	.75
Age	0.16 (0.01)	.01	-0.01 (0.01)	.86
Gender	0.02 (0.09)	.80	0.21 (0.08)	<.001
Social norm	0.11 (0.04)	.09	0.09 (0.03)	.16
N	243		244	
R^2	0.09		0.08	

Note: *B* is standardized beta.

Table S3.3.6 Regression analyses – sample: Italy

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.05 (0.09)	.49	-0.10 (0.14)	.18
Discount rate - ln(*k*)	-0.04 (0.02)	.59	0.02 (0.03)	.77
Age	0.001 (0.01)	.97	0.24 (0.02)	.001
Gender	0.16 (0.08)	.03	0.12 (0.11)	.11
Social norm	0.22 (0.04)	.003	0.13 (0.05)	.09
N	188		189	
R^2	0.07		0.08	

Note: *B* is standardized beta.

Table S3.3.7 Regression analyses – sample: Ireland

	Social Distancing		Hygiene	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.02 (0.13)	.87	-0.18 (0.12)	.08
Discount rate - ln(*k*)	0.21 (0.03)	.04	-0.05 (0.03)	.62
Age	0.20 (0.01)	.05	0.07 (0.01)	.50
Gender	0.15 (0.13)	.14	0.11 (0.12)	.27
Social norm	0.18 (0.06)	.07	0.05 (0.06)	.65
N	98		98	
R^2	0.13		0.06	

Note: *B* is standardized beta.

S3.4 - Gender

We also conducted subsample analyses for women and men (see Table S3.4.1). For both men and women, we found a negative relationship between impulsivity and social distancing compliance, as well as hygiene compliance ($p<.05$). In the male subsample, the relationship between the discount rate and social distancing was weakly positive but with a p-value of .20, while the relationship between the discount rate and hygiene was significant ($B=0.05$, $SE=0.01$, $p=.02$). For women, we found a stable link between the discount rate and social distancing ($B=0.04$, $SE=0.01$, $p<.01$), but the link between the discount rate and hygiene had a p-value of .12. Hence, while the results of the separate analyses for men and women were consistent with the overall pattern, the discount rate was a stronger predictor of social distancing (hygiene) compliance for women (men). It is thus unlikely that gender drives the observed discount rate-compliance relationship. Introducing an interaction term ($p>.05$) between discount rate and gender to the main models in Tables 3.2 and 3.3 did not increase the variance explained by these models.

Table S3.4.1 Regression analyses with compliance as dependent variable by gender

Sample	Men		Women		Men		Women	
Dependent variable	Social Distancing		Social Distancing		Hygiene		Hygiene	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
BIS-Brief Impulsivity	-0.11	<.001	-0.09	<.001	-0.11	<.001	-0.13	<.001
	(0.03)		(0.02)		(0.03)		(0.02)	
Discount rate - ln(*k*)	0.02	.20	0.04	<.01	0.04	.02	0.02	.12
	(0.01)		(0.01)		(0.01)		(0.02)	
Age	0.08	<.001	0.09	<.001	0.11	<.001	0.11	<.001
	(0.002)		(0.002)		(0.002)		(0.002)	
Social norm	0.18	<.001	0.19	<.001	0.11	<.001	0.09	<.001
	(0.01)		(0.01)		(0.01)		(0.01)	
N	2,527		4,066		2,528		4,067	
R^2	0.22		0.17		0.09		0.07	

Note: *B* is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

S3.5 - International versus national students

We can infer whether a student is a national or international student based on whether they indicated having lived in the country of their university for more than five years. The same regression analyses were conducted on the subsamples of national and international students separately (see Table S3.5.1). In both the subsample of national students and that of international students, the impulsivity-compliance relationship was robust. The coefficient of discount rate was positive but had a *p*-value above .05 for both types of compliance in both subsamples, again indicating the sensitivity of this result to sample size.

Table S3.5.1 Regression analyses with compliance as dependent variable by student group (international versus national)

Sample	National students		International students		National students		International students	
Dependent variable	Social Distancing		Social Distancing		Hygiene		Hygiene	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
BIS-Brief Impulsivity	-0.10	<.001	-0.11	.001	-0.12	<.001	-0.15	<.001
	(0.02)		(0.05)		(0.02)		(0.05)	
Discount rate - ln(*k*)	0.02	.09	0.04	.26	0.02	.15	0.03	.33
	(0.004)		(0.01)		(0.01)		(0.01)	
Age	0.08	<.001	0.15	<.001	0.11	<.001	0.09	.02
	(0.001)		(0.004)		(0.002)		(0.004)	
Gender	0.08	<.001	0.14	<.001	0.15	<.001	0.11	<.001
	(0.02)		(0.05)		(0.02)		(0.05)	
Social norm	0.18	<.001	0.15	<.001	0.08	<.001	0.13	<.001
	(0.01)		(0.02)		(0.01)		(0.02)	
N	5,722		870		5,724		870	
R^2	0.22		0.12		0.09		0.06	

Note: B is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

S3.6 - Age differences

Analyses were repeated with subsamples based on different age categories: ages 17-21, 21-26, 26-30 and over age 30 (See Table S3.6.1 and S3.6.2). In all four subsamples, the impulsivity coefficient remained negative for both types of compliance behaviours ($p<.05$). In all subsamples, the discount rate coefficient remained positive for both types of compliance behaviours, but with *p*-values above .05 for all the smaller age groups except for the 26-30-year-old group.

Table S3.6.1 Regression analyses with social distancing as dependent variable by age group

Sample	Age 17-21		Age 21-26		Age 26-30		Age > 30	
Dependent variable	Social Distancing		Social Distancing		Social Distancing		Social Distancing	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
BIS-Brief Impulsivity	-0.10	<.001	-0.09	<.001	-0.14	.01	-0.10	.02
	(0.02)		(0.03)		(0.07)		(0.06)	
Discount rate - ln(*k*)	0.02	.12	0.03	.08	0.10	.04	0.04	.33
	(0.01)		(0.01)		(0.02)		(0.01)	
Gender	0.10	<.001	0.07	<.001	0.04	.38	0.13	.01
	(0.02)		(0.03)		(0.06)		(0.05)	
Social norm	0.19	<.001	0.19	<.001	0.11	.03	0.25	<.001
	(0.01)		(0.01)		(0.03)		(0.02)	
N	3,548		2,258		347		440	
R^2	0.18		0.18		0.21		0.19	

Note: *B* is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as reference group.

Table S3.6.2 Regression analyses with hygiene as dependent variable by age group

Sample	Age 17-21		Age 21-26		Age 26-30		Age > 30	
Dependent variable	Hygiene		Hygiene		Hygiene		Hygiene	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
BIS-Brief Impulsivity	-0.11	<.001	-0.13	<.001	-0.15	.01	-0.19	<.001
	(0.03)		(0.03)		(0.08)		(0.07)	
Discount rate - ln(*k*)	0.02	.22	0.04	.07	0.15	.01	0.01	.77
	(0.01)		(0.01)		(0.02)		(0.01)	
Gender	0.15	<.001	0.14	<.001	0.11	.04	0.23	<.001
	(0.03)		(0.03)		(0.07)		(0.06)	
Social norm	0.09	<.001	0.09	<.001	0.16	.003	0.16	<.001
	(0.01)		(0.01)		(0.03)		(0.03)	
N	3,549		2,259		347		440	
R^2	0.09		0.07		0.08		0.12	

Note: *B* is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

S3.7 - Analyses follow-up data

Students from three countries—the Netherlands, Belgium, and Portugal—were contacted again in December 2020 (T2) for a follow-up survey. We therefore also have data on compliance with social distancing and hygiene measures eight months later for

1,127 students. The exact same questions were used to measure compliance in the second survey.

We used this longitudinal subsample to test whether the relationships identified remained stable over time. The same analyses as presented in Tables 3.2 and 3.3 were repeated twice. First, the exact same model with T1 compliance was estimated but using only the follow-up subsample. Second, a similar set of models was estimated but with social distancing and hygiene compliance as measured at T2 as the dependent variables. The impulsivity and discount rate measures from the first survey were used. The results are presented in Table S3.7.1. The two regressions with T1 compliance for this subsample confirmed the negative impulsivity links, while the discount rate relationships remained positive but with *p*-values above .05. When estimating the models with compliance as measured at T2 as the dependent variables, the negative relationships between impulsivity and both social distancing and hygiene showed to be stable and of a similar size over time. The positive but weak relationships between the discount rate and social distancing and hygiene also remained stable over time.

Table S3.7.1 Regression analyses with compliance at T1 (April/May 2020) and T2 (December 2020) as dependent variable - subsample follow-up

	Social Distancing T1		Hygiene T1		Social Distancing T2		Hygiene T2	
	B (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*	*B* (SE)	*p*
BIS-Brief Impulsivity	-0.12 (0.04)	<.001	-0.15 (0.05)	<.001	-0.13 (0.05)	<.001	-0.14 (0.05)	<.001
Discount rate - ln(*k*)	0.02 (0.01)	.53	0.05 (0.01)	.08	0.03 (0.01)	.24	0.05 (0.01)	.06
Age	0.06 (0.003)	.03	0.16 (0.004)	<.001	0.12 (0.004)	<.001	0.10 (0.003)	<.001
Gender	0.08 (0.04)	<.001	0.15 (0.04)	<.001	0.02 (0.05)	.53	0.16 (0.04)	<.001
Social norm	0.13 (0.02)	<.001	0.06 (0.02)	.05	0.09 (0.02)	<.001	0.07 (0.02)	.01
N	1,124		1,127		1,128		1,127	
R^2	0.15		0.11		0.08		0.12	

Note: *B* is standardized beta. All models include country dummies (PRT, BE), coefficients are not presented, Dutch students serve as a reference group.

S3.8 - Transforming the dependent variables

Since compliance was scored on a five-point scale with more students indicating high compliance, the compliance measures were negatively skewed with a ceiling effect. As a further robustness check, we conducted the same analyses using transformed dependent variables. Social distancing and hygiene were both exponentially and inversely transformed to decrease skewness. Using these variables as the dependent variables with

the same model specifications as in Tables 3.2 and 3.3 did not change any of the main results (see Table S3.8.1)[14].

Table S3.8.1 Regression analyses with transformed dependent variables

	Social Dist. Exponentially transformed		Social Dist. Inverse transformed		Hygiene Exponentially transformed		Hygiene Inverse transformed	
	B (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*
BIS-Brief Impulsiv.	-0.10 (1.08)	<.001	-0.10 (0.01)	<.001	-0.12 (1.03)	<.001	-0.12 (0.005)	<.001
Discount rate - ln(*k*)	0.03 (0.27)	<.01	0.03 (0.001)	<.01	0.03 (0.25)	.03	0.03 (0.001)	.03
Age	0.09 (0.09)	<.001	0.09 (0.0004)	<.001	0.11 (0.08)	<.001	0.11 (0.0004)	<.001
Gender	0.08 (1.02)	<.001	0.09 (0.005)	<.001	0.13 (0.96)	<.001	0.12 (0.005)	<.001
Social norm	0.18 (0.45)	<.001	0.18 (0.002)	<.001	0.10 (0.43)	<.001	0.10 (0.002)	<.001
N	6,593		6,593		6,595		6,595	
Adjusted R^2	0.17		0.17		0.08		0.08	

Note: *B* is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

S3.9 - Alternative dependent variables

In our main analyses, we used composite measures of social distancing and hygiene compliance. We also examined alternative but related dependent variables: the violation of measures and general compliance (Table S3.9.1). To assess the violation of measures, students were asked, '*Have you ever violated the measures related to the coronavirus taken by the [name country] government?*' on a scale from Never (1) to Often (5). Using the same control variables, we found that impulsivity is positively related to the violation of measures (p<.05), in line with the reverse coding of violation compared to compliance. However, the discount rate is not related to the violation of measures (p>.05). To assess general compliance, students were asked to indicate '*To what extent have you followed the measures advised by the [country name] government to prevent the spread of the coronavirus?*' on a scale ranging from 'I have not taken any measures' (1) to 'I have done everything that was possible' (7). We confirmed both results from the main analyses: impulsivity was negatively related to general compliance (p<.05), while the discount rate was significantly and positively related to general compliance (p<.05).

[14] Additionally, Tobit regression analyses provided estimates of the relationships between compliance and both impulsivity and the discount rate that were similar to those from the main analyses.

Table S3.9.1 Regression analyses with alternative but comparable dependent variables

Dependent Variable	Followed Measures		Violation Measures	
	B (SE)	*p*	*B (SE)*	*p*
BIS-Brief Impulsivity	-0.11 (0.02)	<.001	0.10 (0.02)	<.001
Discount rate - ln(*k*)	0.03 (0.01)	.01	-0.02 (0.01)	.11
Age	0.01 (0.002)	.22	0.01 (0.002)	.51
Gender	0.12 (0.02)	<.001	-0.08 (0.02)	<.001
Social norm	0.24 (0.01)	<.001	-0.19 (0.001)	<.001
N	6,613		6,613	
R^2	0.14		0.13	

Note: *B* is standardized beta. All models include country dummies, coefficients are not presented, Dutch students serve as a reference group.

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4

Chapter 4

Face Mask use During the COVID-19 Pandemic: How Risk Perception, Experience with COVID-19, and Attitude Towards Government Interact with Country-Wide Policy Stringency

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Abstract

Background: During the 2020 COVID-19 pandemic, governments imposed numerous regulations to protect public health, particularly the (mandatory) use of face masks. However, the appropriateness and effectiveness of face mask regulations have been widely discussed, as is apparent from the divergent measures taken across and within countries over time, including mandating, recommending, and discouraging their use. In this study, we analyse how country-level policy stringency and individual-level predictors associate with face mask use during the early stages of the global COVID-19 pandemic.

Method: First, we study how (self and other-related) risk perception, (direct and indirect) experience with COVID-19, attitude towards government and policy stringency shape face mask use. Second, we study whether there is an interaction between policy stringency and the individual-level variables. We conduct multilevel analyses exploiting variation in face mask regulations across countries and using data from approximately 7,000 students collected in the beginning of the pandemic (weeks 17 through 19 2020).

Results: We show that policy stringency is strongly positively associated with face mask use. We find a positive association between self-related risk perception and mask use, but no relationship of mask use with experience with COVID-19 and attitudes towards government. However, in the interaction analyses, we find that government trust and perceived clarity of communication moderate the link between stringency and mask use, with positive government perceptions relating to higher use in countries with regulations and to lower use in countries without regulations.

Conclusions: We highlight that those countries that aim for widespread use of face masks may benefit from setting strict measures, stressing self-related risks of COVID-19, and using clear communication.

4.1 Introduction

Mandated face mask use has been one of the most contentious topics during the 2020 COVID-19 pandemic. During the early phase of the pandemic, positions on general mandated face mask use were highly divergent across countries and subject to change within countries (Feng et al., 2020; Sebhatu et al., 2020). Several countries discouraged the use of face masks due to a lack of evidence of its effectiveness, to preserve limited supplies for health care and due to concerns about risk compensation in the form of lowering compliance with other measures (Feng et al., 2020; Lazzarino et al., 2020; Yan, Bayham, et al., 2021). In response to changes in advice from the WHO and with more studies proving the effectiveness of masks (Chu et al., 2020; Eikenberry et al., 2020; Lyu & Wehby, 2020; Mano, 2021; Wei et al., 2021), face mask regulations became more uniform and accepted during later phases of the COVID-19 pandemic. With reoccurring infection outbreaks due to low vaccination rates, but also despite high vaccination rates, for the immediate future face masks may remain to be a cheap, non-invasive, and prudent

intervention. In this study, we focus on the initial phase of the pandemic when regulations were divergent. We study the importance of country-level policy stringency, individual-level factors, and their interaction for the use of face masks. Specifically, we study individual attitude towards government, risk perception, and experience with COVID-19. Studying whether these individual-level variables relate differently to face mask use across different stringency contexts is important, especially now that in later phases of the pandemic countries are constantly changing the stringency of measures reacting to peaks and troughs in infection numbers.

Studies have shown that differences in policy stringency across countries and even regions strongly affected the uptake of measures taken to lower the spread of COVID-19, specifically the use of face masks (Bargain & Aminjonov, 2020; Betsch et al., 2020; MacIntyre et al., 2021). Policy-induced changes result both from a general tendency to obey to authority (French & Raven, 1959; Milgram, 1974) and from the signal that the enforced behaviour is deemed appropriate, reinforcing, or refining a social norm and creating social meaning (Sunstein, 1996, 2020). Due to regulations, wearing a face mask may have a different social meaning in different countries: from being paranoid or being a person at risk in countries without regulations to being a 'good citizen' or abiding by a social contract in countries with regulations. In a large German study, mask-wearing increased rapidly when made mandatory and those wearing masks saw each other as more positive and prosocial, while those not wearing masks were socially "punished", indicating that regulations imposed a social contract (Betsch et al., 2020). Moreover, seeing others wearing a mask, a so-called descriptive norm, was found to be a strong determinant of mask use (Barile et al., 2021). However, even without policies in place, the outbreak of COVID-19 resulted in voluntary engagement in protective behaviours, like staying at home (Yan, Malik, et al., 2021) and mask-wearing (Haischer et al., 2020; Zimmermann et al., 2021).

While government policy is effective in changing behaviour, individuals' perception of government is equally important, as individuals with lower trust are found to have a lower willingness to defer to decisions made by government (Bratspies, 2009; Marien & Hooghe, 2011). In the context of pandemics, trust in government has been related to social distancing compliance (Nivette et al., 2021), quarantine adherence (Desclaux et al., 2017), acceptance of vaccination (van der Weerd et al., 2011) and face mask use (Bargain & Aminjonov, 2020). Of additional importance is the clarity of communication of authorities, as limited health literacy is associated with poorer health and medication nonadherence (Ngoh, 2009; White et al., 2015). It is crucial that communication be clear and unambiguous. A UK study showed that guidance on social distancing and isolation during the COVID-19 pandemic was unclear, and 'mixed messages' were being spread (S. N. Williams et al., 2020). Research has also noted the prevalence of biased, erroneous, and distortive information regarding COVID-19 and various protective behaviours (Gallotti et al., 2020; Zarocostas, 2020). Positive

perceptions about clarity and consistency of information are related to increased compliance with recommended behaviours (Rubin et al., 2009). Hence, both trust in government and perceived clarity of communication are expected to strengthen compliance with face mask regulations.

Additionally, multiple studies have underlined the importance of risk perception for compliance with COVID-19 measures (Bechard et al., 2021; Wise et al., 2020). The widely used Health Belief Model depicts health behaviours as driven by individuals' risk perception of susceptibility and severity of a disease (Becker, 1974). Not only perceived risk for oneself, but also social risk perception – the perceived risk for those in one's environment – plays a role in compliance (Siegrist & Bearth, 2021). Perceptions of the social risk of COVID-19 have been related to engaging in protective measures (Franzen & Wöhner, 2021; Pfattheicher et al., 2020). Relatedly, studies show that antisocial personality traits are linked to lower compliance with regulations (Miguel et al., 2021; Nowak et al., 2020; Wismans, Letina, et al., 2021). In the decision to wear a face mask, the perceived risk of COVID-19 for others could be more important for younger people, who may believe themselves to be less at risk of negative health consequences due to a COVID-19 infection. Asri et al. (2021) showed that older people were motivated by self-regarding risk preferences to wear a mask, while younger people were also motivated by other-regarding concerns. In general, both higher self-related and other-related risk perception is expected to have a positive association with mask usage.

Finally, experience is also known to be important for shaping attitudes, beliefs and consequently behaviour (Broomell et al., 2015; Leventhal et al., 1992; Millar & Millar, 1996; Regan & Fazio, 1977), with a distinction being made between direct (personal) experience and indirect experience (of others) (Regan & Fazio, 1977). Experience with a disease can both stimulate and discourage preventive behaviours. Shahrabani and Benzion (2012) showed that vaccination was perceived less beneficial after influenza-infection. Though, knowing others that suffered from a disease has been positively associated with preventive health behaviour (Dempsey et al., 2006; Jernigan et al., 2001; Macintyre et al., 2001). Related to face mask use during the pandemic, Cherry et al. (2021) showed that testing negative for COVID-19 is associated with increased face mask use support, while testing positive has no effect and in some cases even reduced face mask use support. The latter could be explained by the fact that people may believe that they are immune or less at risk for COVID-19 after infection. Moreover, knowing someone that was infected with COVID-19 is positively related to supporting face mask use and engaging in preventive measures (Cai et al., 2021; Cherry et al., 2021; MacIntyre et al., 2021), possibly because this increases the saliency of COVID-19 and therefore the perceived need for mask use. Consequently, we expect that direct experience with COVID-19 is associated with lower face mask use, while indirect experience with COVID-19 is associated with higher face mask use.

Studies have shown that relationships between individual-level factors and preventive behaviour may be dependent on the context, such as policy stringency. In the case of mobility reduction, it was shown that the effect of policy stringency was more pronounced in high-trust regions relative to low-trust regions (Bargain & Aminjonov, 2020). Also, Pak et al. (2021) found that individual government trust and perception of government truthfulness increased the predicted compliance as policy stringency increases. In countries without any regulations on mask use, government trust and perceived clarity of communication could even negatively associate with face mask usage, as governments do not actively recommend the behaviour. In line with previous studies, we therefore expect that individual attitude towards government positively moderates the association between policy stringency and face mask use.

There are no studies to date looking at the interaction between risk perception or experience and policy stringency. As policy becomes more stringent, it is possible that behaviour is more uniformly changed, and social norms become so strong thereby limiting the association of individual differences with face mask use. In situations without regulations, there is less structure and more ambiguity on what behaviour to perform, consequently individual differences may play a larger role in behaviour. This reasoning is in line with the 'strong situation hypothesis', stating that in strong situations – such as nationwide lockdowns – there is a limited range of appropriate behaviour, thereby constraining the range of behavioural variability. While the strong situation hypothesis focuses on the reduced influence of personality traits and has been debated (Cooper & Withey, 2009; Judge & Zapata, 2015; Meyer et al., 2010; Snyder & Ickes, 1985), it is likely that in a context of more stringent regulations attitudes, like risk perception and experience, are less strongly associated with behaviour. During the pandemic, Götz et al. (2021) found partial support for the interaction between personality and stringency, with certain traits having weaker effects on sheltering-in-place when policies became stricter. Therefore, we expect that the association between risk perception and experience on the one hand and face mask use on the other hand may differ across different policy stringency contexts.

In this study we will analyse how macrolevel policies and individual-level factors independently and jointly associate with face mask use during the early stages of the global COVID-19 pandemic when regulations on face mask use were divergent. We use data from a large sample of approximately 7,000 university students from ten countries (Belgium, Colombia, France, India, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden), collected between 23rd April-12th of May 2020, as part of the Erasmus University Rotterdam International COVID-19 Students Survey (Wismans, Letina, et al., 2020, 2021; Wismans, Thurik, et al., 2021). First, we study how (self-related and other-related) risk perception, (direct and indirect) experience with COVID-19, attitude towards government and policy stringency independently shape face mask use. Second, we study whether the association between individual-level factors and face mask use differs across countries

with different policy stringency by conducting moderation analyses. The cross-country dataset is analysed using multilevel regression analyses. The stringency of face mask regulations is captured by using objective data on regulations on face masks in each country (Hale et al., 2021).

Compared to most of the literature on face mask use, our paper takes a holistic approach by studying how factors that have been previously found to be important for face mask use work out in the context of different regulations (e.g., countries with different face mask policies). Moreover, we are the first to study whether policy stringency moderates the association of perceived clarity of government communication, risk perception and experience with COVID-19 with face mask usage.

4.2 Materials and methods

Sample

We use data from the first wave of the Erasmus University Rotterdam International COVID-19 Student Survey (Wismans, Letina, et al., 2020, 2021; Wismans, Thurik, et al., 2021). The dataset consists of survey data from a large sample of university students from multiple countries. The data were collected during 13 consecutive days in the initial phase of the 2020 COVID-19 pandemic (weeks 17-19, 2020). The survey received approval from the Internal Review Board of the Erasmus University Rotterdam before initiation (ESE IRB-NE Application 2020-05).

The survey was shared with students in Belgium, Colombia, France, India, Ireland, Italy, the Netherlands, Portugal, Spain, and Sweden, primarily using university e-mail addresses and online university platforms. Previous studies have already used this dataset (Wismans, Letina, et al., 2020, 2021; Wismans, Thurik, et al., 2021). The survey was completed online using survey software from Qualtrics. Participation was voluntary, and an informed consent form was provided upon the start of the survey. The survey could be completed in four languages: English, Dutch, French, and Spanish. All translations were made by two native speakers.

In total, the sample consists of 7,403 students from ten countries. After estimating Little's MCAR (X^2=45.76, p=.13), we conclude that data are missing completely at random and use listwise deletion. Due to excluding missing data and restricting our sample to students between 17 and 35 years old, the final dataset used for the analyses consists of 6,905 observations (61% female, mean age = 21.83, *SD* age = 3.23). For more information on both the total sample and country samples, see Table S4.1 in the supplementary material.

Measures

Face mask use

To assess face mask use, we used the following question to construct our dependent variable: "In the past two months, which of the following measures did you follow and to which extent? Please indicate to what extent you disagree or agree with these statements." Several statements related to COVID-19 regulations followed, of which one was 'I used a facemask'. Answers were given on a scale of 1 (Strongly disagree) to 5 (Strongly agree).

Risk perception COVID-19

Self-related risk perception COVID-19: Based on the Health Belief Model, we assessed perceived susceptibility and severity (Becker, 1974) by asking: 'What do you think the likelihood is that in the next two months:' (1) 'You get infected with the coronavirus?' and (2) 'You must be hospitalized if you are infected with the coronavirus?'. We took an average of the two items. Answers could be given on a scale ranging from 1 (No chance at all) to 7 (Absolutely certain*).*

Other-related risk perception COVID-19: The same two questions but then related to the risk of COVID-19 for family and friends were asked: 'What do you think the likelihood is that in the next two months: (1) Your family or friends get infected with the coronavirus?' and '(2) Your family or friends must be hospitalized if they are infected with the coronavirus?'. We took an average of the two items. Answers could be given on a scale ranging from 1 (No chance at all) to 7 (Absolutely certain).

Experience with COVID-19

Direct experience COVID-19: We asked whether participants had been infected with COVID-19, giving the following answer options: 'Yes, I tested positive', 'I think I am/have been infected, but I have not been tested', and 'No, I have not been infected or have not been aware of it'. The first two answer options were recoded as '1' and the last answer option as '0' to create a dummy variable indicating direct experience with COVID-19. We chose to combine the two categories as testing capacity was limited and not openly accessible at the time of data collection in most countries.

Indirect experience COVID-19: We asked whether friends or family had been infected with the coronavirus, giving the following answer options: 'Yes, one or more of them tested positive', 'Yes, one or more of them think they have been infected but have not been tested', and 'No, they have not been infected or have not been aware of it'. The

first two answer options were recoded as '1', and the last answer option as '0', to create a dummy variable indicating indirect experience with COVID-19[15].

Attitude towards government

Government trust: We asked about general trust in the government of the country: 'In general, how much trust do you personally have in the [Country] Government on a scale of 1 (no trust at all) to 10 (full trust)?'.

Perceived clarity communication government: We asked: 'To what extent do you think the communication from the [Country] Government regarding the measures is clear?'. Answers could be given on a scale from 1 (extremely unclear) to 7 (extremely clear).

Policy stringency face mask regulations

Stringency Face Mask Regulations: To assess face mask policy stringency, we used data from the Oxford COVID-19 Government Response Tracker (OxCGRT), which consists of systematically collected data on a broad range of COVID-19-related government responses across countries on a day-to-day basis (Hale et al., 2021). To assess face mask regulations, we used index H6, which recorded policies on the use of facial coverings outside the home on a daily basis for each country using an ordinal scale from 0 to 4. Policies were scored as follows: 0: no policy; 1: Recommended; 2: Required in some specified shared/public spaces outside the home with other people present, or some situations when social distancing is not possible; 3: Required in all shared/public spaces outside the home with other people present or all situations when social distancing not possible and 4: Required outside the home at all times regardless of location or presence of other people. For each country, we took the index average over the period the survey was online and the subsequent 14 days, as the measures are often communicated before they were initiated[16]. The stringency score of each country can be found in Figure 4.1 and Table S4.2 (supplementary material). For the interaction analyses, in which we distinguish between the effects of having no regulation to some regulations and from some regulations to most strict regulations, we categorized the stringency measure. Countries were divided into three groups: low stringency (score '0', Ireland, Netherlands, Sweden), indicating that there was no policy regarding face masks; medium stringency (score 1-3, Belgium, France, Portugal, Spain), indicating that there were intermediate face mask regulations in-between the two "extreme" settings; and high stringency (score '4', Colombia, India, Italy), indicating that a strict policy meaning face masks are required outside the home at all times. This grouping can be found in Figure 4.1.

[15] Additional analyses disaggregating the indirect experience with COVID-19 variable into confirmed COVID-19 and "I think I had it" leads to the same results and conclusions. For the direct experience with COVID-19 variable, the number of observations in the confirmed COVID-19 category was too small (n=17) to conduct reliable sensitivity analyses.
[16] We conducted robustness analyses using alternative calculations for the face mask policy stringency variable (taking the index average of the same period but then a) including the 14 days before the survey period; and b) including the two months before the survey period). These analyses led to similar results and conclusions. The categorization of the countries using the alternative stringency variables remains identical.

Control variables

We controlled for gender (1: female; 0: male) and age (in years), as both have been related to compliance with COVID-19 protective measures (Galasso et al., 2020; Wismans, Letina, et al., 2020). Moreover, as we are interested in concepts that are strongly linked to the country, such as government trust and country regulations, we controlled for being an international versus domestic student. First, it is likely that government trust and the perceived clarity of government communication differ between international and domestic students because international students may have a different frame of reference, experience language barriers, and may be still very new to the country. Second, international students may still be strongly tied to their home country and therefore potentially exposed to different severities of COVID-19 and different COVID-19-related regulations that apply in the home country. Therefore, we asked students whether they had lived in the country where they attend university for more than five years. We infer that those who answered 'yes' are domestic students (value 0), while those who answered 'no' are international students (value 1).

Methodology

We treat our dependent variable as a continuous variable – facilitating the interpretation of the coefficients – and perform linear multilevel regressions due to the hierarchical structure of the data (students nested within countries). In addition, multilevel regressions enable an investigation of explained variations at both the individual and country level. The intraclass correlation is .32, which indicates that 32% of the variation in the dependent variable resides at the country level, which is high (Hox et al., 2017). Because of the relatively low number of countries, we use restricted maximum likelihood with Kenward-Roger standard errors (Elff et al., 2021; McNeish, 2017). Our final sample consists of 6,905 observations in ten countries. Analyses were performed using Stata 16.1.

As a robustness check we replicated Figure 4.2 (see Results section) with the marginal effects that are retrieved after performing a multilevel ordered logit regression, which takes the ordered nature of the five answer categories into account (but the Kenward-Roger standard errors cannot be calculated). Marginal effects indicate the changes in the probability of answering "strongly agree" (the highest category) for our dependent variable as the result of one-unit increases in the independent and control variables. The marginal effects are shown in Figure S4.1, in the supplementary material, and as a percentage of the relative frequency of "strongly agree" in the sample (i.e., 0.24).

Descriptive Statistics

Table 4.1 provides the descriptive statistics of the variables. The regression analyses contain standardized variables only (the 1/0 variables are not standardized).

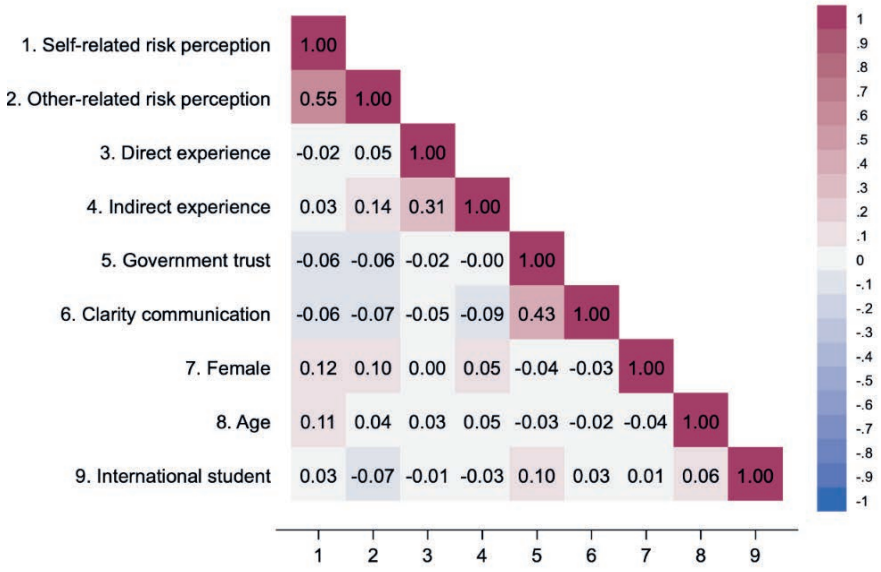
Table 4.2 presents the correlation matrix between the individual-level variables. Correlations are generally low (below ±.10), apart from a few exceptions. We also calculated the variance inflation factors, and they did not exceed 1.5 for any variable (not reported).

Table 4.1 Means and standard deviations individual-level variables

	M	*SD*	Min.	Max.
Face mask use (*1: Strongly Disagree – 5: Strongly agree*)	3.00	1.57	1	5
Self-related risk perception COVID-19 (*1: No chance at all – 7: Absolute certain*)	3.36	1.00	1	7
Other-related risk perception COVID-19 (*1: No chance at all – 7: Absolute certain*)	4.31	1.02	1	7
Direct experience COVID-19 (*1:Yes; 0: No*)	0.10	0.30	0	1
Indirect experience COVID-19 (*1: Yes; 0: No*)	0.29	0.45	0	1
Government trust (*1: Low - 10: High*)	5.96	2.22	1	10
Perceived clarity govt. communication (*1: Extremely unclear – 7: Extremely clear*)	4.54	1.55	1	7
Stringency face mask regulations (*0: No policy – 4: Required everywhere at all times*)	1.79	1.66	0	4
Gender (*1: Female; 0: Male*)	0.61	0.49	0	1
Age (*in years*)	21.83	3.23	17	35
International student (*1: Yes; 0: No*)	0.12	0.33	0	1

Note: SD=standard deviation. Table based on 6,905 observations. Statistics based on the unstandardized variables. Mean and *SD* of the stringency variable at the country level based on ten countries.

Table 4.2 Correlation matrix (individual-level variables)



Note: Numbers are based on 6,905 observations. Pearson correlations are displayed.

4.3 Results

Face mask use and regulations across countries

Figure 4.1 presents the means of our face mask-wearing measure (the dependent variable) across countries. A higher value indicates higher agreement and higher usage of face masks. Mean values are represented by the blue vertical bars in Figure 4.1 and presented above the bars. The stringency of face mask regulations for each country based on the OxCGRT is indicated by the circles. By categorizing the countries, we can more easily draw conclusions on the effects of different types of regulations. The categorization is indicated by the different colours of the circles in Figure 4.1 (green: low – no regulations/recommendations, orange: medium – intermediate regulations, red: high – strict regulations). Exact values and standard deviations are presented in Table S4.2 in supplementary material.

We note large differences in face mask usage across countries in our data, with average agreement per country ranging from 1.43 to 4.37. Colombian and Indian students indicated the highest agreement with face mask use, whereas agreement was lowest among Dutch and Swedish students. French students showed the highest variation in agreement with using face masks. Finally, Figure 4.1 shows that countries without regulations (the Netherlands, Ireland, and Sweden) had the lowest average agreement with face mask use.

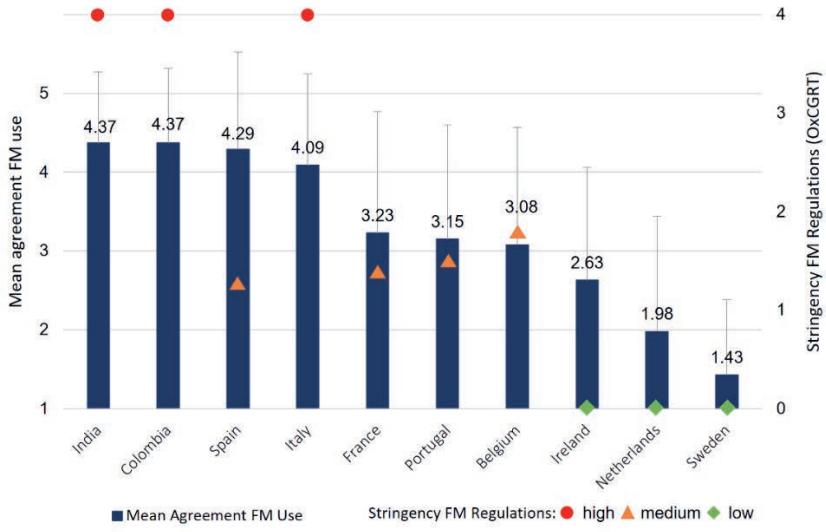


Figure 4.1 Mean agreement face mask (FM) use ranked from high (5) to low (1) and stringency face mask regulations (0-4; including categorization) across countries

Individual-level variables and face mask use

We performed linear multilevel regressions with face mask use as the dependent variable (Hox et al., 2017).

Model 1, presented in Table 4.3, only includes the country-level random intercept. Model 2 of Table 4.3 includes all control variables and independent variables. Figure 4.2 graphically summarizes the results of Model 2.

For Model 2, we reported the change in the unexplained variance at the individual and country levels relative to Model 1 (pseudo R^2). The individual-level variables explained approximately 5% of the variation at the individual level; the country variable explained 63% of the variation at the country level. We also reported the deviance statistic for each model, where a lower value indicates better model fit. Regarding the control variables, we noted that women were significantly more likely to report wearing a face mask than men and that international students (i.e., students studying not in their country of origin) were significantly more likely to report wearing a face mask than domestic students.

Risk perception COVID-19. We noted that self-related risk perception of COVID-19 was positively and significantly associated with face mask use ($p<.001$). A standard deviation increase in this standardized measure is expected to improve agreement with face mask use by 0.14 points. Other-related risk perception of COVID-19 (perceived risk of COVID-19 for family and friends) is not significantly related to face mask use ($p=.15$). The associated coefficient is approximately four times smaller than the coefficient of self-related risk perception (a Wald test for the equality of coefficients results in $p=.003$).

Experience with COVID-19. We do not find a significant association between direct ($p=.27$) or indirect experience ($p=.80$) with COVID-19 and agreement to use a face mask.

Attitude towards government. The individual-level governmental variables did not significantly explain face mask use ($p=.17$ for both variables).

Policy stringency. Including the stringency variable at the country level as a continuous variable (Model 2, Table 4.3) showed a strong positive association between stringency of face mask regulations and agreement with face mask use. A one-standard-deviation increase in this standardized measure is expected to increase agreement with face mask use by 0.90 points. Model 3, Table 4.3 includes the categorized stringency measure (low: no regulations, medium: intermediate regulations, high: strict regulations), showing that both higher and medium stringency of regulations compared to the reference category (low stringency) was significantly positively associated with agreement with face mask use (low; $p=.005$ for medium, and $p<.001$ for high). A Wald test on the difference between the coefficients of the medium and high stringency dummy variables resulted in $p=.019$ (not reported in Table 4.3). Hence, students were not only more likely to agree with face mask use in countries with some measures implemented (relative to none) but were also more likely to wear face masks in countries with strict regimes than

in countries with some intermediate regime. The effect sizes of the regimes in terms of the implied point differences are substantial, that is, they reflect increases of 49% (intermediate regulations) and 78% (strict regulations) relative to the mean of the dependent variable (which is 3.00).

Table 4.3 Linear multi-level regressions with face mask use as the dependent variable

	Model 1			Model 2			Model 3		
	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value
Intercept	**3.26**	**0.31**	**<.001**	**2.98**	**0.19**	**<.001**	**1.68**	**0.28**	**<.001**
Risk perception COVID-19 (individual level)									
Self-related				**0.14**	**0.02**	**<.001**	**0.14**	**0.02**	**<.001**
Other-related				0.03	0.02	.15	0.03	0.02	.15
Experience COVID-19 (individual level)									
Direct experience				-0.06	0.06	.27	-0.06	0.06	.27
Indirect experience				0.01	0.04	.80	0.01	0.04	.80
Government attitude (individual level)									
Government trust				-0.03	0.02	.17	-0.03	0.02	.17
Perceived clarity communication				-0.03	0.02	.17	-0.03	0.03	.18
Policy stringency (country level)									
Stringency facemask regulations				**0.90**	**0.20**	**.002**			
Stringency: medium (vs. low)							**1.48**	**0.37**	**.005**
Stringency: high (vs. low)							**2.35**	**0.40**	**<.001**
Controls (individual level)									
Female				**0.34**	**0.04**	**<.001**	**0.34**	**0.04**	**<.001**
Age				0.01	0.02	.55	0.01	0.01	.54
International student				**0.66**	**0.05**	**<.001**	**0.66**	**0.05**	**<.001**
Variance individual level	2.02	0.03		1.92	0.03		1.92	0.03	
Variance country level	0.95	0.43		0.35	0.18		0.23	0.13	
Pseudo R^2 individual level				0.05			0.05		
Pseudo R^2 country level				0.63			0.76		
Deviance	24496			24166			24160		
AIC / BIC	24502	24523		24192	24281		24188	24284	
Number of individuals	6,905			6,905			6,905		
Number of countries	10			10			10		

Note: SE= Kenward-Roger standard error. Restricted maximum likelihood is used. Estimates in bold represent *p*-values<.05. Each model includes a country-level random intercept.

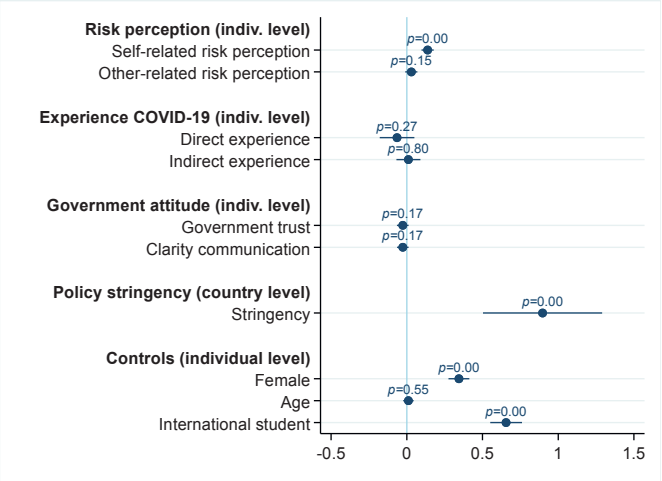


Figure 4.2 Estimation results of Model 2, Table 4.3

Note: Values of estimated coefficients are shown, together with their 95% confidence intervals.

Differences across face mask policy stringency levels

We next focused on how the impact of the individual-level variables differed across countries with different stringency of regulations based on the policy stringency variable. We consecutively added interaction terms between each individual-level variable and the categorical country-level policy stringency variable. Next to our variables of interest, we also added interaction terms between the control variables and the policy stringency variable. A random slope for the specific individual-level variable was added, together with a covariance term between the random intercept and random slope (Snijders & Bosker, 2011).

For three variables, we found significant coefficients of the interaction terms: government trust, perceived clarity of government communication, and the international student variable. For the other individual-level variables no statistically significant interaction coefficients were found. Table 4.4 contains these three models and shows the statistically significant interaction coefficients: Model 1 includes interaction terms between government trust and stringency, Model 2 includes interaction terms between perceived clarity of communication and stringency, and Model 3 includes interaction terms between the international student variable and stringency. Supplementary Table S4.3 shows the regression results for the variables not included in Table 4.4 and Figure 4.3. Figure S4.3 in the supplementary material displays the interaction plots based on Supplementary Table S4.3.

For ease of interpretation, Figure 4.3 shows the interaction plots based on Models 1, 2, and 3 of Table 4.4. Figures 4.3a (government trust) and 4.3b (perceived clarity of

communication) show that higher values for government trust and perceived clarity communication are associated with higher agreement levels to wear face masks in relatively strict countries regarding face mask use. As expected, trust in government and perceived clarity of governmental communication significantly increased face mask use in the most stringent countries (Wald tests: p=.014 for trust and p<.001 for communication) and significantly decreased face mask use in the least stringent countries (p<.001 for trust (Model 1, Table 4.4) and p=.01 for communication (Model 2, Table 4.4)). Furthermore, Figure 4.3c shows that international students were significantly more likely to wear face masks than domestic students in countries without face mask recommendations or requirements. Specifically, this relationship was not significant in countries with medium (p=.112) and high stringency (p=.455). T-tests revealed that international students were more likely to trust the national government of the country where they study – M(internationals)=6.59; M(domestic)=5.88; p<.001 – and were more positive about the government's communication: M(internationals)=4.66; M(domestic)=4.52; p=.02. Because of these differences between international and domestic students we replicated our main results for the sample excluding international students (6,065 observations). See Figure S4.2 in the supplementary material.

Table S4.4 (supplementary material) provides a robustness test of the interaction effects by performing an OLS regression with country dummy variables included (and with cluster-robust standard errors). The results for the interaction terms were qualitatively similar to those in Table 4.4; the same holds for the other individual-level variables.

Table 4.4 Linear multi-level regressions with face mask use as the dependent variable (including interactions)

	Model 1 Interactions with Government trust			Model 2 Interactions with Perceived clarity communication			Model 3 Interactions with International student		
	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value
Intercept	**1.83**	**0.29**	**<.001**	**1.77**	**0.29**	**<.001**	**1.43**	**0.28**	**.001**
Risk perception COVID-19 (individual level)									
Self-related	**0.14**	**0.02**	**<.001**	**0.14**	**0.02**	**<.001**	**0.12**	**0.02**	**<.001**
Other-related	0.03	0.02	.16	0.03	0.02	.14	0.03	0.02	.19
Experience COVID-19 (individual level)									
Direct experience	-0.08	0.06	.20	-0.07	0.06	.24	-0.02	0.06	.75
Indirect experience	0.02	0.04	.65	0.01	0.04	.76	0.03	0.04	.50
Government attitude (individual level)									
Government trust	**-0.31**	**0.05**	**<.001**	-0.03	0.02	.18	0.005	0.02	.79
Perceived clarity communication	-0.02	0.02	.23	**-0.22**	**0.06**	**.01**	-0.01	0.02	.77
Policy stringency (country level)									
Stringency: medium (vs. low)	**1.33**	**0.38**	**.01**	**1.37**	**0.38**	**.01**	**1.81**	**0.36**	**.002**
Stringency: high (vs. low)	**2.25**	**0.41**	**<.001**	**2.25**	**0.41**	**<.001**	**2.65**	**0.39**	**<.001**
Interactions									
Government trust × Stringency: medium (vs. low)	**0.32**	**0.07**	**.01**						
Government trust × Stringency: high (vs. low)	**0.45**	**0.08**	**<.001**						
Perc. clarity communication × Stringency: medium (vs. low)				0.19	0.07	.06			
Perc. clarity communication × Stringency: high (vs. low)				**0.34**	**0.08**	**.001**			
International student × Stringency: medium (vs. low)							**-1.95**	**0.29**	**.005**
International student × Stringency: high (vs. low)							**-1.98**	**0.45**	**<.001**
Controls (individual level)									
Female	**0.35**	**0.04**	**<.001**	**0.35**	**0.04**	**<.001**	**0.33**	**0.03**	**<.001**
Age	0.01	0.02	.53	0.01	0.02	.59	0.03	0.02	.05
International student	**0.61**	**0.05**	**<.001**	**0.62**	**0.05**	**<.001**	**1.69**	**0.22**	**.003**
Variance individual level	1.90	0.03		1.91	0.03		1.83	0.03	
Variance country level	0.24	0.13		0.24	0.13		0.22	0.12	
Variance random slope	0.001	0.003		0.002	0.003		0.07	0.08	
Covariance	-0.002	0.02		-0.02	0.02		-0.11	0.12	
Pseudo R^2 individual level	0.06			0.06			0.09		
Pseudo R^2 country level	0.75			0.75			0.77		
Deviance	24117			24141			23857		
AIC / BIC	24154	24277		24177	24300		23893	24016	
Number of individuals	6,905			6,905			6,905		
Number of countries	10			10			10		

Note: SE= Kenward-Roger standard error. Restricted maximum likelihood is used. Estimates in bold represent *p*-values<.05. Each model includes a random intercept term, a random slope term (for government trust in Model 1, perceived clarity in Model 2, and international student in Model 3), and a covariance term between intercept and slope.

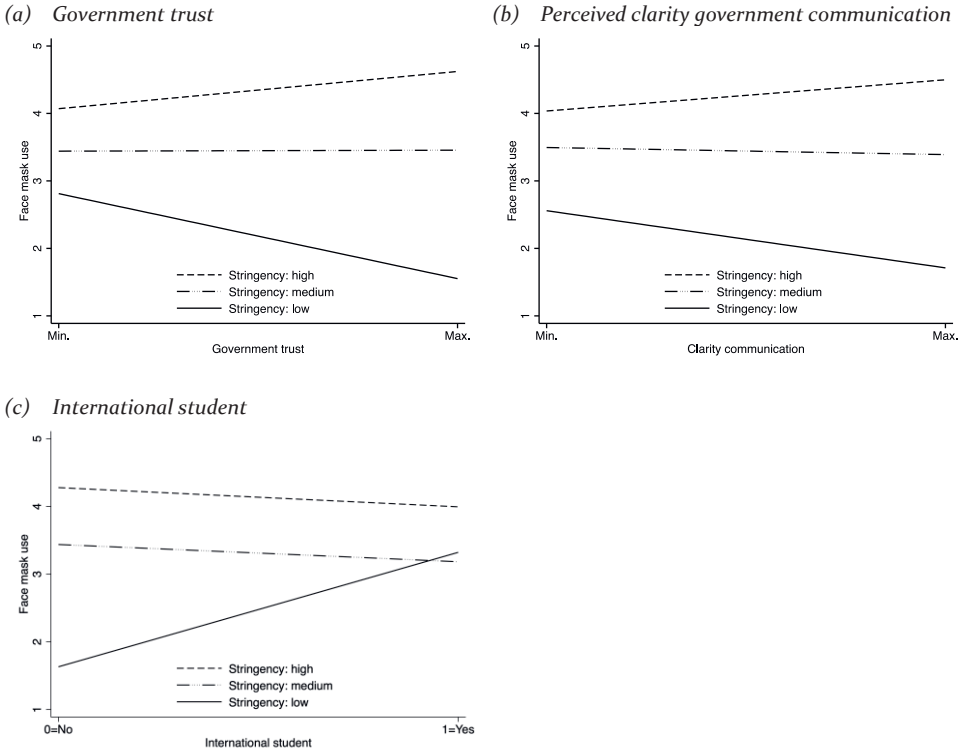


Figure 4.3 Interaction Plots Based on Table 4.4

4.4 Discussion

In 2021, COVID-19 vaccines and treatments have become widely available in rich countries. However, vaccination rates have remained low in some countries, and even in countries with high vaccination rates, new peaks of infection have emerged due to novel and more infectious variants. Moreover, poorer countries usually cannot afford large-scale vaccination. Consequently, many countries still need to rely on face masks and distancing (with lockdowns in extremis) as the main medical precautions. Since face mask usage is economically cheap and less disruptive compared to other regulations, such as social distancing and lockdowns, knowledge about the motives for using them is essential. Moreover, as countries may lower the stringency of their measures, it is interesting to know whether this affects the relationship between mask-use and individual level variables that were found to be important in earlier literature.

Our analyses of almost 7,000 students in ten countries during the early phase of the 2020 COVID-19 pandemic show that the stringency of regulations in a country is most strongly related to face mask use, with stricter rules associated with stricter face mask use.

In distinguishing between the relative stringency of face mask regulations, we show that not only does imposing any regulations relative to no regulations relate to a higher agreement with face mask use but installing strict regulations relative to intermediate regulations also increases agreement. We also find that self-related risk perception of COVID-19 positively relates to agreement with face mask use, while other-related risk perception of COVID-19 did not relate to face mask use. This is in contrast with studies showing that social risk perception affects compliance (Franzen & Wöhner, 2021; Pfattheicher et al., 2020) and studies that show that inducing empathy for vulnerable people and stressing prosocial consequences of mask-wearing is related to a higher motivation to wear a mask (Pfattheicher et al., 2020; van der Linden & Savoie, 2020). Moreover, against expectation, we do not find a relationship between attitude towards government and (in)direct experience with COVID-19 infection and agreement with face mask use.

Analysing the interaction between policy stringency and our individual level factors, we find an interaction effect between policy stringency and attitude towards government. A more positive attitude towards government increases face mask use in stringent countries and decreases face mask use in countries without recommendations or requirements. The finding of an interaction between government trust and policy stringency is in line with the findings of others that studied compliance with other COVID-19 related preventive measures (Bargain & Aminjonov, 2020; Pak et al., 2021). We are the first to show that the same relationship is present between stringency and perceived clarity of government communication, meaning that the link between stringency and face mask use becomes stronger when communication is clearer. Our distinction of low (no regulations), medium and high stringency allows us to draw the conclusion that in a situation without any regulations trust and perceived clarity of communication negatively associate with mask use. In countries without face mask regulations or recommendations, governments did not explicitly advise against the use but did openly question the scientific basis for their effectiveness which may have conveyed a negative attitude towards masks. Hence, a more positive government perception relates to lower face mask use in these countries and to higher use in countries with such regulations. As stated, both obedience to authority and conformity through social pressure may underlie the importance of regulations (Cialdini & Goldstein, 2004; Milgram, 1974). People are in general obedient when it comes to people of power (Milgram, 1974). At the same time, behaviour is contagious. When governments impose face mask regulations, this enforces a social norm that subsequently stimulates the advocated behaviour because people want to conform to the group standard (Cialdini, 2007; Cialdini & Goldstein, 2004).

We did not find an interaction between policy stringency and risk perception or experience with COVID-19. We expected that individual differences in perceptions and experiences would play a smaller role in countries with strict regulations, as these are

'strong' situations in which the range of acceptable behaviour is limited. Nevertheless, it seems that in our sample experience with COVID-19 is not associated with mask usage across all regulation regimes, while the positive association between self-related risk perception of COVID-19 and mask use is present across all policy stringency contexts.

A limitation of this research is that we use self-report data of face mask use. Previous research shows that self-report measures vary in their correspondence to actual behaviour (Prince et al., 2008; Short et al., 2009). While responses were provided anonymously in our survey, it is conceivable that they are subject to social desirability bias. However, recall bias is likely to be low, because the saliency of the pandemic and novelty of face mask use as a behaviour may have made it easier to recall it. Moreover, Petherick et al. (2021) found that survey data on compliance with physical distancing during the pandemic was related to objective mobile-phone mobility data. If a similar situation occurs in the future, collecting more objective measures of face mask use would be worthwhile. Since relevant data could only be collected during a limited time frame, this was outside the options and scope of our research project.

Besides this, the study is limited in that we studied a set of countries that do not cover a random and representative sample of the global population. We focus on factors associated with face mask use among students, a group that represents a specific subsample of the total population with on the one hand below-average incentives for protective behaviours compared to older generations, and on the other hand above-average levels of rule abidance compared to those with an average education (Bish & Michie, 2010). The results should therefore not be generalized to other populations. Since the data were collected at the very beginning phase of the COVID-19 pandemic, further research is needed to study the effects of regulations changing over time and whether perceptions of risk and perceived benefits of face mask use shift over time during a long-lasting pandemic.

As face mask use is only an efficient method to lower the spread of COVID-19 if there is widespread adoption (Howard et al., 2021), governments should put country-wide regulations in place if they decide to involve face masks to halt the pandemic. Our study shows that the stringency of regulations is most strongly associated with face mask use among students. The strength of this relationship can be further increased by clear government communication and enhancing government trust. From our study, it appears that self-related risk perception of COVID-19 is also important for face mask use, while other-related risk perception, direct and indirect experience with COVID-19 are not associated with mask use at all.

4.5 Supplementary material

Table S4.1 Descriptive statistics per country

		NL	BE	PRT	ESP	IND	FR	SWE	IT	IRE	COL	Total
Sample size	*N*	1,066	3,363	1,178	146	183	200	234	188	90	257	6,905
Female	%	57.4%	68.1%	47.6%	66.4%	45.4%	73.0%	56.4%	53.7%	65.6%	63.0%	61.4%
Age (in years)	*M*	20.63	21.95	21.77	22.51	21.37	20.55	24.82	22.48	22.54	23.04	21.83
	(*SD*)	(1.98)	(3.29)	(3.23)	(3.17)	(2.98)	(2.18)	(3.86)	(2.28)	(3.54)	(4.47)	(3.23)
International student	%	30.4%	10.1%	7.8%	2.7%	2.2%	7.5%	9.0%	5.9%	32.2%	0.4%	12.2%
Self-related risk perception COVID-19 (1–7)	*M*	3.23	3.40	3.18	3.07	4.04	3.76	3.51	3.32	3.17	3.48	3.36
	(*SD*)	(0.89)	(1.01)	(0.93)	(0.99)	(1.19)	(1.05)	(0.91)	(0.95)	(1.01)	(1.18)	(1.00)
Other-related risk perception COVID-19 (1–7)	*M*	4.08	4.48	4.10	3.92	4.40	4.56	4.34	4.02	4.27	4.17	4.31
	(*SD*)	(0.94)	(0.99)	(0.96)	(1.16)	(1.25)	(1.10)	(0.90)	(0.98)	(1.05)	(1.21)	(1.02)
Direct experience COVID-19	%	12.9%	12.5%	3.7%	4.1%	0.5%	8.5%	19.2%	6.4%	10.0%	2.7%	10.2%
Indirect experience COVID-19	%	31.4%	38.0%	10.1%	24.7%	0.5%	29.0%	42.3%	18.6%	32.2%	2.7%	28.9%
Government trust (1–10)	*M*	7.29	5.58	6.42	4.18	6.19	5.58	7.03	5.55	6.94	3.61	5.96
	(*SD*)	(1.63)	(2.11)	(2.00)	(2.55)	(2.50)	(2.07)	(2.29)	(2.22)	(1.86)	(2.16)	(2.22)
Perceived clarity government communication (1–7)	*M*	5.13	4.08	5.32	3.53	4.90	4.16	4.86	4.14	5.66	4.78	4.54
	(*SD*)	(1.31)	(1.49)	(1.25)	(1.80)	(1.75)	(1.63)	(1.60)	(1.50)	(1.38)	(1.45)	(1.55)

Note: M=Mean; *SD*=standard deviation.

Table S4.2 Mean and standard deviations (SD) of agreement with face mask (FM) use (1-5) and stringency face mask regulations (0-4) across countries

Country	Mean agreement FM use	*SD* agreement FM use	Observations	Stringency FM regulations (0-4)	Categorization stringency FM regulations
India	4.37	0.90	183	4	high
Colombia	4.37	0.95	257	4	high
Spain	4.29	1.23	146	1.26	medium
Italy	4.09	1.16	188	4	high
France	3.23	1.54	200	1.37	medium
Portugal	3.15	1.45	1,178	1.48	medium
Belgium	3.08	1.49	3,363	1.78	medium
Ireland	2.63	1.43	90	0	low
Netherlands	1.98	1.46	1,066	0	low
Sweden	1.43	0.96	234	0	low
Total	3.00	1.57	6,905		

Table S4.3 Linear multi-level regressions with face mask use as the dependent variable

	Interactions with Female			Interactions with Age			Interactions with Self-related risk perception COVID-19		
	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value
Intercept	**1.73**	**0.28**	**<.001**	**1.69**	**0.28**	**<.001**	**1.68**	**0.28**	**<.001**
Risk perception COVID-19 (individual level)									
Self-related	**0.14**	**0.02**	**<.001**	**0.14**	**0.02**	**<.001**	0.11	0.05	.09
Other-related	0.03	0.02	.15	0.03	0.02	.15	0.03	0.02	.15
Experience COVID-19 (individual level)									
Direct experience	-0.06	0.06	.27	-0.07	0.06	.26	-0.06	0.06	.28
Indirect experience	0.01	0.04	.83	0.01	0.04	.78	0.01	0.04	.85
Government attitude (individual level)									
Government trust	-0.03	0.02	.16	-0.03	0.02	.18	-0.03	0.02	.16
Perceived clarity communication	-0.03	0.02	.19	-0.03	0.02	.17	-0.03	0.02	.19
Policy stringency (country level)									
Stringency: medium (vs. low)	**1.39**	**0.37**	**.01**	**1.47**	**0.37**	**.01**	**1.47**	**0.37**	**.005**
Stringency: high (vs. low)	**2.35**	**0.40**	**<.001**	**2.34**	**0.40**	**<.001**	**2.38**	**0.40**	**<.001**
Interactions									
Female × Stringency: medium	0.14	0.12	.34						
Female × Stringency: high	-0.01	0.14	.97						
Age × Stringency: medium				0.05	0.07	.44			
Age × Stringency: high				0.09	0.08	.27			
Self-related risk × Stringency: medium							0.03	0.07	.66
Self-related risk × Stringency: high							-0.08	0.08	.29
Controls (individual level)									
Female	**0.25**	**0.09**	**.04**	**0.34**	**0.03**	**<.001**	**0.34**	**0.04**	**<.001**
Age	0.01	0.02	.52	-0.05	0.05	.31	0.01	0.02	.60
International student	**0.66**	**0.05**	**<.001**	**0.66**	**0.05**	**<.001**	**0.66**	**0.05**	**<.001**
Variance individual level	1.92	0.03		1.92	0.03		1.91	0.03	
Variance country level	0.22	0.13		0.23	0.13		0.23	0.13	
Variance random slope	0.000	0.000		0.001	0.002		0.001	0.003	
Covariance	0.004	0.004		-0.01	0.02		-0.015	0.02	
Pseudo R^2 individual level	0.05			0.05			0.05		
Pseudo R^2 country level	0.79			0.78			0.79		
Deviance	24163			24166			24161		
AIC / BIC	24199	24322		24202	24325		24197	24320	
Number of individuals	6,905			6,905			6,905		
Number of countries	10			10			10		

Note: SE= Kenward-Roger standard error. Restricted maximum likelihood is used. Estimates in bold represent *p*-values<.05.

Table S4.3 (continued). Linear multi-level regressions with face mask use as the dependent variable

	Interactions with Direct experience COVID-19			Interactions with Other-related risk perception COVID-19			Interactions with Indirect experience COVID-19		
	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value
Intercept	**1.70**	**0.29**	**<.001**	**1.68**	**0.28**	**<.001**	**1.77**	**0.29**	**<.001**
Risk perception COVID-19 (individual level)									
Self-related	**0.14**	**0.02**	**<.001**	**0.14**	**0.02**	**<.001**	**0.14**	**0.02**	**<.001**
Other-related	0.03	0.02	.14	-0.06	0.07	.40	0.03	0.02	.13
Experience COVID-19 (individual level)									
Direct experience	-0.22	0.21	.37	-0.06	0.06	.28	-0.07	0.06	.25
Indirect experience	0.01	0.04	.85	0.004	0.04	.93	-0.24	0.11	.15
Government attitude (individual level)									
Government trust	-0.03	0.02	.19	-0.03	0.02	.16	-0.03	0.02	.20
Perceived clarity communication	-0.03	0.02	.15	-0.03	0.02	.19	-0.03	0.02	.18
Policy stringency (country level)									
Stringency: medium (vs. low)	**1.46**	**0.38**	**.01**	**1.47**	**0.37**	**.005**	**1.38**	**0.38**	**.01**
Stringency: high (vs. low)	**2.35**	**0.41**	**<.001**	**2.34**	**0.4**	**<.001**	**2.29**	**0.41**	**<.001**
Interactions									
Direct experience × Stringency: medium	0.06	0.28	.86						
Direct experience × Stringency: high	-0.54	0.41	.21						
Other-related risk × Stringency: medium				0.10	0.08	.28			
Other-related risk × Stringency: high				-0.03	0.09	.77			
Indirect experience × Stringency: medium							0.30	0.17	.33
Indirect experience × Stringency: high							-0.17	0.26	.52
Controls (individual level)									
Female	**0.34**	**0.04**	**<.001**	**0.34**	**0.04**	**<.001**	**0.34**	**0.04**	**<.001**
Age	0.01	0.02	.54	0.01	0.02	.55	0.01	0.02	.54
International student	**0.65**	**0.05**	**<.001**	**0.67**	**0.05**	**<.001**	**0.65**	**0.05**	**<.001**
Variance individual level	1.91	0.03		1.91	0.03		1.91	0.03	
Variance country level	0.23	0.13		0.23	0.13		0.24	0.14	
Variance random slope	0.05	0.05		0.005	0.004		0.005	0.01	
Covariance	-0.06	0.10		-0.02	0.02		-0.03	0.05	
Pseudo R^2 individual level	0.05			0.05			0.05		
Pseudo R^2 country level	0.78			0.79			0.77		
Deviance	24151			24150			24147		
AIC / BIC	24187	24310		24186	24309		24183	24306	
Number of individuals	6,905			6,905			6,905		
Number of countries	10			10			10		

Note: SE= Kenward-Roger standard error. Restricted maximum likelihood is used. Estimates in bold represent *p*-values<.05.

Table S4.4 OLS Regressions with face mask use as the dependent variable (Including significant interactions)

	Model 1 Interactions with Government trust			Model 2 Interactions with Perceived clarity communication			Model 3 Interactions with International student		
	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value	Coeff.	*SE*	*p*-value
Intercept	**2.76**	**0.04**	**<.001**	**2.73**	**0.04**	**<.001**	**2.70**	**0.04**	**<.001**
Risk perception COVID-19 (individual level)									
Self-related	**0.14**	**0.02**	**<.001**	**0.14**	**0.02**	**<.001**	**0.12**	**0.02**	**<.001**
Other-related	0.03	0.03	.41	0.03	0.03	.39	0.03	0.03	.42
Experience COVID-19 (individual level)									
Direct experience	-0.07	0.10	.46	-0.07	0.09	.49	-0.02	0.07	.82
Indirect experience	0.02	0.05	.50	0.01	0.05	.80	0.02	0.04	.58
Government attitude (individual level)									
Government trust	**-0.32**	**0.05**	**<.001**	-0.03	0.05	.59	0.005	0.03	.88
Perceived clarity communication	-0.02	0.02	.22	**-0.21**	**0.06**	**.01**	-0.005	0.01	.68
Controls (individual level)									
Female	**0.35**	**0.03**	**<.001**	**0.35**	**0.03**	**<.001**	**0.33**	**0.04**	**<.001**
Age	0.01	0.03	.70	0.01	0.03	.74	**0.03**	**0.01**	**.04**
International student	0.61	0.52	.27	0.62	0.53	.27	**1.82**	**0.10**	**<.001**
Interactions									
Government trust × Stringency: medium (vs. low)	**0.33**	**0.06**	**.001**						
Government trust × Stringency: high (vs. low)	**0.46**	**0.07**	**<.001**						
Clarity communication × Stringency: medium (vs. low)				**0.21**	**0.06**	**.01**			
Clarity communication × Stringency: high (vs. low)				**0.33**	**0.05**	**<.001**			
International student × Stringency: medium (vs. low)							**-1.89**	**0.10**	**<.001**
International student × Stringency: high (vs. low)							**-2.07**	**0.32**	**<.001**
R^2	0.23			0.23			0.26		
Number of individuals	6,905			6,905			6,905		
Number of countries	10			10			10		

Note: SE=Cluster-robust standard error. Estimates in bold represent *p*-values<.05. Country dummy variables included

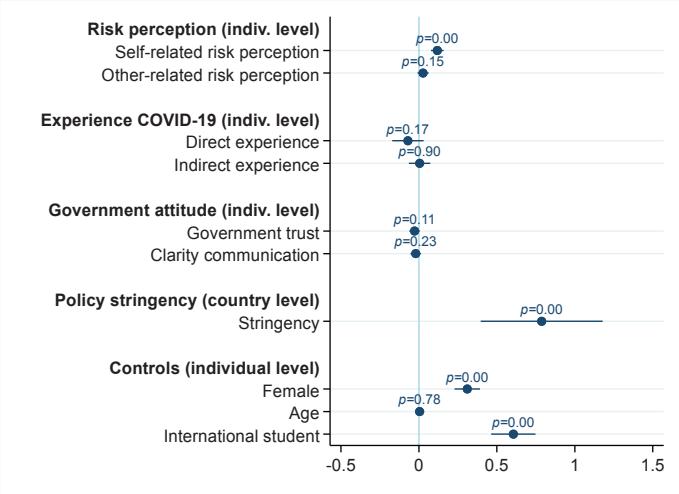


Figure S4.1 Estimation results of multilevel ordered logit regression

Note: Values of estimated average marginal effects (category 'Strongly agree') are shown together with their 95% confidence intervals.

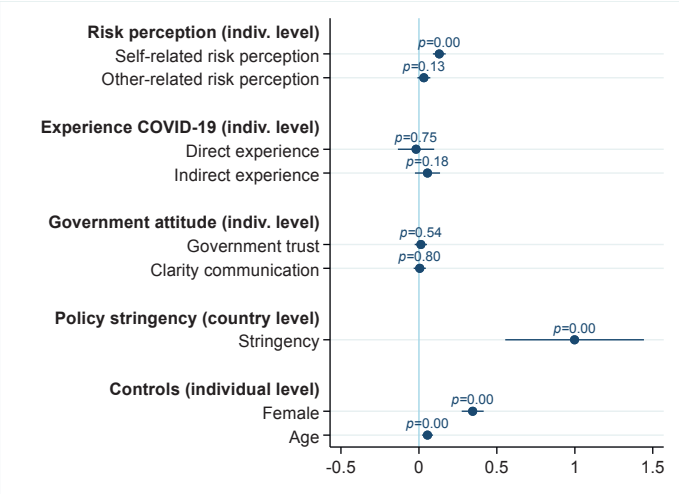
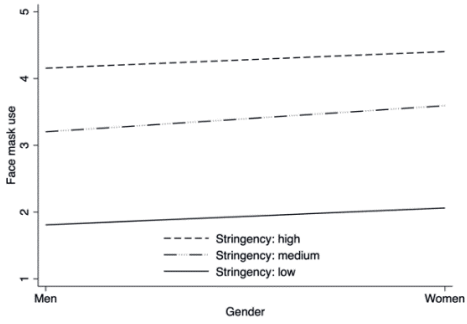


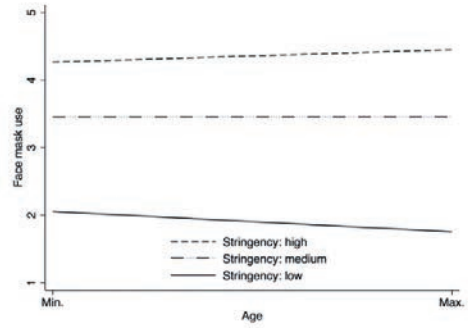
Figure S4.2 Estimation results of Model 2, Table 4.3, without international students

Note: Values of estimated coefficients are shown, together with their 95% confidence intervals.

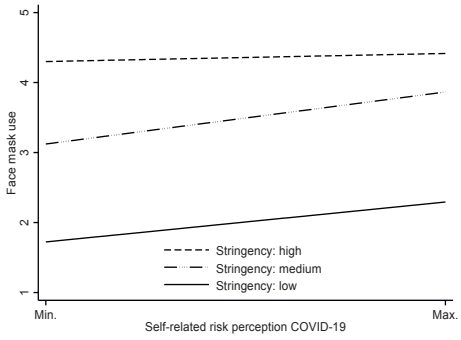
(a) Gender



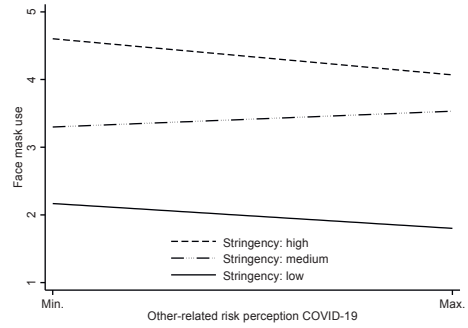
(b) Age



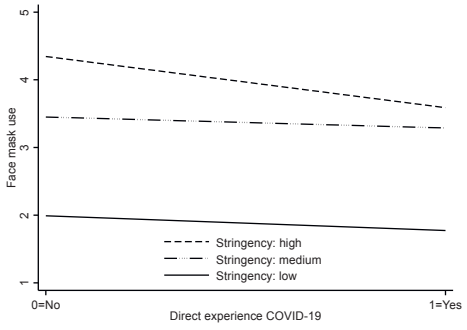
(c) Self-related risk perception COVID-19



(d) Other-related risk perception COVID-19



(e) Direct experience COVID-19



(f) Indirect experience COVID-19

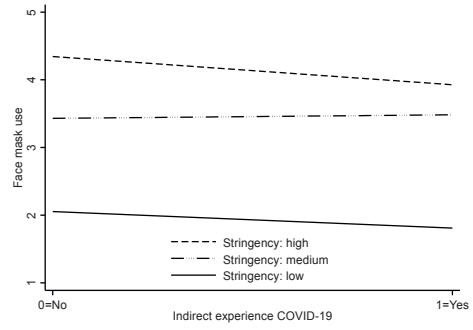


Figure S4.3 Interaction Plots Individual-Level Variables

4.6 Acknowledgements

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II

PART II

COVID-19 Vaccination

5

Chapter 5

Psychological Characteristics and the Mediating Role of the 5C Model in Explaining Students' COVID-19 Vaccination Intention

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Abstract

To achieve herd immunity against COVID-19, it is crucial to know the drivers of vaccination intention and, thereby, vaccination. As the determinants of vaccination differ across vaccines, target groups and contexts, we investigate COVID-19 vaccination intention using data from university students from three countries, the Netherlands, Belgium and Portugal. We investigate the psychological drivers of vaccination intention using the 5C model as mediator. This model includes five antecedents of vaccination: Confidence, Complacency, Constraints, Calculation and Collective Responsibility. First, we show that the majority of students have a positive propensity toward getting vaccinated against COVID-19, though only 41% of students are completely acceptant. Second, using the 5C model, we show that 'Confidence' and 'Collective Responsibility' are most strongly related to students' COVID-19 vaccination intention. Using mediation analyses, we show that the perceived risk and effectiveness of the vaccine as well as trust in the government and health authorities indirectly relate to vaccination intention through 'Confidence'. The perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly relate to vaccination intention through 'Collective Responsibility'. Hence, targeting the psychological characteristics associated with 'Confidence' and 'Collective Responsibility' can improve the effectiveness of vaccination campaigns among students.

5.1 Introduction

The development of a vaccine has been recognized as a crucial means to halt the spread of coronavirus disease 2019 (COVID-19). Since effective vaccines against COVID-19 have been developed (Polack et al., 2020; Voysey et al., 2021), the greatest challenge is to ensure sufficiently high vaccination rates to establish herd immunity. The estimates of the needed vaccination rates to achieve herd immunity range from 67% to 95% (Anderson, Vegvari, et al., 2020; Mills et al., 2020; Randolph & Barreiro, 2020).

In 2019, the World Health Organization declared 'vaccine hesitancy' one of the top ten threats to global health (World Health Organization, 2019). Vaccine hesitancy is defined as the refusal or reluctance to get vaccinated despite the availability of a vaccine (MacDonald, 2015). Vaccine hesitancy has become more problematic in recent decades (Dubé et al., 2013), with the highest levels of scepticism being found in Europe (Larson et al., 2016). In a sample of over 7,000 Europeans, 18.9% of respondents reported being unsure about getting vaccinated against COVID-19, while 7.2% indicated that they will certainly not get vaccinated (Neumann-Böhme et al., 2020). Even more pessimistic numbers have been shown in a British and Irish sample, with only 65% and 69% of respondents fully willing to get vaccinated, respectively (Murphy et al., 2021).

Governments and public health agencies must be prepared to address COVID-19 vaccine hesitancy (Lazarus et al., 2021). Given its novelty, much is still unknown about

the acceptance and motivation behind COVID-19 vaccination. The COVID-19 vaccines differ from previous vaccines in many respects: development speed, innovativeness of the techniques used, uncertainty regarding the magnitude and extent of its effectiveness, and potential side effects. As vaccination willingness is context-, time-, place-, and vaccine-dependent (Dubé et al., 2014), research on COVID-19 vaccination intention and its antecedents is needed, preferably across a variety of target groups and countries.

Previous literature reports potential barriers to vaccine acceptance at different levels (Schmid et al., 2017), ranging from the political and sociocultural levels to the individual level. At the aggregate level, in addition to factors such as the availability and cost of vaccines (MacDonald, 2015), trust in health officials, the media and governments play an important role in vaccination intention (Dubé et al., 2013). At the individual level, studies have, among others, shown the relevance of psychological theories of behaviour for vaccine acceptance, like the theory of planned behaviour (Betsch et al., 2015; Gerend & Shepherd, 2012; Xiao & Wong, 2020). Several models have been developed to integrate previous literature on vaccination behaviour, such as the 3C (MacDonald, 2015), 4C (Betsch et al., 2015) and 5C models (Betsch et al., 2018). Grounded in previous theoretical models, the 5C model aimed at providing a tool useful for both research and practice, reflecting a broad scope of predictors of vaccination intention and behaviour (Betsch et al., 2018). The model includes five psychological antecedents of vaccination, of which the first one, Confidence, relates to trust in the effectiveness and safety of vaccines, in the system that delivers these and in the motivations of policymakers. Secondly, Complacency reflects the perceived risk and perceived level of threat of vaccine-preventable diseases. Thirdly, Constraints reflects the structural psychological and physical barriers, such as those related to geographical accessibility, ability to understand (language and health literacy), and affordability. Fourthly, Calculation relates to individuals' engagement in extensive information searching, which can lead to lower vaccination willingness due to the high availability of anti-vaccination information. Finally, Collective responsibility reflects one's willingness to protect others by getting vaccinated by means of herd immunity (Betsch et al., 2018). The scale designed to assess these five drivers explained more variance in vaccination behaviour compared to previous measures that have focused almost solely on Confidence. Moreover, it was shown that the pattern of the most important Cs within the 5C model varies across vaccines, target groups and countries (Betsch et al., 2018).

Regarding COVID-19 vaccination, previous studies have shown that women, younger adults, unemployed individuals, and those with a lower socioeconomic status are less likely to get vaccinated (Malik et al., 2020; Murphy et al., 2021; Rhodes et al., 2020). Moreover, it was recently shown that psychological profiles play a role: vaccine-hesitant and vaccine-resistant individuals are less altruistic, conscientious, more disagreeable, emotionally unstable, and self-interested than are vaccine-acceptant individuals (Murphy et al., 2021). Finally, higher COVID-19 vaccination intention is associated with more

positive general and COVID-19 vaccination beliefs, as well as higher perceived vaccine efficacy and safety (Karlsson et al., 2021; Rhodes et al., 2020; Sherman et al., 2021).

The importance of studying psychological variables to understand vaccination intention and inform effective interventions has been advocated (Schmid et al., 2017). A deeper understanding of the underlying psychology of vaccine-resistant and vaccine-hesitant groups can enhance the potential effectiveness of the public health messages targeting these groups. In this study, we aim to increase the understanding of COVID-19 vaccination by studying the 5C model and its psychological drivers. Since younger people are less likely to suffer from the negative health consequences of COVID-19 infection (Verity et al., 2020), it is important to know what the main drivers of getting vaccinated are for these individuals. Based on a sample of university students from the Netherlands, Belgium, and Portugal, we pursue the following four objectives.

First, we assess the intention to get vaccinated in our international student sample by using a seven-point scale, ranging from completely resistant to completely acceptant.

Second, as shown in previous research, the antecedents of vaccine hesitancy differ across vaccines, target groups and countries (Betsch et al., 2018). We are the first to study which Cs—Confidence, Complacency, Calculation, Constraints, Collective Responsibility (5C's) – are most important for COVID-19 vaccination intention in a sample of university students.

Third, as stressed by the authors of the 5C model, knowing the relative importance of the Cs is just a first step, which should be followed by further exploration of the potential levers of these drivers (Betsch et al., 2018). Using mediation analyses, we investigate which psychological variables, including COVID-19 vaccine-related and COVID-19-related attitudes and personality traits, affect vaccination intention through the 5Cs. This will improve our understanding of vaccination antecedents and, consequently, for which groups reaching desirable levels of these 5Cs and, thereby, vaccination intention may be problematic. The mediation analyses we performed are summarized in Figure 5.1. Previous studies have shed light on several bivariate relationships between the 5Cs and psychological constructs (Betsch et al., 2018) (presented by the orange arrows in Figure 5.1). We study whether these constructs indeed affect vaccination intention through the suggested C. Additionally, we study the new indirect relationships represented by the blue arrows in Figure 5.1. Direct and total relationships are excluded from Figure 5.1 for clarity reasons.

Finally, integrating all results, we formulate advice for governments and public health officials on which Cs would probably best be targeted, while taking their drivers into account when aiming at increasing vaccination intention among students. Knowing for which students' psychological profiles in our sample the Cs are less likely to be present may facilitate the design of targeted public health vaccination campaigns.

We find that Confidence and Collective Responsibility are most important in explaining COVID-19 vaccination among students of our sample. The perceived risk and effectiveness of the vaccine and trust in the government and health authorities indirectly affect vaccination intention through Confidence. The perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly affect vaccination intention through Collective Responsibility. Thus, vaccination campaigns targeted at students should aim to increase both Confidence and Collective Responsibility, while considering their underlying psychological characteristics.

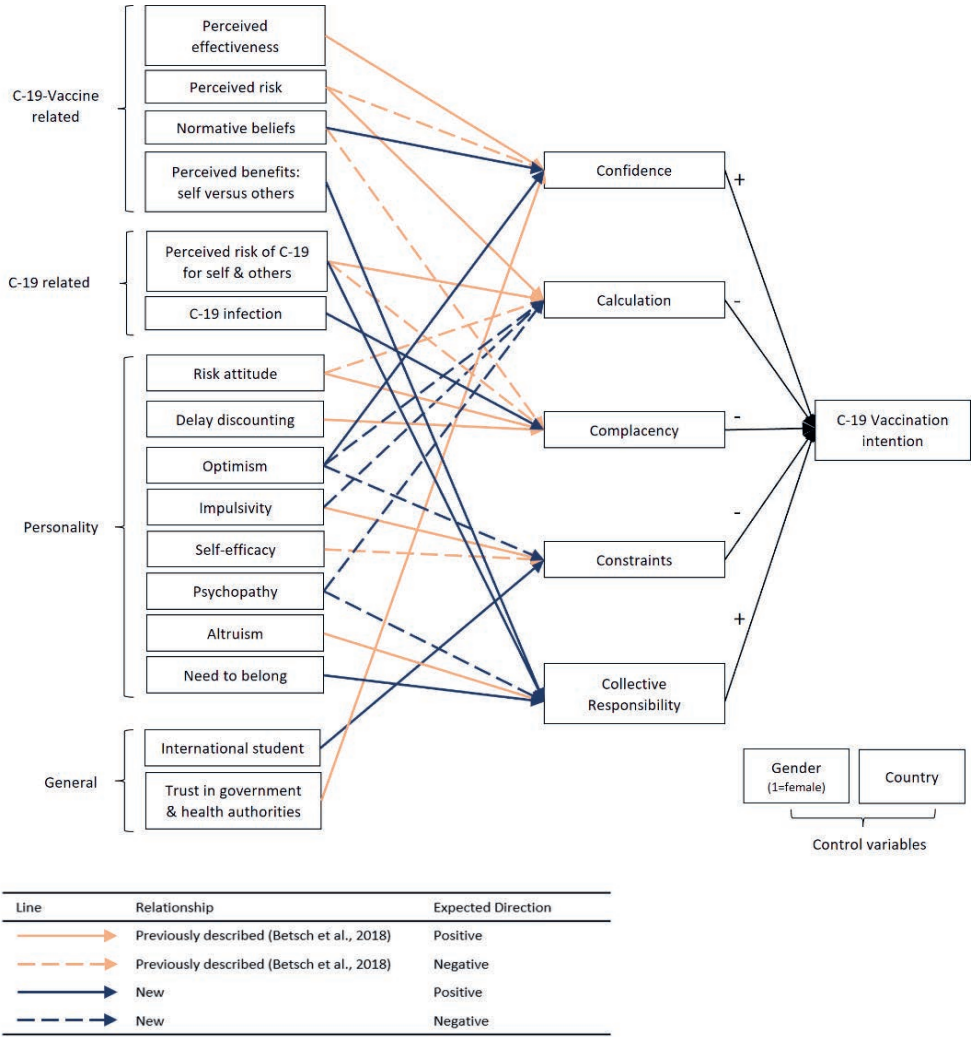

Figure 5.1 Overview of expected mediation relationships

Note: Direct effects are excluded for clarity reasons. C-19=COVID-19

5.2 Materials and methods

Data

For the current study, we make use of data from university students. While we acknowledge this group may not be representative of all young adults, especially in terms of education level, we do believe that this will provide a fairer picture of the drivers of vaccination intention among young adults than studies focusing on the general population. As the severity of the consequences of COVID-19 are largely age-dependent, we expect that the motives for COVID-19 vaccination will strongly differ between older and younger populations. The data used in this study are part of the Erasmus University Rotterdam International COVID-19 Student Survey. This is a longitudinal study on COVID-19-related behaviours and attitudes among university students from multiple countries (Wismans, Letina, et al., 2020). Thus far, data have been collected at two points in time. For both data collections, approval was obtained by the Internal Review Board of the Erasmus University Rotterdam. All students signed an informed consent form before starting the survey.

For the current study, we make use of data collected at both moments (T1 and T2) focusing on students from three countries (The Netherlands, Belgium, and Portugal) that participated in both measurement waves. The second survey concentrated on vaccination intention and attitudes.

The first data collection took place during the early days of the pandemic (weeks 17-19, 2020, T1). In total, data from 7,404 university students in ten countries worldwide were collected, amongst which the Netherlands, Belgium and Portugal. At this time, students were approached through university student systems and invitations sent to university e-mail addresses. During this first survey, students could indicate whether they wanted to participate in a follow-up study by sharing their e-mail address. This follow-up study (T2) took place in December 2020 (weeks 51-52). This time, we approached only students from the Netherlands, Belgium and Portugal who participated at T1 and agreed to be contacted for follow-up. Other country samples were not reapproached since the number of students who agreed to be contacted for follow-up was insufficient to assure large enough samples at T2. Students were contacted through invitations that were sent to the e-mail addresses they provided at T1. In total, 2,902 survey invitations were sent via e-mail at the start of week 51, 2020. Two reminders were sent to those students who did not yet finish or start the survey three and seven days after the first invitation. In total, data were collected from 1,137 students (the Netherlands N=185; Belgium N=658; Portugal N=294), for a response rate of 39.2%. This sample is used for the current study. In the analyses, sample sizes can be slightly lower due to the limited presence of missing values and the use of pairwise deletion.

We briefly discuss the data collection method per country at T1 and T2. At T1, Dutch students from the Erasmus University Rotterdam were approached through two

university research platforms for students in Psychology and students in Business Administration. For these students it is compulsory to participate in research for a number of hours, and they were thus incentivized to participate in the study. Moreover, the study was shared with all students from the Economics faculty by e-mail. In total, we collected 1,090 responses from Dutch students at T1, of which 633 students (58.1%) shared their e-mail address to be contacted for a follow-up study. 185 Dutch students (response rate=29.2%) participated at T2. At T1, data from the Belgian sample was collected by systematically contacting all students (around 40,000) via student e-mail addresses from the University of Namur and the Université catholique de Louvain. Students from all faculties and degrees were approached. In total, 3,645 responses were collected at T1, of which 1,660 approved to be contacted for follow-up (45.5%). From these 1,660 students, 658 participated in the second survey (response rate=39.6%). Finally, the Portuguese students were contacted at T1 by sending invitations to around 9,000 student e-mail addresses of the Instituto Superior Técnico and the Instituto Superior de Economia e Gestão of the University of Lisbon. In total, we collected 1,275 responses at T1 of which 609 agreed to be contacted for follow-up (47.8%), of which 294 participated again at T2 (response rate=48.3%).

As we did not use a completely probabilistic sample, it should be noted that our findings may not be generalizable to all students. However, we believe that, as we approached representative and large groups of students, risk of bias mostly arises from voluntary participation. It is therefore probable that students who are more agreeable and show more socially desirable behaviour are more likely to join in both surveys. To check whether this has affected our outcomes, we conducted all analyses presented in this chapter, controlling for scores on the adapted 13-item short (form C) Social Desirability Scale of Marlow-Crowne (Crowne & Marlowe, 1960; W. M. Reynolds, 1982). The use of social desirability scales has been advocated to check the robustness of results based on self-report data (van de Mortel, 2008). Based on these additional analyses, we find that all conclusions drawn in the current study remain the same.

At both T1 and T2, surveys were shared using the online survey software Qualtrics. At T1, the survey contained questions on COVID-19-related attitudes, compliance with COVID-19 regulations, and several personality traits. For the current study, only the T1 data on personality traits are used. As personality traits are relatively stable over time (Costa Jr & McCrae, 1994), we suppose that this is not a problem for the validity of our outcomes. If anything, using multiple measurement times decreases the probability of common method bias (Podsakoff et al., 2012). At T2, the survey contained similar questions on COVID-19-related attitudes and compliance with regulations. In addition, questions on COVID-19 vaccination intention and vaccination attitudes were posed. Finally, several personality traits were assessed. The surveys could be completed in English, Dutch, or French.

On average, students were 22.92 years old, and 59.3% of the sample was female.

Measures

The operationalization of all variables is explained in this section.

Vaccination intention (T2): Participants were asked the following question: 'If a coronavirus vaccine that was approved safe and effective was available to you free at cost, would you get vaccinated?' Answers could be given on a seven-point scale: 'definitely not' (1), 'very probably not' (2), 'probably not' (3), 'unsure – neutral' (4), 'probably yes' (5), 'very probably yes' (6) and 'definitely yes' (7). A higher score thus indicates a higher intention to get vaccinated against COVID-19. The continuous scale is used instead of grouping students as being acceptant, hesitant, or resistant. This approach offers a more accurate understanding of vaccination intention, as grouping all students who indicate somewhere between 'probably will not' and 'probably will' under hesitant conditions will lower the unique variation that can be exploited.

5C scale (T2): The 5Cs were assessed using the previously validated 5C scale (Betsch et al., 2018). The scale consists of 15 items. Each of the Cs—Confidence, Constraints, Calculation, Complacency and Collective responsibility—is captured by three items. Answers are given on a seven-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'. The scale was adapted to specifically focus on COVID-19 vaccinations. A French translation was available (Guillot et al., 2020), while a Dutch translation was performed by two native Dutch speakers individually, after which a consensus meeting took place to discuss and decide on inconsistencies. All items are scored in a way such that a higher score indicates a higher degree of the C assessed. The scores of one of the items of the Collective Responsibility subscale was reversed to be in line with this scoring ('*When everyone is vaccinated, I don't have to get vaccinated too'*). Internal consistency, as reflected by Cronbach's alpha, is acceptable in our sample: Confidence α =.87, Complacency α=70, Constraints α=.69, Calculation α=.76, Collective responsibility α=.71.

Perceived risk of the COVID-19 vaccine: Bipolar questions were used to assess the perceived risk of the COVID-19 vaccine. Students were asked the following: 'To what extent do you think the following characteristics apply to COVID-19 vaccines?' Answers could be given on a seven-point scale using bipolar adjectives, which is common practice when assessing attitude (Ajzen, 2006). An average score was taken for the following three characteristics: safety ('very unsafe' (1) to 'very safe' (7)), likeliness of side effects ('side effects are very likely' (1) to 'side effects are very unlikely' (7)) and riskiness ('very risky' (1) to 'not risky at all' (7)). The score on safety was reversed before analysis, such that a higher score indicates a higher perceived risk of the vaccine. Internal consistency is very good (α=.85).

Perceived effectiveness of the COVID-19 vaccine: A similar question was used to assess the perceived effectiveness of the COVID-19 vaccine. Students were asked the following: 'To what extent do you think the following characteristics apply to COVID-19 vaccines?' Answers could be given on a seven-point scale, ranging from 'very ineffective' (1) to 'very effective' (7).

Normative beliefs about the COVID-19 vaccine (T2): The descriptive social norms in students' social environment regarding getting vaccinated against COVID-19 was assessed using two questions, distinguishing between the norm among family and that among friends. The following questions were used: '*In general, if a coronavirus vaccine that was approved safe and effective was available to your friends for free, what would most of your friends do?*' and '*In general, if a coronavirus vaccine that was approved safe and effective was available to your family for free, what would most of your family do*?'. Answers were given on a scale from 1 (definitely not get vaccinated) to 7 (definitely get vaccinated). An average of the two answers was taken (Spearman's rho=.62, $p<.001$).

Perceived benefits of the COVID-19 vaccine (T2): A question was asked on the perceived personal versus social benefits of COVID-19 vaccination using a bipolar seven-point scale. We asked students to complete a statement— '*Getting vaccinated against the coronavirus will mainly benefit:*', with answer options ranging from 'myself' (1) to '(vulnerable) others around me' (7).

Perceived risk of COVID-19 for oneself and for others (T2): Three questions were asked about the risk of COVID-19 for the students themselves. These questions asked about the perceived likelihood of getting infected with COVID-19, getting severely ill if infected and being hospitalized if infected. The same three questions were asked about the risk of COVID-19 for the friends and family of the student. Answers could be given on a seven-point Likert scale ranging from 'no chance at al' (1) to 'absolutely certain' (7). Average values of the three items were taken to create a general COVID-19 risk score for oneself and for others. Internal consistency is acceptable (COVID-19 risk: self α=.67; others α=.71).

COVID-19 infection (T2): Students were asked whether they had been infected with the coronavirus before (1=yes, either confirmed by a test or only expected; 0: no or have not been aware of it).

General risk attitude (T2): General risk attitudes were assessed by using the risk propensity scale (Meertens & Lion, 2008), which consists of seven items. All statements were rated in terms of agreement on a nine-point Likert scale, ranging from 'totally disagree' (1) to 'totally agree' (9), except for the final item, which was rated on a scale ranging from 'risk avoider' (1) to 'risk seeker' (9). Higher scores indicate a higher risk-seeking tendency. Internal consistency was good, at α=.77. A French translation was previously presented based on a back translation approach (Ferrero, 2016). The scale was translated to Dutch by two native speakers who first translated the scale individually, after which a consensus meeting took place to discuss and decide on inconsistencies.

Delay discounting (T1): Delay discounting is a behavioural measure related to impulsivity and reflects the degree to which people are able to delay rewards, i.e., a measure of impatience. Delay discounting was assessed by the discount rate, with a higher rate reflecting a faster devaluation of delayed rewards and thus greater impulsivity. To capture the discount rate in a fast and accurate manner, the 5-trail Adjusting Delay

Discounting Task was used, in which students had to make five consecutive hypothetical choices between receiving €1,000 after a specific delay and receiving €500 directly (Koffarnus & Bickel, 2014). The task starts with a delay of 3 weeks, which is increased or decreased based on previous choices. The discount rate is calculated using the hyperbolic discounting model (Mazur, 1987) and is log-transformed before analysis, as is commonly done in previous research (Koffarnus & Bickel, 2014; Yoon & Higgins, 2008).

Impulsivity (T1): The Barratt Impulsiveness Scale-Brief, which is a short unidimensional version of the BIS-11, was used to assess the personality construct of impulsivity (Patton et al., 1995; Steinberg et al., 2013). It consists of 8 items scored on a four-point scale, ranging from 'rarely/never' (1) to 'almost always/always' (4). Half of the items were reverse scored. Validated French and Dutch translations were used (Bayle et al., 2000; Lijffijt & Barratt, 2005). The reliability was good, at α=.75.

Optimism (T1): Using the Life-Orientation Test-Revised, dispositional optimism was measured (Scheier et al., 1994). Both Dutch and French translations were already available (ten Klooster et al., 2010; Trottier et al., 2007). The scale consists of 10 items, of which four are filler items. Answers are given on a five-point scale, ranging from 'strongly disagree' (1) to 'strongly agree' (5). Higher scores indicate a higher level of dispositional optimism. Internal consistency was good, as reflected by Cronbach's alpha (α=.81).

Self-efficacy (T1): General self-efficacy was measured using the General Self-Efficacy Scale, which was designed to predict individuals' coping with daily hassles and adaptation after stressful events (Schwarzer & Jerusalem, 1995). The scale consists of ten items scored on a four-point scale (1: not at all true; 4: exactly true). French and Dutch translations were available (Dumont et al., 2000; Teeuw et al., 1994). Internal consistency was very good, at α=.85.

Psychopathy (T1): To assess subclinical psychopathy, the psychopathy subscale of the Short-Dark Triad was used (D. N. Jones & Paulhus, 2014). The scale generally consists of 9 items. One item ('*I enjoy having sex with people I hardly know*') was not included due to cultural controversy. Answers were given on a five-point scale, ranging from 'strongly disagree' (1) to 'strongly agree' (5). Previously made Dutch and French translations were used (Atitsogbe et al., 2020). Internal consistency was relatively low but acceptable (α=.64).

Altruism (T1): The altruism (versus antagonism) subscale of the 100-item version of the HEXACO Personality Inventory-Revised was used, which consists of four questions scored on a five-point scale (1: 'strongly disagree'; 5: 'strongly agree') (Lee & Ashton, 2018). Two questions were reverse coded and then transformed; higher scores indicate higher levels of altruism (i.e., being sympathetic and kind). Dutch and French translations were available (Boies et al., 2004; de Vries et al., 2008). Internal consistency was low, at α=.58. Previous studies have found similar low alphas of the altruism subscale while also showing high test-retest reliability and validity (Lee & Ashton, 2018; Romero et al., 2015). There

has been a debate on the relevance of alpha values in evaluating brief personality constructs in such cases (de Vries, 2013; McCrae et al., 2011).

Need to belong (T2): The need to belong was assessed using the single-item Need to Belong scale (SIN-B) (Nichols & Webster, 2013). It is shown that the SIN-B explains most of the reliable variance of the longer Need to Belong scale (Nichols & Webster, 2013). The psychometric properties of the scale are good. Participants indicated to what extent they agreed with the statement '*I have the strong need to belong*' on a five-point scale (1: strongly disagree; 5: strongly agree). A French translation was taken from a French version of the full Need to Belong scale (Sanquirgo et al., 2012), and a Dutch translation was made by two native speakers and decided upon after a consensus meeting.

Trust in government and health authorities (T2): Trust in government was measured using the following item: 'In general, how much trust do you personally have in the [name country] government on a scale from 1 (no trust at all) to 10 (full trust)?' Trust in health authorities was assessed using a similar question and scale: 'In general, how much trust do you personally have in health authorities on a scale from 1 (no trust at all) to 10 (full trust)?' Since the two scores were highly correlated (r=.68), we used an average of the two scores for analyses.

International student (T1): We inferred that students who answered 'no' to the question '*Have you lived in [name country] for more than 5 years?*' were international students, which was coded with a value of 1.

Gender (T1): Gender was included as a binary variable, with female (1) and male (0) as answer options.

Descriptive statistics

The means and standard deviations of all variables and correlations between all variables and vaccination intention and the 5C scale are presented in Table 5.1.

Methodology

The analyses used are linked to the first three objectives of the study. For the first objective, to assess the willingness to get vaccinated in our sample, the percentage of students who indicated a certain degree of willingness to get vaccinated against COVID-19 were calculated and discussed. For the second objective, studying the link between the 5C model and vaccination intention, one-sided ordinary least squares (OLS) regression analyses were conducted with the 5C subscales as independent variables, vaccination intention as a dependent variable, and country and gender as control variables. We controlled for country differences by including country dummies, and Dutch students were used as a reference group. The standardized coefficients of the regression analysis were used to assess the effect sizes of all Cs to conclude which of these components is most important in explaining COVID-19 vaccination intention among students. Finally, for the third objective, to study the indirect effects of a set of psychological characteristics

on vaccination intention through the 5C model, mediation analyses were conducted following the procedure suggested by Hayes using the PROCESS macro in SPSS (Hayes, 2017). For each C of the 5C model, three individual regression models were carried out to estimate the indirect effects of the psychological variables expected to be mediated by the C of interest. The first regression model estimated, Model 1, includes the independent variables and control variables, with vaccination intention as the dependent variable. This model presents the total effect of the independent variables (path c, see Figure 5.2). The second regression model, Model 2, includes all independent variables and control variables, with the mediator as the dependent variable. This model includes path 'a' (Figure 5.2) and presents the relationship between the psychological variable and the C of interest. Finally, Model 3 is similar to Model 2, but includes—next to the independent variables and controls—the mediator as a predictor, with vaccination intention as the dependent variable. This model contains the direct effect (path c', Figure 5.2), representing the link between the psychological variable and vaccination intention now controlling for the mediator, and path b (Figure 5.2), representing the link between the mediator and COVID-19 vaccination intention. Inference on the indirect effect should not be based on the significance of the paths that define it (a and b), but on explicit estimation of the effect by using bias-corrected bootstrapping, which is now considered the standard for testing mediation (Hayes & Scharkow, 2013; Shrout & Bolger, 2002). Therefore, to estimate the point estimates and confidence intervals of the indirect effects (a*b), we estimated 95% bias-corrected confidence interval (95% BC-CI) using PROCESS. We conclude that indirect effects are statistically significant if the 95% BC-CI excludes zero. As the unstandardized indirect effect cannot be interpreted as a measure of effect size (Cheung, 2009), we present standardized indirect effects for all continuous independent variables and partially standardized indirect effects for all binary independent variables (Cheung, 2009; Hayes, 2017). Each of the three regression models were estimated including all the psychological variables expected to be related to a particular C at the same time. Consequently, the direct and indirect effects were estimated whilst controlling for the other predictors of the C. All resulting paths can therefore be interpreted as if they had been estimated simultaneously using simultaneous equation modelling (Hayes, 2017). All data analyses were conducted using IBM SPSS for Windows Version 25.0 (*IBM SPSS Statistics for Windows, Version 25.0*, 2017).

Table 5.1 Range, mean (*M*) and standard deviations (*SD*) of all variables and correlations of all variables with vaccination intention and the 5C scale

Variable (range)	*M*	*SD*	1	2	3	4	5	6
1. Vaccination intention (1-7)	5.79	1.43	-					
2. Confidence (1-7)	4.97	1.48	.63***	-				
3. Complacency (1-7)	2.08	1.09	-.50***	-.41***	-			
4. Constraints (1-7)	1.88	1.01	-.47***	-.49***	.53***	-		
5. Calculation (1-7)	4.79	1.44	-.29***	-.32***	.21***	.25***	-	
6. Collective Responsibility (1-7)	6.04	1.08	.65***	.56***	-.59***	-.51***	-.24***	-
7. Perceived risk C-19 vaccine (1-7)	3.57	1.32	-.57***	-.79***	.33***	.45***	.35***	-.50***
8. Perceived effectiveness C-19 vaccine (1-7)	5.17	1.20	.42***	.66***	-.34***	-.35***	-.20***	.42***
9. Descriptive norm C-19 vaccine (1-7)	5.37	1.33	.61***	.53***	-.33***	-.38***	-.28***	.45***
10. Benefits C-19 vaccine: self vs others (1-7)	5.45	1.41	-.05	.04	.06**	-.02	.003	.07**
11. Perceived risk C-19: Self (1-7)	3.09	0.93	-.01	-.10***	-.20***	.03	.03	.08***
12. Perceived risk C-19: Others (1-7)	4.23	0.92	.001	-.06**	-.19***	-.02	.04	.13***
13. Infection C-19 (0/1)	0.21	0.40	-.09***	-.10***	.12***	.09***	.02***	-.07**
14. Risk attitude (1-9)	3.69	1.24	-.12***	-.09***	.24***	.07**	-.002	-.18***
15. Delay discounting (ln(.00011) – ln(24))	-6.11	1.78	-.03	-.06***	.08**	.07**	.01	-.06*
16. Optimism (1-5)	3.29	0.75	.01	.12***	.05	-.08***	.03	.01
17. Impulsivity (1-4)	1.96	0.46	-.10***	-.09***	.11***	.06**	-.09***	-.10***
18. Self-efficacy (1-4)	3.08	0.45	-.01	.04***	.05*	-.10***	.12***	.03
19. Psychopathy (1-5)	1.89	0.52	-.09***	-.10***	.21***	.15***	.02	-.16***
20. Altruism (1-5)	4.06	0.59	.01	-.03	-.13***	-.02***	.12***	.13***
21. Need to belong (1-5)	3.40	1.03	.08***	.01	-.06*	.003	.02	.09***
22. International student (0/1)	0.13	0.33	.02	.04	.04	.06**	.001	-.03
23. Trust govt. & health authorities (1-10)	6.61	1.86	.43***	.67***	-.32***	-.35***	-.22***	.40***
24. Female (0/1)	0.59	0.49	-.12***	-.21***	-.04	.05	.10***	-.03

Note: *: $p<.10$, **: $p<.05$, ***: $p<.01$, C-19=COVID-19, govt.=government.

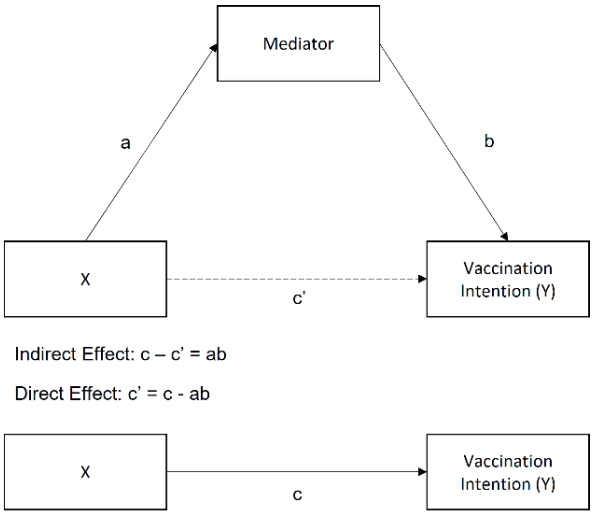

Figure 5.2. All paths involved in the mediation analyses, excluding covariates

5.3 Results

COVID-19 vaccination intention among students

Vaccination intention was measured on an ordinal scale, ranging from definitely not to definitely yes. We asked about intention under the condition that the COVID-19 vaccine was approved as being safe and effective and could be received free of cost. Figure 5.3 shows the percentage per vaccination intention category and cumulative percentages indicated with a dashed dark blue line (from positive to negative propensity). While the majority of students (85.49%) indicated that they intended to get vaccinated within a range between 'probably' and 'definitely', only 40.9% of the students were totally convinced to get vaccinated ('definitely yes'). Only a very small group was totally resistant to COVID-19 vaccination (1.58%) and indicated that they will 'definitely not' get vaccinated. Almost 1 out of 10 students (9.41%) indicated a negative propensity toward COVID-19 vaccination, as they answered within a range between 'probably not' and 'definitely not'. A total of 5.10% of students indicated being unsure about getting the COVID-19 vaccination and had neither positive nor negative vaccination intention.

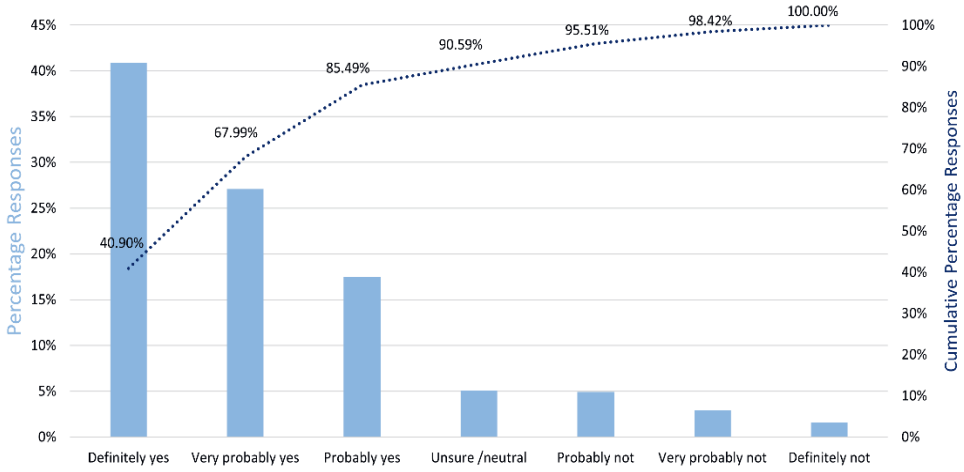

Figure 5.3 Vaccination intention in percentages per category and cumulative percentages (*N*=1,137)

5C model and COVID-19 vaccination intention

Table 5.2 presents the results of an OLS regression analysis containing the 5Cs as independent variables and vaccination intention as the dependent variable while controlling for gender and country. The regression model shows good fit and high explained variance (R^2=0.54). Variance inflation factors of the model are all between 1.1 and 2.1, indicating that there is no multicollinearity.

The table shows that all Cs are significantly related to vaccination intention in the expected direction based on the previous literature. Higher Confidence in the vaccine and higher feelings of Collective Responsibility both relate to higher intentions to get vaccinated against COVID-19, while Complacency, Calculation and Constraints are negatively related to COVID-19 vaccination intentions. Relative to the other Cs, the effect sizes of Confidence (B=0.32, β=0.33, *SE*=0.03, *p*<.001) and Collective Responsibility (B=0.46, β=0.35, *SE*=0.04, *p*<.001) are largest. We therefore infer that the levels of Confidence and Collective Responsibility play the most important role in explaining the intention to get vaccinated against COVID-19 among students.

Table 5.2 OLS regression analysis with vaccination intention (1-7) as the dependent variable

	B	95%-CI	β	*SE*	*p*
Intercept	2.25	[1.62, 2.88]		0.32	<.001
Confidence	0.32	[0.27, 0.37]	0.33	0.03	<.001
Complacency	-0.16	[-0.23, -0.09]	-0.12	0.04	<.001
Constraints	-0.08	[-0.15, -0.003]	-0.05	0.04	.04
Calculation	-0.06	[-0.10, -0.01]	-0.06	0.02	.01
Collective Responsibility	0.46	[0.39, 0.53]	0.35	0.04	<.001
Female (=1)	-0.11	[-0.23, 0.01]	-0.04	0.06	.08
Belgium dummy (=1)	-0.003	[-0.17, 0.16]	-0.001	0.09	.97
Portugal dummy (=1)	-0.03	[-0.21, 0.16]	-0.01	0.10	.79
R^2	0.54				
F	163.680 (p<.001)				
N	1,127				

Note: B is the unstandardized beta, and *β* is the standardized beta. Dutch students serve as the reference group.

The 5C model as a mediator in explaining vaccination intention

For the third objective, mediation analyses were conducted (Hayes, 2017). Models were estimated for all expected predictors of a particular C at the same time. In this way, we could ascertain the direct and indirect effects of the variables of interest while accounting for the effects of the other predictors of the studied C. In Tables 5.3 to 5.7, the results of mediation analyses are presented, while each table presents the analyses of a particular C.

Figure 5.4 shows an example of all relationships presented in the tables, using the example of the perceived safety of the vaccine as an independent variable and Confidence

as a mediator (Table 5.3). In Figure 5.4, we do not show the covariates for clarity reasons, while they are controlled for in the analyses. As shown above, Confidence is strongly positively related to COVID-19 vaccination intention among students. The results of the mediation analyses in Table 5.3 show that the perceived risk of the COVID-19 vaccine is most strongly associated with vaccination intention through Confidence (*ab*=-0.17; 95% bias-corrected confidence interval (95% BC-CI) = [-0.22, -0.13]), of which all corresponding relationships are visually presented in Figure 5.4. Additionally, the perceived effectiveness of the vaccine (*ab*=0.09; 95% BC-CI = [0.07, 0.12]) and trust in the government and health authorities (*ab*=0.11; 95% BC-CI = [0.08, 0.14]) are positively and significantly related to vaccination intention through Confidence. Moreover, a higher descriptive norm (normative beliefs) surrounding COVID-19 vaccination among students' family and friends (*ab*=0.03., 95% BC-CI = [0.02, 0.05]) is also significantly related to higher COVID-19 vaccination intention through Confidence, although the indirect effect is small. Finally, the descriptive norm has a very strong direct relationship with vaccination intention, even after controlling for Confidence (β=0.38, p<.01).

Table 5.3 Mediation analyses with Confidence as the mediator and vaccination intention as the dependent variable (*N*=1,124)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Confidence		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	β	p	β	p	β	p	Indirect effect [95% BC-CI]
Predictors							
Trust in government & health authorities	0.11	<.001	0.29	<.001	-0.004	.88	**0.11 [0.08 , 0.14]**
Normative beliefs	0.41	<.001	0.08	<.001	0.38	<.001	**0.03 [0.02 , 0.05]**
Perceived risk of vaccine	-0.29	<.001	-0.44	<.001	-0.12	<.001	**-0.17 [-0.22 , -0.13]**
Perceived effectiveness of vaccine	0.07	.01	0.23	<.001	-0.02	.51	**0.09 [0.07 , 0.12]**
Optimism	-0.04	.08	0.03	.08	-0.05	.02	0.01 [-0.001 , 0.02]
Control variables							
Female (=1)	0.03	.26	-0.04	.02	0.04	.07	
Belgium dummy (=1)	0.08	.01	-0.05	.01	0.10	<.001	
Portugal dummy (=1)	0.01	.63	-0.002	.28	0.02	.43	
Mediator							
Confidence					0.39	<.001	
R^2	0.48		0.76		0.51		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

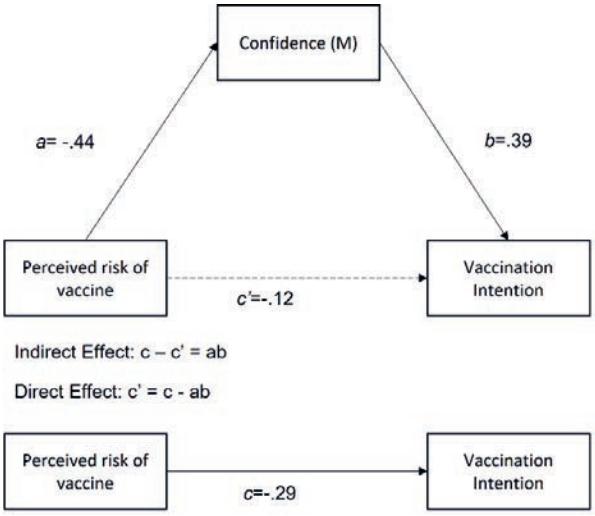

Figure 5.4 Example of all paths involved in mediation analyses using the independent variable 'perceived risk of vaccine' and mediator 'Confidence' (Table 5.3), excluding covariate

Table 5.4 presents the analyses involving Calculation as a mediator. The perceived risk of the COVID-19 vaccine is significantly and negatively related to vaccination intention through Calculation (*ab*=-0.04, 95% BC-CI = [-0.06, -0.02]). A higher perceived risk of the vaccine is related to more Calculation, which is subsequently related to a lower intention to get vaccinated against COVID-19. Moreover, a small indirect effect is present for the level of impulsivity, and more impulsive students show lower levels of Calculation, which is related to lower vaccination intention (*ab*=0.01, 95% BC-CI = [0.01, 0.02]). Other indirect effects, which were expected, are insignificant.

Table 5.4 Mediation analyses with Calculation as the mediator and vaccination intention as the dependent variable (*N*=1,129)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Calculation		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Perc. risk of C-19: self	0.06	.02	-0.06	.08	0.06	.04	0.01 [-0.001 , 0.01]
Perc. risk of C-19: others	0.01	.76	0.03	.37	0.01	.68	-0.003 [-0.01 , 0.004]
Perceived risk of vaccine	-0.57	<.001	0.35	<.001	-0.53	<.001	**-0.04 [-0.06 , -0.02]**
Risk attitude	-0.07	.01	-0.02	.53	-0.07	.01	0.002 [-0.01 , 0.01]
Optimism	-0.03	.18	0.04	.20	-0.03	.23	-0.004 [-0.01 , 0.002]
Impulsivity	-0.06	.03	-0.11	<.001	-0.07	.01	**0.01 [0.01 , 0.02]**
Psychopathy	0.002	.94	0.02	.50	0.004	.87	-0.002 [-0.01 , 0.004]
Control variables							
Female (=1)	-0.02	.38	0.02	.47	-0.02	.42	
Belgium dummy (=1)	-0.01	.77	0.03	.51	-0.01	.83	
Portugal dummy (=1)	0.001	.98	-0.03	.41	-0.003	.94	
Mediator							
Calculation					-0.11	<.001	
R^2	0.34		0.14		0.35		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Analyses with Complacency as a mediator are presented in Table 5.5. All expected indirect effects are significant. Stronger indirect effects are present for the descriptive norm surrounding COVID-19 vaccination among students' social circles (*ab*=0.12, 95% BC-CI = [0.09, 0.15]). A higher descriptive norm surrounding COVID-19 vaccination is related to lower Complacency and therefore to higher vaccination intention. Moreover, the perceived risk of COVID-19 for both students themselves (*ab*=0.05, 95% BC-CI = [0.03, 0.08]) and for their social environment (*ab*=0.05, 95% BC-CI = [0.02, 0.07]) is associated with higher vaccination intention through lower Complacency. Having been infected with COVID-19 is related to higher Complacency and, therefore, lower vaccination intention (partially standardized *ab*=-0.05, 95% BC-CI = [-0.11, -0.003]). Students' general risk attitude (*ab*=-0.05, 95% BC-CI = [-0.08, -0.03]) and discount rate (*ab*=-0.03, 95% BC-CI = [-0.05, -0.01]) are also indirectly negatively associated with COVID-19 vaccination intention through higher Complacency.

Table 5.5 Mediation analyses with Complacency as the mediator and vaccination intention as the dependent variable (*N*=1,128)

Dependent variable	**Model 1** Vaccination Intention		**Model 2** Complacency		**Model 3** Vaccination Intention		**Indirect effect**
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Perceived risk of C-19: self	0.03	.33	-0.15	<.001	-0.03	.33	**0.05 [0.03 , 0.08]**
Perceived risk of C-19: others	0.04	.13	-0.12	<.001	0.0003	.99	**0.05 [0.02 , 0.07)**
Normative beliefs	0.60	<.001	-0.33	<.001	0.49	<.001	**0.12 [0.09 , 0.15]**
C-19 Infection	-0.03	.24	0.06	.02	-0.01	.76	**-0.05 [-0.11 , -0.003]**
Risk attitude	-0.07	.003	0.15	<.001	-0.02	.40	**-0.05 [-0.08 , -0.03]**
Delay discounting	-0.02	.47	0.09	<.001	0.01	.51	**-0.03 [-0.05 , -0.01]**
Control variables							
Female (=1)	-0.05	.08	-0.04	.18	-0.06	.01	
Belgium dummy (=1)	0.02	.60	-0.11	.003	-0.02	.49	
Portugal dummy (=1)	-0.01	.75	-0.15	<.001	-0.06	.05	
Mediator							
Complacency					-0.35	<.001	
R^2	0.38		0.23		0.48		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Table 5.6 shows the mediation analyses with Constraints as a mediator. We only find a small significant indirect effect of self-efficacy (*ab*=0.03, 95% BC-CI = [0.003, 0.07]). Students with a higher level of self-reported self-efficacy perceive fewer constraints, which is related to higher vaccination intention. However, a significant direct effect of self-efficacy on vaccination intention remains after controlling for Constraints (β=-0.09, *p*<.01). Optimism, impulsivity and being an international student do not indirectly relate to vaccination intention through Calculation as the confidence intervals corresponding to these variables contain zero.

Table 5.6 Mediation analyses with Constraints as the mediator and vaccination intention as the dependent variable (*N*=1,129)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Constraints		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Optimism	0.02	.62	-0.05	.11	-0.01	.78	0.02 [-0.003 , 0.05]
Impulsivity	-0.11	<.001	0.03	.42	-0.10	<.001	-0.01 [-0.04 , 0.02]
Self-efficacy	-0.06	.10	-0.07	.03	-0.09	.003	**0.03 [0.003 , 0.07]**
International Student	0.01	.64	0.06	.05	0.04	.11	-0.09 [-0.18 , 0.01]
Control variables							
Female (=1)	-0.10	<.001	0.01	.63	-0.10	<.001	
Belgium dummy (=1)	-0.08	.07	0.05	.22	-0.05	.16	
Portugal dummy (=1)	0.06	.14	-0.09	.03	0.02	.60	
Mediator							
Constraints					-0.47	<.001	
R^2	0.05		0.03		0.26		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

Analyses with Collective Responsibility as a mediator are presented in Table 5.7. We show that the risk of COVID-19 for family and friends, as perceived by students, is positively related to vaccination intention through Collective Responsibility (*ab*=0.08, 95% BC-CI = [0.04, 0.13]). Moreover, several personality traits are indirectly associated with vaccination intention through Collective Responsibility. Higher levels of psychopathy traits are negatively related to vaccination intention through lower levels of Collective Responsibility (*ab*=-0.08, 95% BC-CI = -0.13, -0.04]). Conversely, higher levels of altruism (*ab*=0.06, 95% BC-CI = [0.01, 0.10]) and the need to belong (*ab*=0.07, 95% BC-CI = [0.03, 0.11]) positively indirectly relate to vaccination intention through Collective Responsibility.

Table 5.7 Mediation analyses with Collective Responsibility as the mediator and vaccination intention as the dependent variable (*N*=1,127)

	Model 1		**Model 2**		**Model 3**		**Indirect effect**
Dependent variable	Vaccination Intention		Collective Responsibility		Vaccination Intention		
Paths	c (total effect)		a		b and c' (direct effect)		a*b
Coefficient	*β*	*p*	*β*	*p*	*β*	*p*	Indirect effect [95% BC-CI]
Predictors							
Perceived risk of C-19: others	0.03	.27	0.13	<.001	-0.05	.04	**0.08 [0.04 , 0.13]**
Benefits vaccine: self vs others	-0.04	.13	0.05	.09	-0.08	<.001	0.03 [-0.01 , 0.07]
Pyschopathy	-0.10	<.001	-0.13	<.001	-0.02	.35	**-0.08 [-0.13 , -0.04]**
Altruism	0.01	.66	0.09	.01	-0.04	.09	**0.06 [0.01 , 0.10]**
Need to Belong	0.14	<.001	0.11	<.001	0.06	.01	**0.07 [0.03 , 0.11]**
Control variables							
Female (=1)	-0.14	<.001	-0.08	.01	-0.08	<.001	
Belgium dummy (=1)	-0.14	<.001	-0.09	.04	-0.09	.01	
Portugal dummy (=1)	0.03	.41	0.06	.12	-0.01	.82	
Mediator							
Collective Responsibility					0.65	<.001	
R^2	0.07		0.08		0.45		

Note: The indirect effects that are bold printed do not contain zero in their 95% bias-corrected confidence intervals (95% BC-CI) and are interpreted as being statistically significant. β is a standardized coefficient. The indirect effect is completely standardized for continuous variables and partially standardized for binary variables.

5.4 Discussion

According to the results, the majority of the 1,137 Dutch, Belgian and Portuguese students in our sample do not have a full and definite intention to get vaccinated against COVID-19. More than half of them (57.7%) fall on a continuum between leaning toward acceptance and leaning toward resistance. Although a large majority of our sample has a positive propensity toward getting vaccinated against COVID-19 (85% of students indicate intentions between 'probably' and 'definitely'), the group of students who are completely acceptant of the vaccine (41%) is quite small. At the same time, only a very small group indicates to refuse a vaccination (1.6%). To achieve herd immunity through vaccination, it is crucial that more students shift their intention toward a more positive definite answer. Most gains can be achieved by targeting students who already have a positive propensity toward vaccination but are not completely certain. As previous studies mostly use yes/no scales to assess vaccination intention, it is not possible to directly compare our results to those of previous studies. For example, using a yes/no format, 95% of respondents indicate a willingness to be vaccinated against COVID-19 in a sample of students in Italy (Pastorino et al., 2021).

5C drivers of students' COVID-19 vaccination intention

We show that all five components of the 5C model—Confidence, Calculation, Complacency, Constraints and Collective Responsibility—are related to COVID-19

vaccination among students in our sample. Confidence, i.e., the degree of trust in the vaccine and the system that delivers it, and Collective Responsibility, i.e., the willingness to protect others by getting vaccinated, are most strongly related to COVID-19 vaccination intention. This suggests that campaigns targeted at increasing vaccination intention among students will likely be most successful when focused on enhancing the levels of both Confidence and Collective Responsibility. Smaller negative links are present between vaccination intention and Complacency, Constraints, and Calculation.

Psychological profiles underlying COVID-19 vaccination intention

We show that psychological profiles indeed play an important role in explaining vaccination intention. As vaccination campaigns will likely be most successful when targeted at Confidence and Collective Responsibility, we discuss which psychological variables underlie these drivers and should therefore be considered when designing interventions.

First, we show that the perceived risk and effectiveness of the vaccine both affect vaccination intention through changes in Confidence levels. We find that the level of Confidence is lower for students in our sample who perceive the vaccine as being riskier (e.g., less safe and with a higher risk of side effects) and less effective. Moreover, trust in the government and health authorities plays an important role in explaining vaccination intention through Confidence. Students with lower trust in these institutions report lower levels of Confidence, which translates into lower vaccination intention. Finally, the descriptive norm in students' environment—the degree to which family and friends intend to get vaccinated—has a small effect on intention through Confidence. Moreover, we show that the descriptive norm also has a strong direct relationship with vaccination intention.

With respect to Collective Responsibility, it is evident that the perceived risk of COVID-19 for people in a student's social circle indirectly relates to his/her vaccination intention through Collective Responsibility. Students in our sample who perceive the risk of COVID-19 for their environment to be low indicate a lower intention to get vaccinated against COVID-19, motivated by a lower willingness to protect others. Moreover, we show that personality plays an important role in explaining the perception of vaccination as a Collective Responsibility. Psychopathy traits, which are related to antisocial behaviour caused by deficits in empathy, emotion, and self-control (D. N. Jones & Paulhus, 2014), negatively relate to Collective Responsibility and, therefore, to a lower intention to get vaccinated. Similarly, students with more altruistic personalities, e.g., those who feel more sympathy toward others and want to help those in need, have a higher intention to get vaccinated against COVID-19, through higher levels of Collective Responsibility. Additionally, the degree to which students feel the 'need to belong' indirectly relates to higher vaccination intention through Collective Responsibility. The need to belong relates both to the human needs of wanting to affiliate with others and wanting to be accepted

by others (Baumeister & Leary, 1995). We expect that both a need to be in contact with others at risk for COVID-19 without worrying and signalling prosocial behaviour to be accepted by others underlie the indirect positive relationship between the need to belong and vaccination intention through Collective Responsibility.

Implications for vaccination campaigns and interventions

What implications can these results have for public health policy? First, the data suggest that seeking to increase both Confidence and Collective Responsibility simultaneously will be worthwhile since vaccination interventions that address multiple underlying drivers have been shown to be more successful (Frew & Lutz, 2017). We provide several suggestions for both drivers separately.

Based on the findings of our study, in targeting Confidence it is important to influence the perceived safety and effectiveness of the COVID-19 vaccine. In our survey, the most prevalent reasons for not getting vaccinated were related to worries about safety, side effects, development speed and the wish for the vaccine to be proven effective and safe over a longer period. By challenging the misinformation surrounding the vaccine and providing factual information on, for example, the reasons that the vaccine was able to be developed so fast, Confidence in the vaccine can be increased. However, it is important to think about how and who communicates this information because, for people with a strong prior opinion, a correction of information could backfire and lead to even more divided attitudes (Glaeser & Sunstein, 2014). Since we showed that low Confidence is related to lower trust in the government and health authorities in our sample, information about safety and efficacy should preferably be communicated by people not within traditional positions of authority. A good strategy would be to use 'surprising validators', i.e., people seen as credible to the target audience but who are not expected to share this information (Glaeser & Sunstein, 2014). To reach students, one could, for example, think of campaigns including peers or celebrities.

We find Collective Responsibility to be the strongest predictor of COVID-19 vaccination among students of our sample. It is logical that this is an important driver for this group since students are less at risk of developing severe health consequences if infected by COVID-19. Willingness to protect others by getting vaccinated is thus a strong motivator. We show that the perceived risk of COVID-19 for others in a student's social circle indirectly affects his or her vaccination intention through Collective Responsibility. Students with at-risk family members may thus be more likely to get vaccinated to protect those around them. Vaccination campaigns aimed at students may therefore be more successful by showing the risks for those in the close environment of students. Explaining the concept of herd immunity through vaccination is an important approach, as was also experimentally shown (Betsch et al., 2017). Students can and should be made aware that they are not just making an individual decision but also a collective decision when deciding whether to get vaccinated. To increase identification, campaigns could discuss

reasons why certain groups are unable to get vaccinated (e.g., people with allergic reaction to vaccines, autoimmune diseases or other conditions). Nevertheless, our results also indicate that students in our sample with less altruistic, emphatic, and social personalities were less likely to feel Collective Responsibility. Influencing these personality traits is likely to be very difficult, maybe even impossible. But one should consider that, as these students feel less empathy toward others, campaigns focused on stressing the prosocial consequences of vaccination may not be sufficient to influence certain groups as strongly and could even promote the idea of free riding (Ibuka et al., 2014). Therefore, it remains important to communicate the personal risks of COVID-19 for young adults, for example, by communicating the possibilities of long-lasting adverse consequences of COVID-19, also known as 'long COVID' (Mahase, 2020).

In addition to positively affecting vaccination intention through Confidence and Complacency, we show that the descriptive norm has a strong direct relationship with vaccination intention. Descriptive norms have been proven to be strong drivers of behaviour, especially in times of uncertainty (Cialdini, 2009). Vaccination campaigns may be more successful if they make the norm among students more salient by stressing that the majority of students intend to get vaccinated.

In most countries, young adults will be the last in line for vaccination. Although this makes sense from a health perspective, governments should realize that by the time students must actively decide whether to get vaccinated, the vaccination strategy may have already led to decreased infection rates and, therefore, also to a lower perceived risk of COVID-19. Importantly, when family members are already vaccinated, the level of Collective Responsibility may decrease through a lower perceived risk of COVID-19 for others. It is therefore vital that campaigns focused on students start early on since the necessity of vaccination is most salient at that stage, and, therefore, positive intentions can be formulated. Studies show that once a strong enough intention to get vaccinated is formed, this likely translates into action (Auslander et al., 2019). In terms of policy, to enhance the transition from intention to behaviour, the process of getting vaccinated should be easy, fast and without unforeseen barriers (daCosta DiBonaventura & Chapman, 2005).

Limitations and future research

The study has several limitations. *First*, we measure vaccination intention and not actual vaccination behaviour. As the intention-behaviour gap shows us that not all intentions translate into behaviour (Sheeran, 2002), it would be interesting to research whether our results also hold with actual vaccination behaviour as the dependent variable. *Second*, as we did not use a probabilistic sample, the use of inferential techniques is not entirely justifiable (Copas & Li, 1997; Smith, 1983). While we used a large sample of students from three countries and, during the sampling process, approached large and representative groups of students, participation was (mostly) on a voluntary basis. Since

we expected students with higher levels of social desirability to be more likely to participate, we conducted all analyses controlling for social desirability. The fact that our conclusions remained the same strengthen our belief in the validity of our results. However, it is possible that our sample suffers from other type of non-response bias and that our results should therefore be interpreted with caution. *Third*, as discussed, vaccination intention is context- and time-dependent. Since we use a snapshot of vaccination intention assessed in December 2020, attitudes and intention toward vaccination may have shifted over time. *Finally*, for future research, an important next step will be to design and test which interventions have the best outcomes in both experimental and real-life settings.

Despite its limitations, our study provides governments and public health officials with much needed levers of the important drivers of COVID-19 vaccination intention among students. Given the suggested rate of COVID-19 vaccination acceptance in our sample, we hope that our findings will contribute to the designing and improving of effective public health messaging to increase the acceptance above the percentages needed to achieve herd immunity.

5.5 Data availability

The survey data that support the findings of this study are available from the EUR Data Repository (doi: 10.25397/eur.14356229).

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PART III

Entrepreneurship and the COVID-19 pandemic

6

Chapter 6

Entrepreneurial Intention of Dutch Students During the COVID-19 Pandemic: Are Today's Students Still Tomorrow's Entrepreneurs?

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Abstract

In early 2020, it became clear that policy and public health responses to the pandemic would generate an unprecedented economic crisis. Entrepreneurship is documented as helping economies recover from economic slowdowns (Koellinger & Thurik, 2012). Hence, in this chapter we assess the development of entrepreneurial intention (EI) during the pandemic. In particular, we focus on EI of students, since they may be the ones to create a novel wave of firms to fill in the gaps caused by the crisis or to replace firms weakened by the crisis. The present analysis is the first to investigate whether and in which direction EI has changed in the beginning of the COVID-19 pandemic using a survey of 1,090 students from Erasmus University Rotterdam. Moreover, we study how a set of COVID-19-related, context-related, and demographic variables is connected to changes in EI. While most students report their EI to be unaffected by the pandemic, 16% report a decrease in EI, and 19% report an increase in EI. These changes appear to be most strongly associated with pandemic-induced changes in mental health and with gender. We find that students who report a negative change in their mental health are more likely to indicate lower EI rather than higher EI. Moreover, females are more likely to indicate decreased EI due to the pandemic, while males are more likely to report increased EI, indicating a potential increase in the gender gap in entrepreneurship. Additionally, students with higher trust in the government are less likely to report lower EI relative to similar EI. Finally, we also find associations between change in EI and expected income in 10 years, compliance with COVID-19 regulations, age, and international student status.

6.1 Introduction

The COVID-19 pandemic has considerably affected the global economy, specifically hurting businesses and consequently business owners (Belitski et al., 2022). Nationwide lockdowns forced businesses to remain closed for many consecutive months, resulting in a substantial increase in economic uncertainty (Altig et al., 2020). While bankruptcies decreased by 17% in 2020 in the Netherlands—mainly due to fiscal measures taken by the government to counteract the effects of the pandemic—they are expected to increase when fiscal support phases out (Smid & Ciobica, 2021). According to Statistics Netherlands, in the fourth quarter of 2020, the pandemic resulted in the highest economic downturn in the Netherlands (-3.8%) since World War II. Moreover, the unemployment rate in the Netherlands rose from 2.9% to 4.6% between March and August 2020 (Statistics Netherlands, 2021). While multiple governmental support measures have limited negative consequences to a large extent, the COVID-19 pandemic revealed the risks associated with being a business owner, showing how external factors outside entrepreneurs' control can impact their businesses. In a survey among small and medium-sized enterprise (SME) owners in 23 countries conducted during the pandemic in 2020, 61% of business owners indicated that the existence of their business was under

threat due to the pandemic (Stephan, Zbierowski, Pérez-Luño, Klausen, et al., 2021a). Moreover, Kuckertz et al. (2020) reported that the growth and innovation potential of start-ups are at risk due to the pandemic and the measures taken by governments. Finally, it was shown that self-employed workers were affected more strongly than wage workers by the financial insecurities caused by the pandemic in terms of psychological distress (Patel & Rietveld, 2020), that their perceived level of burnout increased (Torrès, Benzari, et al., 2021; Torrès et al., 2022) and that health perception was affected (Torrès, Fisch, et al. 2021).

While most focus has been on the consequences of the pandemic for current and nascent entrepreneurs, the consequences of the COVID-19 pandemic may also shape the future of entrepreneurship by altering entrepreneurial intentions (EI) and the profile of the future entrepreneur (Liñán & Jaén, 2022). Potential future entrepreneurs have witnessed the pandemics' sizeable negative consequences and the economic uncertainty related to business ownership. This may negatively affect the EI of today's students. Therefore, the pandemic may not only have affected the current business landscape but could also lead to a future (temporary) decline in the number of start-ups. In line with this possibility, studies have shown that macroeconomic conditions when young shape job preferences for the rest of one's live, with those entering the job market during a recession giving higher priority to income for the rest of their lives (Cotofan et al., 2020). As Cotofan et al. (2020) also argued, the so-called 'impressionable years' (between ages 18 and 25) are crucial for shaping future preferences. Literature has shown that the historical environment in which a young person becomes active in the adult world shapes the formation of lasting values, attitudes, and preferences. During the impressionable years, people are highly susceptible to attitude change, although afterward this susceptibility drops drastically and remains low for the rest of one's life (Krosnick & Alwin, 1989). Taking this into account, students who form their future job preferences—and thus entrepreneurial aspirations—during the COVID-19 pandemic may have different attitudes and preferences for the rest of their lives.

On the other hand, the COVID-19 pandemic may have also increased the EI of students. As the job market has become increasingly challenging during the pandemic, the expected difficulties associated with finding a job could lead to higher EI due to more necessity-based entrepreneurship. Aucejo et al. (2020), for example, showed that in a US sample, 40% of students lost a job, internship or job offer and that the perceived probability of finding a job before graduation decreased by 20%. Moreover, studies have shown that graduates who enter the job market during a recession suffer from the consequences for up to ten years due to lower job opportunities and lower wages (Brunner & Kuhn, 2014; Kahn, 2010; Schwandt & von Wachter, 2019). The expected difficulties of finding employment may shift some students in the direction of self-employment, also

known as necessity entrepreneurship[17] (Bosma & Harding, 2007; van der Zwan et al., 2016). At the same time, the pandemic has changed consumption patterns, and stimulated growth in certain sectors, such as online retail, digital transformation, and healthcare (Donthu & Gustafsson, 2020; Sheth, 2020). These changes may create gaps in the market and hence opportunities for new businesses. Students may perceive these new business opportunities, which could translate into reporting increases in EI, also known as opportunity entrepreneurship (Bosma & Harding, 2007; van der Zwan et al., 2016). EI could therefore have increased both due to necessity as well as to opportunity. Taken together, EI may thus have shifted in two directions.

In addition to the potentially bidirectional changes in EI due to the pandemic, it is likely that perceptions of entrepreneurship are affected differently among various groups of students, influencing the profile of the next generation of entrepreneurs. In other words, some individual characteristics may affect whether EI stays the same, increases or decreases during the pandemic. With respect to the profile of current entrepreneurs, Grashuis (2021) showed that the effects of the pandemic varied across groups, with unemployment being more likely for younger, female, and nonwhite individuals. Moreover, Kuckertz (2021) showed that start-ups founded during the pandemic are characterized less by entrepreneurial teams and more by habitual entrepreneurs, indicating that the profile of the current entrepreneur may already have changed. With respect to future entrepreneurs, certain groups of students may be more discouraged by the pandemic from starting a business than others. For instance, due to their more risk-averse nature (Borghans et al., 2009; Verheul et al., 2012), women may be more discouraged by the perceived increase in uncertainty associated with starting a business, consequently increasing the already existing gender gap in entrepreneurship in the future.

With the considerable negative economic impact of the COVID-19 pandemic, entrepreneurship will be a key component in economic recovery. It is well documented that entrepreneurial activity affects economic growth, competitiveness, employment creation and high-quality innovation (Thurik & Wennekers, 2004; van Praag & Versloot, 2007; van Stel et al., 2005). The disruption of the pandemic may even call for more innovative start-ups, since the pandemic forced businesses and education to go online overnight, creating space for newcomers to enter these markets (Liñán & Jaén, 2022). If young adults are discouraged from starting a business, this situation may result in a decline in the factors that are influenced by entrepreneurship, such as innovation and job creation, leading to even longer-lasting consequences of the pandemic.

While there is a large body of literature on the drivers of EI, little is known about the effects of (health) crises on changes in EI. Brück et al. (2010) studied the effect of

[17] The entrepreneurship literature often distinguishes between necessity-driven and opportunity-driven entrepreneurship. While the first group is pushed into entrepreneurship because of the lack of other options in the labor market, the latter group is pulled into entrepreneurship because they see a business possibility (Bosma & Harding, 2007; R. W. Fairlie & Fossen, 2020; van der Zwan et al., 2016).

extreme events on individual perceptions and expectations of entrepreneurship and showed that natural disasters and terrorist attacks increase fear of failure, while violent conflict decreases it. Moreover, they showed that natural disasters mostly discourage females and older and low-income individuals from starting a business. Brück et al. (2010) showed that terrorist attacks positively affected the entrepreneurial activity of all population groups. In contrast, studying a sample of Afghans living in conditions of war and terror, Bullough et al. (2014) found that perceptions of danger from the environment lowered EI, while this effect was diminished for those with high resilience and entrepreneurial self-efficacy. Moreover, the perception of economic crisis as an obstacle negatively affects the likelihood of starting a business (Arrighetti et al., 2016). With respect to the COVID-19 pandemic, Ruiz-Rosa et al. (2020) showed that the EI of students decreased during the pandemic compared to before the pandemic.

Current study

As stressed by Liñán and Jaén (2022), it is important that the effects of the COVID-19 pandemic on EI be investigated, specifically focusing on the determinants that encourage and discourage changes in these intentions. While EI has been criticized as a measure of entrepreneurship[18], we believe that as the focus of this research lies on tomorrow's start-ups rather than today's start-ups it is crucial to use EI as an outcome. Moreover, according to Ajzen's Theory of Planned Behaviour, intention is a significant predictor of eventual behaviour. This link has been widely validated in the psychology literature for various behaviours (Kim & Hunter, 1993) and for entrepreneurial behaviour in particular (Kautonen et al., 2013, 2015).

In the current paper, we study the drivers of self-reported change in EI of a sample of 1,090 university students from the Netherlands. First, we investigate whether students self-report that their intentions have changed and, if so, in which direction. As stated above, the pandemic could have a two-sided effect on EI. On the one hand, it may lower EI due to the unprecedented high levels of economic uncertainty and exposure to the adverse consequences of the pandemic on businesses. On the other hand, it may strengthen EI through increases in necessity entrepreneurship – due to the unpredictability of the job market - and opportunity entrepreneurship – due to changed consumption patterns and the growth of certain sectors. Second, we study how a set of COVID-19-related, context-related and demographic variables relates to changes in EI. Specifically, we study four COVID-19-related variables: the self-reported effect of the pandemic on students' mental health, the self-reported effect of the pandemic on students' financial security, perceived risk of COVID-19 (infection and hospitalization) and compliance with COVID-19 measures. Additionally, we study how expectations of future income are connected to EI change. As discussed, governmental measures have considerably reduced the negative impact of the pandemic on businesses. Therefore, we

[18] Top entrepreneurship journals tend not to allow studies that use EI as an outcome measure.

also study the relationship between government trust and change in EI due to the pandemic. Moreover, we investigate how the COVID-19 pandemic may change or add to existing gender differences in entrepreneurship given that, despite initiatives to decrease the gender gap, women are underrepresented in entrepreneurship (Elam et al., 2019) and have lower intentions to start a business after graduation (Dabic et al., 2012; Elam et al., 2019; F. Wilson et al., 2007) Finally, we control for age, whether students are involved in a business or economics related study and whether students are domestic or international. We conduct a multinomial logistic regression analysis to investigate which variables relate to an increase or decrease in EI compared to no change in intentions.

As there is hardly any literature available on the drivers of change in entrepreneurial aspirations during pandemics, we do not formulate explicit hypotheses but will take an inductive approach and interpret and reflect on the outcomes in the discussion.

6.2 Data & measures

Dataset

We make use of data that were collected as part of the Erasmus University Rotterdam International COVID-19 Student Survey (Wismans, Letina, et al., 2020, 2021; Wismans, Thurik, et al., 2021). The first survey of this initiative took place during the early phase of the COVID-19 pandemic (April/May 2020, weeks 17-19). University students from ten countries worldwide participated. For the current study, we make use of data collected from Dutch university students who took part in this first survey. The sample consists of students from multiple faculties of the Erasmus University Rotterdam and was distributed using university platforms and university e-mail addresses. The survey could be completed in Dutch or in English. The total sample consisted of 1,090 students. All students signed an informed consent form before beginning the survey, and the study was approved by the Internal Review Board of the Erasmus University Rotterdam.

Measures

Change in entrepreneurial intention: Change in EI was measured by the following question: 'During the past two months, did your intention of starting your own firm change in a positive or negative way?'. Participants answered on a 5-point scale, ranging from 'It is much lower' (1), 'It is lower' (2), 'It remained equal' (3), 'It is higher' (4), and 'It is much higher (5). For statistical analyses, we created three groups: lower intentions (original values: '1', '2'), similar intentions (original value: '3') and higher intentions (original values: '4', '5').

Effect of COVID-19 on mental health: To assess how the pandemic affected students' mental health at the time of our survey, we asked the following question: 'How did/does the current corona crisis affect your general mental health?'. Answers were given

on a 5-point Likert scale, including 'Strongly negatively affected' (1), 'Slightly negatively affected' (2), 'Did not affect in any way' (3), 'Slightly positively affected' (4), and 'Strongly positively affected' (5).

Effect of COVID-19 on financial security: Similarly, to assess how the pandemic affected students' financial security at the time of our survey, we asked the following question: 'How did/does the current corona crisis affect your financial security/situation?'. Answers were given on a 5-point Likert scale, including 'Strongly negatively affected' (1), 'Slightly negatively affected' (2), 'Did not affect in any way' (3), 'Slightly positively affected' (4), and 'Strongly positively affected' (5).

Perceived personal risk of COVID-19: We asked two questions concerning the perceived personal risk of COVID-19. We asked about perceived likelihood that the following events would occur in the next two months: 'You get infected with the coronavirus?' and 'You must be hospitalized, if you are infected with the coronavirus?'. Answers were given on a 7-point Likert scale, ranging from 'No chance at al' (1) to 'Absolutely certain' (7). For the current study, we took the average of these two items to capture the perceived personal risk of COVID-19 (Pearson's r: .22, p<.001).

Compliance with COVID-19 measures: We measured compliance with COVID-19 measures on a 7-point Likert scale by asking the following question: 'To what extent have you followed the measures advised by the government to prevent the spread of the coronavirus?'. Answers ranged from 'I have not taken any measures' (1) to 'I have done everything that was possible' (7).

Expected income in 10 years: To assess expected yearly income, we asked the following question: 'What do you think your yearly income will be in 10 years in euros (i.e., do not adjust for your expectation of inflation over this period)?'. Answers were given on a 7-point Likert scale, including €0-€10.000 (1), €10.000-€30.000 (2), €30.000-€50.000 (3), €50.000-70.000 (4), €70.000-90.000 (5), €90.000-€110.000 (6), and more than €110.000 (7). We will treat this measurement as a continuous variable.

Government trust: We asked students the following question: 'In general, how much trust do you personally have in the Dutch Government on a scale from 1 (no trust at all) to 10 (full trust)?'.

Gender: A binary variable, with 0 reflecting male and 1 reflecting female.

Control variables: We controlled for age, study direction and international student status. Most students in our sample studied a subject related to business or economics (78%). As EI is expected to be higher for these students, we control for this factor using a binary variable (1: Economics/business related subject; 0 Other). Finally, our sample included international students (30.5%). As these students may have different levels of EI in general and may have a different frame of reference (e.g., different impacts of COVID-19 in their home country), we controlled for this aspect.

6.3 Results

Entrepreneurial intention and change in entrepreneurial intention

In Figure 6.1, we present students' self-reported change in EI as percentages. Most of the students (66%) indicated that their EI had not changed in a positive or negative way during the past two months. Nevertheless, the EI of one-third of students changed in a positive or negative direction during the beginning phase of the COVID-19 pandemic. As may be expected, the change occurred in both directions: in total, 15.76% of students indicated that their EI had become (much) lower, while 19.17% of students indicated that their EI had become (much) higher. For the rest of this paper, we use a categorization into three groups (lower, similar, higher).

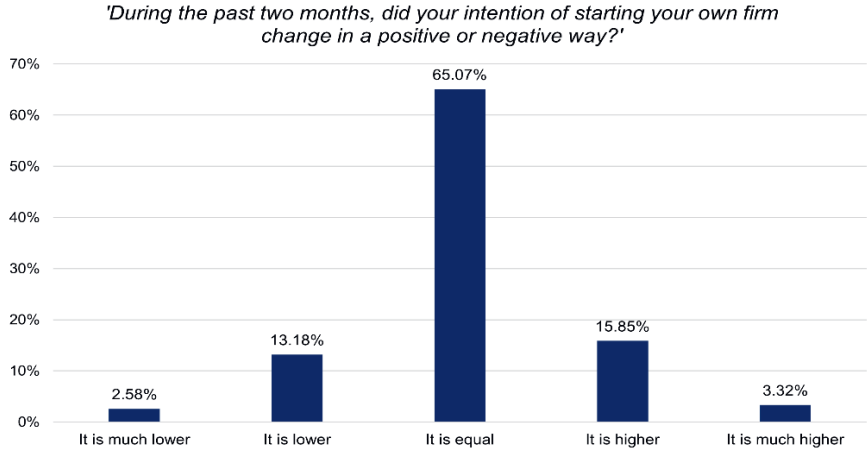

Figure 6.1. Frequencies (in %) of change in entrepreneurial intention (*N*=1,085)

Correlations, means, standard deviations

To assess which factors contributed to increases and decreases in EI in the context of a pandemic, we investigated a set of COVID-19-related, context-related and demographic variables. In Table 6.1, we present means and standard deviations (SD) for variables treated as continuous and percentages for categorical variables. Our sample consisted of slightly more females (57.5%) than males, which is representative for the gender distribution in higher education (World Economic Forum, 2020). Moreover, the majority of the sample studied a subject related to economics or business (77.5%), and most were domestic students (69.5%). Government trust was relatively high (*M*=7.28), which is in line with previous research showing increased political trust during the acute phase of the pandemic (Oude Groeniger et al., 2021). In Table 6.2, correlations between

all variables are presented. The strongest correlations were present between EI change and the effect of COVID-19 on mental health (r=.13, p<.001), gender (r=-.18, p<.001), and expected income in 10 years (r=.19, p<.001). However, these correlations only present linear relationships, while a multinomial logistic regression analysis – presented in the next part - will help us investigate whether there were nonlinear relationships among the variables studied and increasing versus decreasing EI.

Table 6.1 Means (*M*), standard deviations (*SD*) and frequencies (in %) of all variables

	M	*SD*	%
Change EI			
Lower			15.76%
Same			65.97%
Higher			19.17%
Effect C-19: mental health	2.39	0.89	
Effect C-19: financial security	2.78	1.04	
Perceived risk C-19	3.23	0.89	
Compliance C-19 measures	5.86	0.99	
Government trust	7.28	1.64	
Expected income 10 years	4.49	1.41	
Gender			
Male			42.45%
Female			57.54%
Age	20.76	2.81	
Economics/business student			
Economics/business student			77.53%
Other			22.47%
International student			
Domestic student			69.52%
International student			30.48%

Note: C-19 = COVID-19.

Table 6.2 Correlations of all variables included in analysis

	1	2	3	4	5	6	7	8	9	10	11
1. Change EI	-										
2. Effect C-19: mental health	.13***	-									
3. Effect C-19: financial security	.07**	.20***	-								
4. Perceived risk C-19	-.02	-.06*	-.06*	-							
5. Compliance C-19 measures	-.03	-.03	.03	.06**	-						
6. Government trust	.04	.05*	.12***	-.09***	.05*	-					
7. Expected income 10 years	.19***	.04	.02	-.06*	-.005	.0002	-				
8. Gender (female=1)	-.18***	-.06*	-.07**	.14***	.17***	-.07**	-.37***	-			
9. Age	-.03	-.02	-.09***	-.01	.02	.004	.08***	-.10***	-		
10. Econ/business student	.07**	.04	.10***	-.06**	.04	.08**	.24***	-.12***	-.10***		
11. International student	.08***	-.08***	-.10***	.19***	.11***	-.24***	.09***	.09***	-.05	.02	-

Note: C-19=COVID-19, *: p<.10, **: p<.05, ***: p<.01

Multinomial logistic regression explaining change in EI

To assess which of the variables were associated with a reported increase or decrease relative to unaffected EI during the COVID-19 pandemic, we conducted a multinomial logistic regression using 1,071 observations in total. The results of this analysis are presented in Table 6.3. Column 1 presents the betas (B), standard errors (*SE*), odds ratios (*OR*), accompanying 95% confidence intervals (95% CI's) and *p* values for lower EI compared to similar EI, while Column 2 does so for higher EI compared to similar EI and Column 3 does so for higher EI compared to lower EI. The full model is significantly better at explaining changes in EI than the model including only the intercept ($X^2(20)=113.61$, $p<.001$).

With respect to the COVID-19-related variables, a change in one's mental health due to the COVID-19 pandemic was significantly associated with changes in EI. Specifically, those who reported worsened mental health due to the pandemic were also more likely to report lower EI compared to similar EI (B=-0.24, *OR*=0.78, *p*=.02), while those who reported improved mental health during the pandemic were more likely to report higher EI compared to similar EI (B=0.24, *OR*=1.27, *p*<.01)[19]. In line with this result, those reporting higher EI compared to lower EI were more likely to report that the pandemic had a positive impact on their mental health (B=0.48; *OR*=1.61, *p*<.001). We did not find any relationship between the effect of the pandemic on students' financial security and changes in EI. Additionally, perceived personal risk of COVID-19 (in terms of getting infected with or hospitalized due to COVID-19) did not relate to changes in students' EI due to the pandemic. Interestingly, compliance with COVID-19 regulations in the Netherlands (i.e., regulations related to social distancing and improved hygiene) had a comparable relationship with reporting lower EI relative to similar EI (B=-0.18, *OR*=0.83, *p*=.04) and with reporting higher EI relative to similar EI (B=-0.21, *OR*=0.81, *p*=.01). This result indicates a U-shaped relationship between compliance and changes in EI, with students who were more compliant with COVID-19 regulations being more likely to report changes in EI in both directions, while those who reported lower compliance with COVID-19 regulations being more likely to report that the pandemic had not affected their EI.

Trust in government was negatively associated with reporting lower EI compared to similar EI: those with higher trust in government were less likely to report a decrease in EI compared to reporting similar EI (B=-0.11, *OR*=0.90, *p*=.04). There was a trend toward significance (*p*=.06) for the odds of reporting higher EI relative to lower EI, such that those who reported higher trust in government were more likely to report increased EI relative to decreased EI (B=0.13, *OR*=1.14). However, this link was not significant at conventional significance levels.

[19] This result was further shown in additional analyses not presented here, in which we included a categorical version of the mental health variable (lower, similar, higher), using similar as reference group.

Table 6.3 Results of multinomial logistic regression with change in EI as the dependent variable

	Lower EI vs. similar EI				*Higher EI vs. similar EI*				*Higher EI vs. lower EI*			
	B (*SE*)	*OR*	95% CI	*p*	B (*SE*)	*OR*	95% CI	*p*	B (*SE*)	*OR*	95% CI	*p*
Effect C-19: mental health	**-0.24 (0.11)**	**0.78**	**[0.64 , 0.97]**	**.02**	**0.24 (0.09)**	**1.27**	**[1.06 , 1.51]**	**.01**	**0.48 (0.13)**	**1.61**	**[1.26 , 2.07]**	**<.001**
Effect: C-19: financial security	-0.12 (0.09)	0.89	[0.75 , 1.05]	.18	-0.01 (0.08)	0.99	[0.85 , 1.16]	.94	0.11 (0.11)	1.12	[0.91 , 1.38]	.29
Perceived risk C-19	-0.03 (0.10)	0.97	[0.80 , 1.18]	.77	-0.05 (0.09)	0.95	[0.79 , 1.14]	.56	-0.03 (0.12)	0.98	[0.76 , 1.24]	.84
Compliance C-19 measures	**-0.18 (0.09)**	**0.83**	**[0.70 , 0.99]**	**.04**	**-0.21 (0.08)**	**0.81**	**[0.69 , 0.95]**	**.01**	-0.03 (0.11)	0.98	[0.79 , 1.20]	.81
Government trust	**-0.11 (0.05)**	**0.90**	**[0.81 , 1.00]**	**.04**	0.02 (0.05)	1.02	[0.92 , 1.12]	.76	0.13 (0.07)	1.14	[1.00 , 1.29]	.06
Expected income 10 years	-0.09 (0.07)	0.92	[0.80 , 1.05]	.22	**0.24 (0.06)**	**1.27**	**[1.12 , 1.44]**	**<.001**	**0.33 (0.09)**	**1.39**	**[1.17 , 1.64]**	**<.001**
Female	**0.42 (0.20)**	**1.52**	**[1.02 , 2.26]**	**.04**	**-0.57 (0.18)**	**0.57**	**[0.40 , 0.81]**	**.002**	**-0.99 (0.25)**	**0.37**	**[0.23 , 0.61]**	**<.001**
Age	0.04 (0.03)	1.04	[0.98 , 1.10]	.21	**-0.09 (0.05)**	**0.91**	**[0.83 , 1.00]**	**.04**	**-0.13 (0.05)**	**0.88**	**[0.79 , 0.97]**	**.01**
Economics/business student	0.20 (0.21)	1.23	[0.81 , 1.86]	.34	0.16 (0.23)	1.18	[0.76 , 1.84]	.47	-0.04 (0.28)	0.96	[0.55 , 1.68]	.89
International student	**-0.58 (0.22)**	**0.56**	**[0.36 , 0.86]**	**.01**	0.31 (0.19)	1.36	[0.95 , 1.96]	.09	**0.89 (0.26)**	**2.43**	**[1.45 , 4.06]**	**<.001**
N	1075											
-2 Log likelihood (ic. only)	1898.409											
-2 Log likelihood (full model)	1784.801											
X^2 (*df*=20)	113.609***											
Nagelkerke R^2	0.12											

Note: C-19=COVID-19, *OR*=odds ratio, 95% CI=95% confidence interval, ic=intercept. Coefficients that are significant at 5% level are bold printed. *: $p<.10$, **: $p<.05$, ***: $p<.01$

Expected yearly income in 10 years was significantly positively related to reporting higher EI relative to similar EI due to the COVID-19 pandemic (B=0.24, *OR*=1.27, *p*<.001). This relationship was also present and positive for those reporting higher EI relative to lower EI (B=0.33, *OR*=1.39, *p*<.001). This result may indicate that those with higher ambitions or career expectations in terms of expected income were more likely to report that the pandemic led to increased levels of EI.

We found a strong relationship between gender and changes in EI. Females were more likely to report lower EI relative to similar EI (B=0.42, *OR*=1.52, *p*=.04) and less likely to report higher EI relative to similar EI (B=-0.57, *OR*=0.57, *p*=.002). In line with this result, we found a strong negative link between being female and reporting higher EI relative to lower EI (B=-0.99, *OR*=0.23, *p*<.001).

Finally, regarding the control variables, we found that age was negatively related to reporting higher EI compared to similar EI (B=-0.09, *OR*=0.91, *p*=.04) and higher EI compared to lower EI (B=-0.13, *OR*=0.88, *p*=.01). This indicates that younger students were more likely to report increased EI relative to similar and lower EI. There was no association between being an economics or business student or studying in another area and changes in EI. We did find that international students, compared to domestic students, were less likely to report lower EI compared to similar EI (B=-0.58, *OR*=0.56, *p*=.01) and thereby more likely to report higher EI compared to lower EI (B=0.89, *OR*=1.45, *p*<.001).

6.4 Discussion

The 2020 COVID-19 pandemic has had an unprecedented effect on businesses. As entrepreneurship is a vital component for economic recovery and growth (P. D. Koellinger & Thurik, 2012; Thurik & Wennekers, 2004), it is crucial to obtain an understanding of how the pandemic has affected the entrepreneurial aspirations of the future workforce. We studied the change in entrepreneurial intentions (EI) due to the pandemic in a large group of Dutch university students. We showed that while EI remained the same for approximately two out of three students, one out of three students reported a change. Interestingly, students reported both decreases (16%) and increases in EI (19%) due to the pandemic. One could argue that, overall, EI has stayed the same on average or even increased slightly. Nonetheless, it is important to study whether the profile of future entrepreneurs may have changed due to the COVID-19 pandemic. Therefore, we investigated how a set of COVID-19-related, context-related, and demographic variables relate to changes in EI in both directions. We will discuss and interpret our findings in sequence below.

Variables that were found to be most strongly associated with change in EI are gender and changes in mental health due to the pandemic. Despite initiatives to decrease the gender gap, women are still underrepresented in entrepreneurship (Elam et al., 2019). It is therefore important to assess whether the COVID-19 crisis will exacerbate

this imbalance. In our sample, we find a strong association between EI change and gender, showing that females are more likely than males to report decreased EI and less likely to report increased EI during the pandemic. This result indicates that given that EI is already higher for males in general (Dabic et al., 2012; Elam et al., 2019; F. Wilson et al., 2007), this difference may grow due to the pandemic. Previous research has shown that women perceive more (gender-specific) obstacles to entrepreneurship, such as (perceived) lack of support, less favourable perception of oneself and the entrepreneurial environment, household responsibilities and lower chances of obtaining external capital from investors (Guzman & Kacperczyk, 2019; Langowitz & Minniti, 2007; Shinnar et al., 2012; Verheul et al., 2012). It is possible that the COVID-19 pandemic has further enhanced these barriers, especially those related to the perception of the entrepreneurial environment. Recent studies have shown that employment and income losses have been largerfor women than men during the COVID-19 pandemic, which is explained by increased household responsibilities and concentration of female employment in more severely affected sectors (Alon et al., 2020b, 2020a, 2021; Graeber et al., 2021). While these changes most likely do not apply to our sample of students, it was shown that the first lockdown is associated with a shift toward more traditional beliefs in gender norms (Boring & Moroni, 2021), which may also affect EI. Finally, studies have shown that personality differences between men and women also underlie disparities in entrepreneurial aspirations. Women generally have lower levels of self-efficacy and are more risk averse than men (Borghans et al., 2009; Verheul et al., 2012). As the business environment is more uncertain than ever (Altig et al., 2020), a risk averse personality and lower belief in one's capacity to overcome potential obstacles (i.e., self-efficacy) could deter women from pursuing a career in entrepreneurs in the current uncertain economy. In line with our findings, Giotopoulos et al. (2017) showed that during the 2008 economic crisis gender was more strongly negatively related to entrepreneurial high growth intentions compared to noncrisis years, indicating that female entrepreneurship suffered more during the crisis.

Second, we found that pandemic-induced changes in mental health were strongly related to changes in EI. Specifically, students who indicated worse mental health due to the pandemic were more likely to report lower EI and less likely to report similar or higher EI. Only recently have scholars started to pay attention to the mental health of entrepreneurs (Wiklund et al., 2018, 2019; Wismans, Kamei, et al., 2021; Wismans, Thurik, et al., 2020). It has been shown that worse mental wellbeing is related to lower firm performance among entrepreneurs, which some have explained by the Conservation of Resources Theory (Gorgievski et al., 2010; Hobfoll, 2001; Stephan, 2018). Entrepreneurs with better mental health have more cognitive and affective resources, which enable them to be more persistent and creative, to identify opportunities, and to spend more effort on their work (Stephan, 2018). This same mechanism may apply to students who report a negative impact of the pandemic on their mental health. As they may have fewer resources available to identify business opportunities, they report a lower intention to start a

business and vice versa. Overall, 65.3% of our sample indicates that their mental health has been (strongly) negatively affected by the COVID-19 pandemic, while only 12.1% indicates a (strong) positive effect. This result may indicate that the pandemic not only takes its toll on the mental health of the majority of students but also that it may have further-reaching effects due to its indirect consequences on entrepreneurial aspirations.

Moreover, we studied the relationship of three other COVID-19-related variables with changes in EI. First, students' perceived risk of COVID-19 (the perceived likelihoods of getting infected with and hospitalized due to COVID-19) is not related to changes in EI. Second, self-reported compliance with COVID-19 regulations in the Netherlands (such as social distancing and increasing hand hygiene) is related to changes in EI. We show that there is a U-shaped relationship between self-reported compliance and EI change. Students who report having followed COVID-19 regulations more closely are more likely to report higher and lower EI compared to similar EI. This indicates that students with lower compliance may be more likely to be unaffected in terms of their EI. Possibly, the lives of low-compliance students were less heavily altered by the pandemic, which could explain why they are more likely to report unaffected EI. Third, while almost 40% of students in our sample indicate that the COVID-19 pandemic has negatively affected their financial situation, we do not find a relationship between changes in financial security and changes in EI. This result may come as a surprise, given that previous research has shown that preference for financial security, financial assets and household capital affect EI and the transition to self-employment (Dunn & Holtz-Eakin, 2000; Millman et al., 2010; Raijman, 2001; van Gelderen et al., 2008).

Regarding general government trust, we show that those with higher trust in Dutch government are less likely to report lower EI compared to similar EI. As discussed in the introduction, governments imposed numerous measures to reduce the negative consequences of the pandemic on the economy. Students with lower trust in the government may be less confident in the capability of the government to limit adverse consequences for business owners, explaining the negative association between government trust and reporting decreased EI. Personal experiences with business failure or struggle (due to the pandemic) in one's environment may also underlie this relationship.

In our survey, we ask students about their expected yearly income in 10 years. We find that those with a higher expected income in 10 years are more likely to report increases in EI compared to similar EI and decreased EI. In other words, students with higher expectations of future income are more likely to report increased EI during the pandemic. The measure of expected income is less straightforward to interpret, as it could capture multiple beliefs and characteristics of the students, such as ambition, major, and overconfidence, which each may have their own effect It is therefore not possible to completely disentangle the underlying processes of this relationship. For instance, one's level of general optimism could both underlie expectations about future income and

increases in EI during the pandemic. At the same time, students that have recently come up with a business idea may indicate both enhanced EI during the pandemic as well as higher expectations of future income.

Finally, we controlled for several variables, among which age and international student status are found to be related to EI change. Specifically, older students are less likely to report increased EI compared to decreased and similar EI. Moreover, international students are more likely to report increased EI and less likely to report decreased EI, indicating that the EI of international students may be differently and more positively affected by the pandemic than that of domestic students. We do not find differences in changes in EI between students who pursue studies related to economics and business and students who pursue other studies.

There are several caveats to our study that should be borne in mind when interpreting the outcomes. First, we have assessed change in EI. While students may indicate that their EI has changed due to the pandemic, we do not know what this change means for their actual level of EI. For example, if decreases in EI are mainly present in students who were already unwilling to start a business before the pandemic (low levels of EI becoming even lower), this result has less severe consequences than if these decreases are mainly present in students with high levels of EI before the pandemic. Second, the change in EI is self-reported retrospectively. Students were forced to think about how the pandemic has affected their EI, which is arguably not something students have thought about before participating in the survey. For future research, it would be meaningful to compare postpandemic or midpandemic EI levels to prepandemic EI levels and use these comparisons to infer change. Third, our data were collected during the beginning phase of the pandemic (April/May 2020). At that time, nobody was completely aware of the long-lasting consequences of the pandemic. Thereafter, more (or less) severe changes in EI could have occurred. Importantly, changes in EI could be reversible, meaning that when the pandemic has ended, EI levels may return to their prepandemic states. While this possibility is not in line with previous research that shows that macroeconomic conditions during one's impressionable years (18-25) shape preferences for the rest of one's life (Cotofan et al., 2020; Krosnick & Alwin, 1989), future research using longitudinal data assessing EI before, during and after the COVID-19 pandemic would be worthwhile. Fourth, while studying EI is, in the context of our study, a useful outcome measure, for future research, it would be valuable to investigate whether the COVID-19 pandemic caused changes in or gave rise to factors that lower the transition from EI to actual entrepreneurial behaviour. Finally, our study is only able to draw conclusions about associations between the factors we study and change in EI. In interpreting the results, one should keep in mind that we cannot draw any causal claims.

Meanwhile, the 2020 COVID-19 pandemic has continued to impact the world for at least two years (at the time of writing the present article). While the economy is recovering more quickly than expected, with labour participation rates in the Netherlands

even increasing beyond prepandemic levels, there are still concerns about the consequences of the pandemic on self-employment and specifically on EI. Therefore, this study aimed to shed light on potential changes in the future of the entrepreneurial landscape caused by the COVID-19 pandemic. Fortunately, we find that in our sample, EI remains the same for most students, and both increases and decreases in EI are reported. Slightly more students report increased EI than decreased EI. Disturbingly, we show that gender is strongly associated with reported changes in EI, with females being more likely to report decreased EI, while males are more likely to report increased EI. This result could have consequences for the gender gap in entrepreneurship. Furthermore, changes in mental health due to the pandemic have a strong association with reported EI. As the pandemic has strongly affected the mental health of the majority of young adults, this situation could have indirect consequences for other aspects of life as well, such as career choice, and consequently for the economy. Finally, we find that reported changes in EI are associated with compliance with COVID-19 regulations, government trust, expected income in ten years, age and international student status. Initiatives focused on stimulating entrepreneurship among students could take our findings into account and try to avert negative consequences, for example, by giving more attention to mental health and gender-specific barriers caused by or perceived due the pandemic.

6.5 Acknowledgments

The current study is part of the Erasmus University Rotterdam International COVID-19 Student Survey, a larger project in which data of students from ten countries was collected. RT is also member of *LabEx Entrepreneurship*, funded by the French government (LabEx Entreprendre, ANR-10-Labex-11-01).

7

Chapter 7

COVID-19 Vaccination: Lower Intention and Coverage among Entrepreneurs Compared to Employees

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UNDER EMBARGO

8

Chapter 8

Conclusion

Soon after the outbreak of the COVID-19 pandemic, the essential role played by humans and specifically by their behaviour for the course of the pandemic was acknowledged. The immensely disruptive consequences of the pandemic on everyday life inspired me to gather behavioural insights related to the COVID-19 pandemic and make this the topic of my dissertation. This dissertation aimed to improve our understanding of individual differences that are associated with preventive health behaviours - such as compliance with public health regulations and COVID-19 vaccination - and behaviours that have been affected by the pandemic - like entrepreneurship. In this conclusion chapter a summary of the results and implications of the different chapters of this thesis are given. Moreover, some limitations and suggestions for future research are discussed. Finally, a general conclusion is given.

8.1 Summary and societal implications of chapters

Part 1: Compliance with COVID-19 measures

Part 1 consists of three Chapters (2-4) that deal with compliance with COVID-19 measures. In **Chapter 2** we studied whether individual compliance with different COVID-19 public health measures can be treated as a sole construct. Using a ten-country student sample, this study revealed that compliance related to Hygiene (hand washing, coughing behaviours) is distinct from compliance related to Social Distancing behaviours (being in physical contact with others). Studying the ten countries in our sample individually, we conclude that the Social Distancing-Hygiene distinction is present and similar also on a country-level. This means that one cannot simply rank students as being "more or less compliant with COVID-19 measures" (e.g., Harper et al., 2020; Plohl & Musil, 2021). We showed that the two types of behaviours are only weakly correlated with each other, and differently predicted by individual attitudes towards public health measures, descriptive norms, and key demographics. Attitudes towards public policy and descriptive norms are found to be more predictive of social distancing than of hygiene compliance, which may be unsurprising given that hygiene behaviours are less visible, more routinized, and less problematized in the media. From a scientific perspective, this study implies that future and existing research treating public health compliance as a simple construct obfuscates the dimensionality of compliance which risks poorer prediction of individuals' compliance behaviours and problems in generating valid public health recommendations. These results should make public health authorities aware that they require inhabitants to change multiple types of behaviour that may require distinct interventions. They tentatively suggest that interventions aimed at enhancing social distancing benefit more from influencing attitudes and descriptive norms than interventions aimed at enhancing hygiene.

Chapter 3 covered the role of impulsivity in compliance with COVID-19 measures. Public health measures taken in response to the COVID-19 pandemic required

people to change their behaviour and forced them to carefully make trade-offs between the – for example- now 'risky' act of attending a social gathering (with immediate positive reinforcement) and the 'safe' option of staying at home (with delayed positive reinforcement). For less future-oriented and more impulsive individuals – who in general think less about the consequences of their behaviour - making these decisions is anticipated to be harder. Therefore, we investigated the link between self-reported impulsivity and delay discounting on the one hand and compliance with social distancing and hygiene measures on the other hand in Chapter 3. Using a large student sample, we established a consistent negative link between the self-reported personality trait of impulsivity and compliance with both type of COVID-19 measures. Contrary to our expectations, we found a weak positive association between the discount rate—as measured by a behavioural task—and social distancing and hygiene compliance. This indicates that students with a higher discount rate (i.e., more impatient, and more strongly present-biased) were more likely to show social distancing and hygiene behaviours. In subsequent sensitivity analyses, this relationship remained predominantly positive though very small. In Chapter 3 we discussed potential explanations for this relationship, including the possible effect of COVID-19 induced stress on both discounting and compliance and the perception that compliance has short-term benefits. Interestingly, after the publication of Chapter 3, other studies have reported similar findings strengthening the belief in this positive link. For example, Calluso et al. (2021) found an overall greater compliance to containment measures in individuals with higher discount rates. Moreover, Ma et al. (2022) found a lower willingness to quarantine in countries with a stronger culture of long-term orientation. At the same time, Krawiec et al. (2022) did not confirm a link between health and monetary discount rates on the one hand and compliance with preventive COVID-19 measures on the other. In conclusion, our study highlights the importance of individual differences in impulsivity regarding compliance with public health measures during a pandemic. Policymakers could take these findings into account to communicate messages in a more tailored and targeted manner, realizing that more impulsive individuals will be more likely to respond automatically and deliberate less about behavioural consequences of noncompliance. Moreover, the opposing results regarding impulsivity and discount rate underline the fact that the two are distinct concepts and should not be used interchangeably. Further research into the relationship between delay discounting and behaviour during pandemics is warranted.

Among all public health measures taken during the pandemic, the (mandated) use of face masks was debated most heavily. While countries' perspectives on their use came closer during later phases of the pandemic, it is valuable to know how different policies affected the uptake of masks in the early phase of the pandemic when face mask regulations were divergent. In **Chapter 4**, we therefore analysed how country-level policy stringency and individual-level predictors associated with face mask use in a ten-country

student sample. The individual level predictors we studied were (self and other-related) risk perception, (direct and indirect) experience with COVID-19, and attitude towards government. Moreover, we investigated whether there is an interaction between policy stringency and these variables. Unsurprisingly, we found that policy stringency is strongly positively associated with face mask use. Furthermore, we found a positive association between self-related risk perception and mask use, but no relationship of mask use with experience with COVID-19 and attitudes towards government. Using interaction analyses, we showed that government trust and perceived clarity of communication did moderate the link between stringency and mask use, with positive government perceptions relating to higher use in countries with regulations and to lower use in countries without regulations. Our results imply that, as face mask use is only an efficient method to lower the spread of COVID-19 if there is widespread adoption (Howard et al., 2021), it may be worthwhile for governments to put country-wide regulations in place if they decide to involve face masks to halt pandemics. The strength of this relationship can be further increased by clear government communication and efforts to enhance government trust, realizing that especially the latter is easier said than done. Finally, stressing self-related risk of COVID-19 may be more important than stressing other-related risk of COVID-19 when aiming to increase face mask use.

Part 2: COVID-19 vaccination

Part 2 focused on COVID-19 vaccination. Inspired by studies advocating the importance of studying psychological variables to understand vaccination hesitancy and inform effective interventions (Betsch et al., 2018; Schmid et al., 2017), we designed and carried out the study described in **Chapter 5.** This chapter provides insights into vaccination behaviour by studying the relationship between COVID-19 vaccination intention, the 5C model, and underlying psychological drivers. Using a student sample from three countries, we showed that the majority of students had a positive propensity toward getting vaccinated against COVID-19 in December 2020, though only 41% of students were completely acceptant. Using the 5C model, we found that 'Confidence' and 'Collective Responsibility' are most strongly related to students' COVID-19 vaccination intention. Subsequently, we showed that the perceived risk and effectiveness of the vaccine as well as trust in the government and health authorities indirectly relate to vaccination intention through 'Confidence'. While the perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly relate to vaccination intention through 'Collective Responsibility'. Our findings demonstrate the suitability of the 5C scale in explaining COVID-19 vaccination intention and imply that vaccination campaigns aimed at young adults may seek to increase both Confidence and Collective Responsibility. A good approach would be to target both antecedents simultaneously, as vaccination interventions that address multiple underlying drivers at the same time have been shown to be more successful (Frew & Lutz, 2017). In the design

of future campaigns our findings on the psychological factors associated with vaccination intention through Confidence and Collective responsibility could be used as starting points. For example, in targeting Confidence, it could be important to provide information about and challenge misinformation surrounding the vaccine to increase perceived vaccine effectiveness and safety. A strategy could be to share this information through 'surprising validators', people seen as credible to the target audience but who are not expected to share this information (Glaeser & Sunstein, 2014). With respect to Collective Responsibility, it may be effective to emphasize the risks of COVID-19 for those in students' close social environment and to explain the concept of herd immunity. At the same time, as we showed Collective Responsibility was less present in students with less altruistic, emphatic, and social personalities, stressing personal risks remains important as these groups will be less driven by stressing prosocial consequence of vaccination. More suggestions have been given in Chapter 5. Finally, we also showed a strong direct association between the descriptive norm (whether friends and family intend to get vaccinated) and COVID-19 vaccination intention. This may indicate that vaccination campaigns could be more successful by making the prevailing norm among students more salient by stressing that most students (intend to) get vaccinated.

Part 3: Entrepreneurship and the COVID-19 pandemic

The final part of this thesis consisted of two chapters related to entrepreneurship. In **Chapter 6**, we studied how the pandemic has affected the entrepreneurial aspirations of the future workforce in the beginning phase of the pandemic using a large sample of Dutch students. We found that entrepreneurial intentions remained the same for most students, and both increases (19%) and decreases (16%) are reported. Several individual factors are associated with this self-reported change in entrepreneurial intentions, of which gender and pandemic-induced changes in mental health seem to play the biggest role. Females are more likely to report decreases in entrepreneurial intentions, while males are more likely to report increases in entrepreneurial intentions during the pandemic. This result is quite disturbing, if females are indeed less likely to start a business due to the pandemic this could have consequences for the already existing gender gap in entrepreneurship (Elam et al., 2019). Furthermore, students who report a negative change in their mental health due to the pandemic are more likely to indicate decreased entrepreneurial intentions rather than increased entrepreneurial intentions. As the pandemic has strongly affected the mental health of the majority of young adults, our study tentatively suggests that this may have indirect consequences for other aspects, such as career choice as well. Moreover, we showed that students with higher trust in the government are less likely to report decreased entrepreneurial intentions relative to similar entrepreneurial intentions. Finally, we find associations between the change in entrepreneurial intentions and expected income in 10 years, compliance with COVID-19 regulations, age, and international student status. Initiatives focused on stimulating

entrepreneurship among students in the aftermath of the pandemic could take our findings into account, amongst others by giving more attention to changes in mental health caused by and gender-specific barriers perceived due the pandemic. One of the limitations of this study is that it made use of cross-sectional data collected during an early phase of the pandemic. Future research investigating whether these associations and changes remained during later stages (or after) the COVID-19 pandemic is therefore needed.

Finally, in **Chapter 7**, we investigated COVID-19 vaccination behaviour of entrepreneurs and employees. To our surprise, two recent studies showed that entrepreneurs compared to employees indicate a lower willingness to get vaccinated against COVID-19 (Nguyen et al., 2022; Valckx et al., 2022). We tried to replicate the difference in COVID-19 vaccination willingness between entrepreneurs and employees and study whether this difference is explained by key demographics, vaccination attitudes and COVID-19 context, including the financial impact of the pandemic, wellbeing, and government attitude. We made use of three datasets. First, using a large Eurobarometer sample, covering 27 countries, we show that COVID-19 vaccination coverage (February 2022) is lower among entrepreneurs than among employees. Second, we studied COVID-19 vaccination intention (December 2020) using a large representative Dutch sample from the LISS panel and actual vaccination status (July 2021) using data from the Understanding America Study. Also, in the latter two datasets we found a gap in vaccination intention and status between the two groups which does not disappear when controlling for the sets of variables described. Our results indicate that demographics and vaccination attitudes are much more important in the decision to get vaccinated than contextual influences, such as the degree to which one was affected by the pandemic financially or mentally. Given the importance of large-scale vaccination and that entrepreneurs may potentially serve as role models, it is important to understand the reasons for their lower willingness to get vaccinated. Future research on the drivers of this gap is warranted, amongst others focusing on the role of social normative influences and personality differences.

8.2 Limitations & future research

In each chapter, chapter specific limitations have been discussed. In this section we list three of the most important general limitations of this dissertation. An obvious limitation of this thesis stems from its reliance on self-report data. The EURICSS data that was used for Chapters 2 to 6 was collected using an online survey. While this type of data has several advantages, being inexpensive and allowing to gather data quickly during the unforeseen situation of the COVID-19 pandemic, it may also be prone to biases and is bound to be more subjective. While anonymity was emphasized and the data were collected in an online environment, social desirability bias could have been present with students overreporting their compliance with public health measures or their intention

to get vaccinated. Though, Petherick et al. (2021) showed that survey data on compliance with physical distancing during the pandemic was strongly related to objective mobile-phone mobility data. Moreover, to assess personality traits and attitudes we tried to make use of validated scales as much as possible. However, if a similar situation occurs in the future, collecting more objective measures of behaviour would be worthwhile. Related to the use of cross-sectional survey data, it is evident that the results reported in this dissertation show associations and not necessarily causal relationships.

Second, as the pandemic went through several phases, the findings in this thesis could be time dependent. In our studies we implicitly model attitudes, public health behaviours and entrepreneurial intentions as being stable, while in reality these are dynamic behaviours that likely (strongly) fluctuate over time and over the course of the pandemic. While compliance with public health measures in general remained high, Petherick et al. (2021) showed that there is temporal variation in compliance with different measures. Over the course of 2020, social distancing, for example, declined with decelerating speed followed by a small rebound near the end of the year. When interpreting the outcomes of this thesis the potential time dependency of our results deserves attention. Related to this, unfortunately, we did not possess pre-pandemic data. While the pandemic provided an ideal situation to study the effect of this crisis by means of a natural experiment, we did not have access to such pre-pandemic data and therefore needed to rely on measures collected during – and therefore potentially affected by – the pandemic.

Finally, while the chapters in this thesis provide insight into the relationship of individual characteristics and attitudes with public health related behaviours and pandemic induced changes in entrepreneurial intention, there is still a 'translation' to be made from the results presented to using them to inform (public health related) interventions and policy aimed at increasing compliance, vaccination coverage or entrepreneurial intentions. As mentioned, our results do not imply causality and the mere fact that an association between factors is present does not necessarily make them effective in interventions or accompanying campaigns. While we conclude some chapters with potential implications of our findings and advice for policy, our results should only be interpreted and used as hints or starting points for future research and not as direct evidence for effective policy. For instance, the standalone finding that being more impulsive is associated with being less compliant with COVID-19 regulation is not directly informative. We suggested that, as more impulsive individuals rarely engage in extensive forethought, one may infer that emphasizing the consequences of noncompliance or facilitating alternative outlets for impulses (such as physical activity) may decrease the risk of high-impulsivity individuals to engage in risky behaviour during pandemics. Yet, to make this 'translation' future research should be conducted to analyse whether there is a causal relationship here and interventions based on these empirical results are also effective in practice.

8.3 General conclusion

While the chapters in this thesis all cover behaviour in relation to the COVID-19 pandemic, this dissertation did not aim to answer one overarching research question. Apart from the chapter specific contributions, there are three messages based on all these chapters that I want to end this dissertation with.

First, Part 2 and Part 3 focused on gaining insights into factors that are associated with students' compliance with public health measures and COVID-19 vaccination willingness. An underlying goal of these studies – and most of the literature on these topics – is to use these insights to boost the levels of these behaviours. While studies consistently show that students, and those of younger age in general, are less likely to comply or get vaccinated against COVID-19 compared to older-aged individuals, it needs to be mentioned that – based on Chapter 2 through Chapter 5 - compliance and vaccination willingness were actually very high in our student samples. Younger people have been scapegoated in the media, e.g., by focusing on student parties during lockdown. Given that younger age groups are much less at risk to develop severe cases of COVID-19 and in general have larger social networks compared to older age groups (Wrzus et al., 2013), this negative framing does not do justice to the sacrifices made and high compliance levels shown. Some have used to 'Social Identity Theory' to explain high compliance of groups less at risk, which proposes that identifying with a specific group provides a social identity and a corresponding description of what is involved in being a member of that group (including adhering to the norms of the group) (Jetten et al., 2020; Tajfel & Turner, 1982). Being a member of multiple groups (nation, community, peers, family), people can have multiple social identities that can differ in saliency over time. Especially at the start of the pandemic, the feeling of a (nation- and community-wide) social identity was strong and therefore students may have been motivated to act in the interest of their community instead of being driving by individual risk perceptions (Neville et al., 2021; Stevenson et al., 2021). Related to this, experts have recommended political leaders to cultivate a sense of shared identity to increase compliance (Van Bavel et al., 2020; Vignoles et al., 2021). The Social Identity Theory is also in line with the importance of social norms for preventive health behaviour that we find in multiple chapters of this thesis. Social norms are perceptions of what behaviour is expected by others, done by others, or approved by others (Cialdini & Goldstein, 2004). These norms are often tied to social identities, with each group having their own norms (Abrams et al., 1990; Neville et al., 2021). Chapter 2 showed that the descriptive norm (do friends and family strictly follow public health measures) positively relates to social distancing and hygiene compliance. In Chapter 5 we found that the descriptive norm surrounding COVID-19 vaccination in students' social circles was strongly linked to the intention to get vaccinated against COVID-19. Finally, we concluded Chapter 7 with the suggestion to study whether differences in social norms between entrepreneurs and employees surrounding COVID-19 vaccination may explain the vaccination gap present between the

two groups. Taken together, the studies in this thesis seem to underscore the importance of the Social Identity Theory and social norms in influencing behaviour of young adults during a global pandemic.

Second, several chapters of this thesis have indicated the importance of government trust and attitude towards government in relation to the behaviours that we studied. Specifically, Chapter 4 showed that the attitude towards the government affected the relationship between policy stringency and face mask use, with positive government perceptions relating to higher use in countries with regulations and to lower use in countries without regulations. Moreover, in Chapter 5 we found that government trust is positively related to COVID-19 vaccination intention through enhanced levels of Confidence in the vaccine. Chapter 6 showed that students with higher trust in government were less likely to report decreases in their entrepreneurial intentions compared to reporting unaffected entrepreneurial intentions. Finally, in Chapter 7, government attitude was positively related to COVID-19 vaccination intention among entrepreneurs and employees. In line with this, other papers have shown the relevance of government trust for the adoption of health behaviours during the pandemic and even the rate of decline of these behaviours over time (Han et al., 2021; Sachs et al., 2022). In their paper on lessons learnt from behavioural science during the pandemic, Williams et al. (2020) draw a similar conclusion. They state that 'trust is one of public health's biggest prophylactics', being a strong predictor of adherence to regulations and acceptance of vaccines (Williams et al., 2020).

Finally, overall, the chapters in this dissertation contribute to the literature on the importance of individual differences for preventive health behaviours. The pandemic has shown that behavioural insights are important when tackling global societal issues like the COVID-19 pandemic. As discussed by Kelly and Barker (2016), an error often made when designing policies related to behaviour is to appeal to common sense, i.e., the idea that understanding human behaviour is so obvious that it does not need further research. Additionally, a widespread misapprehension in policy and public health campaigns is that they often assume that people act rationally, and that knowledge and its rational assessment are enough to drive behaviour (Kelly & Barker, 2016; Putters, 2022). However, people mostly do not apply rational calculation weighing pros and cons when they decide on certain behaviours, but rather rely on automatic and instinctive responses to environmental and social cues (Kahneman, 2011; Kelly & Barker, 2016). In these decisions, individual differences in capabilities, personality, attitudes, social environments, and norms, may play a role. The pandemic has again emphasized that, as the effectiveness and outcomes of policy in the real world largely depends on behavioural choices of the public, it is important not to appeal to common sense, but study what drives behaviour and behaviour change. This dissertation has underlined that there are indeed many individual and social environmental differences that matter in explaining pandemic-related behaviours. While awareness of the value of behavioural insights for policy and

interventions already witnessed a surge over the past decade, as demonstrated by the creation of governmental Behavioural Insights Teams in multiple countries, this awareness has further increased during the pandemic (European Centre for Disease Prevention and Control, 2021; Halpern, 2015; OECD, 2017; Sunstein et al., 2022). Hopefully, the lessons learned from the pandemic will increase the use of insights from social and behavioural sciences during potential next pandemics, but also in approaching other large-scale societal issues which involve collective behaviour change, like climate change.

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English Summary

Soon after the outbreak of the COVID-19 pandemic, the essential role of human behaviour for the course of the pandemic was acknowledged. This dissertation aims to improve our understanding of individual differences that are associated with behaviour during the COVID-19 pandemic. The chapters are divided in three parts: (1) Compliance with COVID-19 measures (Chapter 2, 3 and 4), (2) COVID-19 vaccination (Chapter 5 and 7), and (3) Entrepreneurship and the COVID-19 pandemic (Chapter 6 and 7).

In **Chapter 2** we study whether individual compliance with different COVID-19 public health measures can be treated as a sole construct. We show that compliance with measures related to Hygiene (hand washing, coughing behaviours) is uniformly distinct from compliance with measures related to Social Distancing (limiting physical contact with others). This means that one cannot simply rank students as being "more or less compliant with COVID-19 measures". We show that the two types of behaviours are only weakly correlated with each other, and differently predicted by individual attitudes towards public health measures, descriptive norms, and key demographics. These factors are more predictive of compliance with Social Distancing than of compliance with Hygiene.

Chapter 3 covers the relationship of impulsivity and delay discounting with compliance with COVID-19 measures. We establish a consistent negative link between the self-reported personality trait of impulsivity and compliance with both social distancing and hygiene measures. Contrary to our expectations, we find a weak positive association between the discount rate—as measured by a behavioural task—and social distancing and hygiene compliance. This seems to indicate that students with a higher discount rate (i.e., more impatient, and more strongly present-biased) are more likely to show social distancing and hygiene behaviours. While this relationship remains predominantly positive in subsequent sensitivity analyses, it is very small. Further research on this relationship is warranted.

In **Chapter 4**, we analyse how country-level policy stringency and individual-level predictors associate with face mask use in a ten-country student sample. Unsurprisingly, we find that policy stringency is strongly positively associated with face mask use. Furthermore, we find a positive association between self-related risk perception of COVID-19 and mask use, but no relationship of mask use with experience with COVID-19 and attitudes towards government. Using interaction analyses, we show that government trust and perceived clarity of government communication moderate the link between stringency and mask use. Positive government perceptions relate to higher use in countries with regulations and to lower use in countries without regulations.

Chapter 5 provides insights into vaccination behaviour by studying the relationship between COVID-19 vaccination intention, the 5C model, and psychological drivers. We show that the majority of students in our sample had a positive propensity

toward getting vaccinated against COVID-19 in December 2020. The 5C model covers the five most important antecedents of vaccination: *Confidence, Constraints, Complacency, Calculation,* and *Collective Responsibility*. Using the 5C model, we find that Confidence and Collective Responsibility are most strongly related to students' COVID-19 vaccination intention. Subsequently, we show that the perceived risk and effectiveness of the vaccine as well as trust in the government and health authorities indirectly relate to vaccination intention through 'Confidence'. While the perceived risk of COVID-19 for one's social circle and altruism, the need to belong and psychopathy traits indirectly relate to vaccination intention through Collective Responsibility. We also show a strong direct association between the descriptive norm (the perception of what others do) and COVID-19 vaccination intention. Our findings demonstrate the suitability of the 5C scale in explaining COVID-19 vaccination intention.

In **Chapter 6**, we study how the pandemic affected the entrepreneurial aspirations of the future workforce using a large sample of Dutch students. We find that entrepreneurial intention remained the same for most students, with both increases (19%) and decreases (16%) reported. Several individual factors are associated with this self-reported change in entrepreneurial intentions, of which gender and pandemic-induced changes in mental health seem to play the biggest role. Females are more likely to report decreases in entrepreneurial intentions, while males are more likely to report increases in entrepreneurial intentions during the pandemic. Furthermore, students who report a negative change in their mental health due to the pandemic are more likely to indicate decreased rather than increased entrepreneurial intentions.

In **Chapter 7**, we try to replicate earlier research that discovered a COVID-19 vaccination gap between entrepreneurs and employees. Using three large datasets we confirm that entrepreneurs have a lower COVID-19 vaccination willingness (both intention and behaviour) compared to employees. We find that this vaccination difference cannot be fully explained by differences in key demographics, vaccination attitudes and the context of the pandemic between the two groups. Our results indicate that demographics and vaccination attitudes are more important in the decision to get vaccinated than contextual influences, such as the degree to which one was affected by the pandemic financially or mentally. Given the importance of large-scale vaccination and that entrepreneurs may potentially serve as role models, it is important to understand the reasons for their lower willingness to get vaccinated. Future research on the drivers of this gap is warranted, amongst others focusing on the role of social normative influences and personality differences.

This dissertation also has some overall contributions. First, it showed that, in general, compliance and vaccination intention were very high in our large and global student samples. These high levels may be explained by the Social Identity Theory, which posits that people derive a social identity from the groups to which they identify with and change their behaviour to belong to the group accordingly. This is also underlined by the

strong positive links we find between social norms on one hand and compliance and vaccination intention on the other hand. Second, in line with the literature, several chapters of this thesis indicated the importance of government trust and attitude towards government in relation to the behaviours that we studied. Finally, the pandemic has shown that insights from social and behavioural sciences are important when approaching pandemics. As the effectiveness and outcomes of policy in the 'real world' largely depends on behavioural choices of the public, it is important to study what drives behaviour and behaviour change. This thesis has underlined that there are indeed many individual and social environmental differences that matter in explaining pandemic-related behaviours. Hopefully, the lessons learned from the pandemic will increase the use of behavioural insights during next pandemics, but also in approaching other large-scale societal issues which involve collective behaviour change, such as climate change.

Nederlandse Samenvatting

Niet lang na de uitbraak van de COVID-19 pandemie werd de essentiële rol van de mens en met name zijn gedrag voor het verloop van de pandemie erkend. Het doel van dit proefschrift is om ons begrip van de samenhang tussen individuele verschillen en gedrag tijdens de COVID-19 pandemie te verbeteren. De hoofdstukken zijn opgedeeld in drie onderdelen: (1) Naleving van COVID-19 maatregelen (Hoofdstuk 2, 3 en 4), (2) COVID-19 vaccinatie (Hoofdstukken 5 en 7), en (3) Ondernemerschap en de COVID-19 pandemie (Hoofdstukken 6 en 7).

In **Hoofdstuk 2** bestuderen we of de individuele naleving van verschillende COVID-19 maatregelen behandeld kan worden als zijnde één construct met behulp van een grote steekproef van studenten. We tonen aan dat naleving van maatregelen met betrekking tot Hygiëne (handen wassen, hoestgedrag) uniform verschilt van naleving van maatregelen met betrekking tot *Social Distancing* (limiteren van fysiek contact met anderen). Dit betekent dat men studenten niet simpel kan rangschikken als "meer of minder houdend aan de COVID-19 maatregelen". We laten zien dat de twee soorten gedrag slechts zwak met elkaar zijn gecorreleerd en verschillend worden voorspeld door individuele attitudes ten aanzien van de maatregelen, descriptieve normen, en demografische gegevens. Deze factoren zijn sterker gerelateerd aan de naleving van Social Distancing maatregelen dan aan de naleving van Hygiëne maatregelen.

Hoofdstuk 3 behandelt de relatie van impulsiviteit en *delay discounting* met de naleving van COVID-19 maatregelen. We vinden een consistent negatieve link tussen de zelf gerapporteerde persoonlijkheidseigenschap impulsiviteit en naleving van zowel social distancing als hygiëne maatregelen. In tegenstelling tot onze verwachtingen, vinden we een zwak positief verband tussen de *discount rate* - gemeten door middel van een gedragstaak - en naleving van social distancing en hygiëne. Dit lijkt te betekenen dat studenten met een hogere *discount rate* (d.w.z., ongeduldiger, en meer '*present-biased*') meer geneigd zijn om zich te houden aan social distancing en hygiëne maatregelen. Hoewel dit positieve verband ook wordt aangetoond in de meerderheid van onze sensitiviteitsanalyses, is het verband erg zwak. Verder onderzoek naar deze relatie is nodig.

In **Hoofdstuk 4** analyseren we hoe de striktheid van mondkapjesbeleid op landniveau en verschillen op individueel niveau samenhangen met het gebruik van mondkapjes in een steekproef van studenten uit tien landen. Niet verassend vinden we dat de striktheid van beleid sterk positief geassocieerd is met het dragen van een mondkapje. Daarnaast vinden we een positief verband tussen eigen risicoperceptie van COVID-19 en mondkapjesgebruik, maar geen relatie met de ervaring met COVID-19 en houding ten aanzien van de overheid. Door middel van interactieanalyses laten we zien dat het vertrouwen in de overheid en de duidelijkheid van overheidscommunicatie het verband tussen de striktheid van beleid en mondkapjesgebruik beïnvloedt. Een positieve

perceptie van de overheid is gerelateerd aan hoger gebruik in landen met regelgeving met betrekking tot mondkapjes en aan lager gebruik in landen zonder regelgeving met betrekking tot mondkapjes.

In **Hoofdstuk 5** focussen we op vaccinatiegedrag en bestuderen we de relatie tussen COVID-19 vaccinatie intentie, het 5C model, en verschillende psychologische factoren. We tonen aan dat de meerderheid van de studenten in onze steekproef geneigd was om zich te laten vaccineren tegen COVID-19 in december 2020. Het 5C model omvat de vijf belangrijkste antecedenten van vaccinatie: *Confidence* (vertrouwen), *Constraints* (barrières), *Complacency* (zelfgenoegzaamheid/onverschilligheid), *Calculation* (calculerend), and *Collective Responsibility* (collectieve verantwoordelijkheid). Met behulp van dit 5C model tonen we aan dat 'Confidence' en 'Collective Responsibility' het sterkst gerelateerd zijn aan de COVID-19 vaccinatie intentie van studenten. We tonen aan dat zowel het waargenomen risico en de effectiviteit van het vaccin als vertrouwen in de overheid en gezondheidsautoriteiten indirect relateren aan vaccinatie intentie via 'Confidence'. Het waargenomen risico van COVID-19 voor de sociale kring, altruïsme, de behoefte om erbij te horen, en psychopathie eigenschappen hangen indirect samen met vaccinatie intentie via 'Collective Responsibility'. We tonen daarnaast aan dat er een sterke directe associatie is tussen de descriptieve norm (de perceptie van wat anderen doen) en COVID-19 vaccinatie intentie. Onze bevindingen tonen de geschiktheid van het 5C model voor het verklaren van COVID-19 vaccinatie gedrag.

In **Hoofdstuk 6** bestuderen we hoe de pandemie de ambitie om te gaan ondernemen van de toekomstige beroepsbevolking heeft beïnvloed met behulp van een grote steekproef van Nederlandse studenten. We stellen vast dat de intentie om te ondernemen voor de meeste studenten gelijk is gebleven, met zowel gerapporteerde stijgingen (19%) als dalingen (16%). We vinden een associatie tussen verschillende individuele factoren en deze zelf gerapporteerde verandering in de intentie om te ondernemen, waarvan geslacht en door de pandemie veroorzaakte veranderingen in de mentale gezondheid de grootste rol lijken te spelen. Vrouwen zijn meer geneigd om tijdens de pandemie een daling in hun intentie om te ondernemen te rapporteren, terwijl mannen meer geneigd zijn een stijging te rapporteren. Daarnaast zijn studenten die een negatieve verandering in hun mentale gezondheid als gevolg van de pandemie melden meer geneigd om een gedaalde intentie om te ondernemen te rapporteren dan een gestegen intentie om te ondernemen.

In **Hoofdstuk 7** proberen we eerder onderzoek te repliceren dat een verschil in COVID-19 vaccinatie bereidheid tussen ondernemers en werknemers aantoonde. Gebruikmakend van drie grote datasets bevestigen we dat ondernemers een lagere bereidheid hebben om zich te laten vaccineren tegen COVID-19 (zowel intentie als daadwerkelijk gedrag) vergeleken met werknemers. We tonen aan dat dit vaccinatieverschil niet volledig verklaard wordt door verschillen tussen deze twee groepen met betrekking tot demografische gegevens, vaccinatie attitudes en de context van de

pandemie. Onze resultaten tonen aan dat demografische gegevens en vaccinatie attitudes belangrijker zijn bij de beslissing om gevaccineerd te worden tegen COVID-19 dan contextuele invloeden, zoals de mate waarin iemand financieel of mentaal getroffen werd door de pandemie. Gezien het belang van grootschalige vaccinatie en het feit dat ondernemers mogelijk als rolmodel kunnen dienen, is het belangrijk om de redenen voor hun lagere bereidheid tot vaccineren beter te begrijpen. Vervolgonderzoek naar de oorzaken van deze kloof is nodig, onder andere gericht op de rol van sociale normatieve invloeden en persoonlijkheidsverschillen.

Dit proefschrift heeft ook nog enkele algemene bijdragen. Ten eerste toont het aan dat naleving en vaccinatie-intentie in het algemeen erg hoog waren in onze grote en wereldwijde studentensteekproeven. Een mogelijke verklaring hiervoor zou gegeven kunnen worden door de *Social Identity Theory*, deze stelt dat mensen een sociale identiteit ontlenen aan de groepen waarmee ze zich identificeren en hun gedrag op basis daarvan aanpassen om erbij te horen. Dit sluit ook aan bij de sterke positieve relaties die we vinden tussen de geldende sociale norm en zowel naleving als vaccinatie-intentie. Ten tweede wijzen verschillende hoofdstukken in dit proefschrift, in lijn met de literatuur, op het belang van het vertrouwen in en de houding ten aanzien van de overheid in relatie tot het bestudeerde gedrag. Tot slot heeft de COVID-19 pandemie bevestigd dat inzichten uit de sociale en gedragswetenschap belangrijk zijn bij de aanpak van pandemieën. Aangezien de effectiviteit van beleid in de werkelijkheid van de 'echte wereld' grotendeels afhangt van gedragskeuzes van het publiek, is het belangrijk om te onderzoeken wat gedrag en gedragsverandering drijft. Dit proefschrift benadrukt dat er inderdaad veel individuele en sociale omgevingsverschillen zijn die ertoe doen bij het verklaren van gedrag tijdens een pandemie. Hopelijk leiden de lessen die geleerd zijn uit de pandemie tot een toename in het gebruik van gedragsinzichten bij volgende pandemieën, maar ook bij het benaderen van andere grootschalige maatschappelijke problemen die te maken hebben met collectieve gedragsverandering, zoals klimaatverandering.

About the Author

Annelot Wismans was born on the 29th of March 1993 in Rotterdam, the Netherlands. Before starting her PhD, she obtained a Bachelor of Science in Psychology at the University of Leiden in 2015 and a Bachelor of Science in Business Administration at the Rotterdam School of Management in 2016. In 2018, she completed the Master of Science in Economics and Business Economics, specializing in Behavioural Economics, at the Erasmus School of Economics. In December of that year Annelot started as a PhD candidate as part of an interdisciplinary project connecting economics and psychology under the supervision of Professor Dr. Roy Thurik and Professor Dr. Ingmar Franken. She carried out her research within the Department of Applied Economics at the Erasmus School of Economics as a member of the Erasmus Research Institute of Management and the Erasmus University Rotterdam Institute for Behaviour and Biology.

Annelot's research can be broadly divided into two themes: studies obtaining behavioural insights from the COVID-19 pandemic (amongst others focusing on preventive health behaviours) and studies on the psychology of entrepreneurship. Her work has been published in *Applied Psychology, BMC Public Health, Management Review Quarterly, Social Psychological Bulletin, Personality and Individual differences,* and *PLOS One.* One of her studies has been published as a chapter in the book '*The COVID-19 Crisis and Entrepreneurship*: *Perspectives and Experiences of Researchers, Thought Leaders, and Policymakers'.* Annelot will continue her career outside the academic world.

Portfolio

Publications

Publications in journals

- Wismans, A., Kamei, K., Thurik, R., & Torrès, O. (2021). The link between attention-deficit hyperactivity disorder symptoms and entrepreneurial orientation in Japanese business owners. *Management Review Quarterly*, *71*, 857–872.
- Wismans, A., Letina, S., Thurik, R., Wennberg, K., Franken, I., Baptista, R., Marín, J. B., Block, J., Burke, A., Dejardin, M., Janssen, F., Santarelli, E., & Torrès, O. (2020). Hygiene and social distancing as distinct public health related behaviours among university students during the COVID-19 Pandemic. *Social Psychological Bulletin*, *15*(4), 1–26.
- Wismans, A., Letina, S., Wennberg, K., Thurik, R., Baptista, R., Burke, A., Dejardin, M., Janssen, F., Santarelli, E., & Torrès, O. (2021). The role of impulsivity and delay discounting in student compliance with COVID-19 protective measures. *Personality and Individual Differences*, *179*, 110925.
- Wismans, A., Thurik, R., Baptista, R., Dejardin, M., Janssen, F., & Franken, I. (2021). Psychological characteristics and the mediating role of the 5C Model in explaining students' COVID-19 vaccination intention. *PLOS O*ne, *16*(8), e0255382.
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Publications in books

- Wismans, A., Lodder, M., & Thurik, R. (2022). Entrepreneurial intention of Dutch students during the COVID-19 pandemic: Are today's students still tomorrow's entrepreneurs? In D. B. Audretsch & I. A. M. Kunadt (Eds.), *The COVID-19 Crisis and Entrepreneurship*: *Perspectives and Experiences of Researchers, Thought Leaders, and Policymakers* (pp. 187-207). Springer, Cham.

Manuscripts submitted

- Wismans, A., Jansen, P., Thurik, R., Prinzie, P., & Franken, I. Seeking the roots of entrepreneurship: childhood and adolescence extraversion predict entrepreneurial intention in adults.

Manuscripts in progress

- Wismans, A., Van der Zwan, P., & Thurik, R. COVID-19 vaccination: lower intention and coverage among entrepreneurs compared to employees.
- Mukerjee, J., Wismans, A., Torrès, O., & Thurik, R. Measuring Play and Play in entrepreneurship.

Teaching

- 2019-2022: Supervision of bachelor and master theses (Erasmus School of Economics)
- 2020-2022: Supervision of bachelor internships (Erasmus School of Economics)
- 2021-2022: Teaching assistant BSc seminar Strategy Economics – module "Are entrepreneurs born or made?" (Erasmus School of Economics)
- 2020-2021: Teaching assistant MSc seminar Strategic Behaviour – module "Biases in managerial decision making" and supervision of research projects (Erasmus School of Economics)

PhD courses

- Academic Writing (Erasmus Research Institute of Management)
- Addiction (Erasmus School of Social and Behavioural Sciences, Erasmus University Rotterdam)
- Applied Econometrics (Erasmus Research Institute of Management)
- Behavioural Decision Theory (Erasmus Research Institute of Management)
- Decision Making in Theory and Practice (Faculty of Social and Behavioural Sciences, Leiden University)
- Empirical Research Methodology and Measurement (Erasmus Research Institute of Management)
- Experimental Methods in Business Research (Erasmus Research Institute of Management)
- Mediation, Moderation, and Conditional Process Modelling (Erasmus Research Institute of Management)
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Certificates

- Graduate Management Admission Test (GMAT): 710
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Refereeing for academic journals

- 2019, 2020: Small Business Economics
- 2021: Acta Psychologica, BMJ Open, Journal of Business Venturing Insights, Personality and Individual Differences, PLOS One, Scandinavian Journal of Psychology, Trends in Psychology, Small Business Economics
- 2022: PLOS One, International Entrepreneurship and Management Journal

Presentations

- 2020: paper accepted for Innovation Management, Entrepreneurship and Sustainability Conference (cancelled due to COVID-19)
- 2019-2022: internal seminars Department of Applied Economics (Organisation, Strategy and Entrepreneurship (OSE) group) and Department of Psychology, Education and Child Studies ("ROCKS" seminar)
- 2020-2022: annual PhD Day Department of Applied Economics
- 2021: Conference "Resilience and Recovery after COVID-19: insights from the social & behavioural sciences"
- 2022: internal seminar at Montpellier Business School, Montpellier, France

Other

- 2020-2022: Organisation COVID-19 "speeddates" - Applied Economics department and OSE group
- 2021: Working group on Mental wellbeing of PhD's - Applied Economics department
- 2022: member of the PhD Board - Applied Economics department

Education

- 2012-2015: Bachelor of Science in Psychology (*cum laude*), University of Leiden, Leiden
- 2013-2016: Bachelor of Science in Business Administration (*cum laude*), Rotterdam School of Management, Rotterdam
- 2016-2018: Master of Science in Economics and Business – Specialization in Behavioural Economics (*cum laude*), Erasmus School of Economics, Rotterdam

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Ahmadi, S., *A motivational perspective to decision-making and behavior in organizations*, Supervisors: Prof. J.J.P. Jansen & Dr T.J.M. Mom, EPS-2019-477-S&E

Albuquerque de Sousa, J.A., *International stock markets: Essays on the determinants and consequences of financial market development*, Supervisors: Prof. M.A. van Dijk & Prof. P.A.G. van Bergeijk, EPS-2019-465-F&A

Alves, R.A.T.R.M, Information Transmission in Finance: Essays on Commodity Markets, Sustainable Investing, and Social Networks, Supervisors: Prof. M.A. van Dijk & Dr M. Szymanowska, EPS-2021-532-LIS

Anantavrasilp, S., *Essays on Ownership Structures, Corporate Finance Policies and Financial Reporting Decisions*, Supervisors: Prof. A. de Jong & Prof. P.G.J. Roosenboom, EPS-2021-516-F&E

Ansarin, M., *The Economic Consequences of Electricity Pricing in the Renewable Energy Era*, Supervisors: Prof. W. Ketter & Dr Y. Ghiassi-Farrokhfal, EPS-2021-528-LIS

Arampatzi, E., Subjective Well-Being in Times of Crises: Evidence on the Wider Impact of Economic Crises and Turmoil on Subjective Well-Being, Supervisors: Prof. H.R. Commandeur, Prof. F. van Oort & Dr M.J. Burger, EPS-2018-459-S&E

Arslan, A.M., *Operational Strategies for On-demand Delivery Services*, Supervisors: Prof. R.A. Zuidwijk & Dr N.A. H. Agatz, EPS-2019-481-LIS

Avci, E., *Surveillance of Complex Auction Markets: A Market Policy Analytics Approach*, Supervisors: Prof. W. Ketter, Prof. H.W.G.M. van Heck & Prof. D.W. Bunn, EPS-2018-426-LIS

Aydin Gökgöz, Z. Mobile Consumers and Applications: Essays on Mobile Marketing, Supervisors: Prof. G.H. van Bruggen & Dr B. Ataman, EPS-2021-519-MKT

Azadeh, K., Robotized Warehouses: Design and Performance Analysis, Supervisors: Prof. M.B.M. de Koster & Prof. D. Roy, EPS-2021-515-LIS,

Balen, T.H. van, Challenges of Early-Stage Entrepreneurs: The Roles of Vision Communication and Team Membership Change, Supervisors: Prof. J.C.M. van den Ende & Dr M. Tarakci, EPS-2019-468-LIS

Bansraj, S.C., *The Principles of Private Equity: Ownership and Acquisitions*, Supervisors: Prof. J.T.J Smit & Dr V. Volosovych, EPS-2020-507-F&A

Bavato, D., *With New Eyes: The recognition of novelty and novel ideas*, Supervisors: Prof. D.A. Stam & Dr S. Tasselli, EPS-2020-500-LIS,

Bernoster, I., *Essays at the Intersection of Psychology, Biology, and Entrepreneurship,* Supervisors: Prof. A.R. Thurik, Prof. I.H.A. Franken & Prof. P.J.F Groenen, EPS-2018-463-S&E

Blagoeva, R.R., The Hard Power of Soft Power: A behavioral strategy perspective on how power, reputation, and status affect firms, Supervisors: Prof. J.J.P. Jansen & Prof. T.J.M. Mom, EPS-2020-495-S&E

Breet, S., A Network Perspective on Corporate Entrepreneurship: How workplace relationships influence entrepreneurial behavior, Supervisors: Prof. J.J.P. Jansen, Prof. J. Dul & Dr L. Glaser, EPS-2022-545-S&E

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The COVID-19 pandemic has had an unparalleled impact on the entire global population. Two tools of governments to curb a pandemic are the installation of preventive public health regulations and widespread vaccination. Both these tools are only effective if collectively complied with and effectively adopted. Hence, strategies to halt the pandemic heavily relied on human behaviour. It was therefore quickly acknowledged that insights from social and behavioural science were needed. The urgent need for research on behaviour during the COVID-19 pandemic formed the start of this dissertation. We focus on explaining individual behaviour and try to disentangle which individual characteristics and attitudes are important for behavioural choices and outcomes during the pandemic. Specifically, this thesis consists of six studies that can be broadly divided into three themes. Part 1 is about compliance with COVID-19 measures. Part 2 focuses on COVID-19 vaccination. Finally, Part 3 deals with entrepreneurship during the COVID-19 pandemic. Several chapters are based on data collected as part of the Erasmus University Rotterdam International COVID-19 Student Survey.

Annelot Wismans (1993) was born in Rotterdam, the Netherlands. She started her PhD in December 2018 after obtaining a Master of Science in Behavioural Economics (Erasmus School of Economics), and Bachelors of Science in Psychology (University of Leiden) and Business Administration (Rotterdam School of Management).

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