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Psychological factors associated with vaccine attitudes and vaccination behaviors

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Abstract

High vaccine uptake is important to limit the spread of infectious diseases. Knowing what factors are related to vaccination decisions can help health authorities communicate effectively with the public about vaccines. In the studies included in the present thesis, we investigated psychological factors associated with vaccine acceptance by surveying the general population (Studies I–III) and health professionals (Study IV) in Finland. We focused on childhood vaccines, influenza vaccines, and a hypothetical COVID-19 vaccine (no COVID-19 vaccine was available at the time of data collection).

Although many previous studies have investigated the extent to which vaccine attitudes are related to vaccination decisions, fewer studies have addressed factors that motivate people to hold negative vaccine attitudes and reject vaccines. We examined whether nonconformist identity (Study I) and psychological disease-avoidance mechanisms (Study II) are related to vaccine attitudes and vaccination decisions. In Study I, we found that individuals who reported higher nonconformist tendencies held more negative vaccine attitudes. The relationship between nonconformist identity and vaccine refusal was, however, very small. This suggests that some individuals might hold negative vaccine attitudes to express a nonconformist identity, but that many of these individuals still decide to get vaccinated. In Study II, we found that individuals who reported more aversive reactions to potential pathogen transmission (germ aversion) during the COVID-19 pandemic were more willing to get vaccinated and perceived vaccines as safer, than those less germ aversive. This contradicts research conducted before the pandemic suggesting that germ-aversive individuals have more negative vaccine attitudes, possibly because they are more likely to consider vaccines as potential contaminants. We speculate that this contradiction is due to germ-aversive individuals responding more strongly to the pandemic, making them more motivated to protect themselves against disease.

A frequently mentioned explanation for why some individuals reject vaccines is that the diseases the vaccines prevent against are not prevalent in the environment and therefore not perceived to pose a threat. The COVID-19 pandemic offered an opportunity to investigate people's willingness to get vaccinated during an immediate disease threat. In Study III, we studied how perceived disease risk, objective disease risk, and perceived vaccine safety was associated with people's willingness to get vaccinated against

COVID-19 during the early phase of the pandemic. We found that those who perceived the disease as potentially severe for other people were slightly more willing to be vaccinated. That people perceived a prospective COVID-19 vaccine to be safe was the strongest predictor of their willingness to take the vaccine. Study III thus suggested that vaccine-safety concerns make individuals less willing to take vaccines also during considerable disease threat.

Receiving a vaccine recommendation from a health professional has been reported by laypeople as the main reason for taking vaccines. In Study IV, we investigated health professionals' willingness to recommend vaccines to patients. Although most health professionals held positive vaccine attitudes, a non-negligible proportion questioned the benefits and safety of vaccines. Worryingly, these health professionals were less willing to guide their patients towards getting vaccinated. Because health professionals with higher education had more positive vaccine attitudes, we speculate that more vaccine-related training might increase health professionals' confidence in vaccines and their willingness to recommend vaccines to patients.

Based on the strong relationship between perceived vaccine safety and willingness to get vaccinated, the findings presented in the current thesis suggest that health authorities should focus on vaccine safety in their communication with the public—even during times of immediate disease threat. Public communication might be more effective if authorities consider the different motives individuals have for holding certain vaccine attitudes. For example, messages could be formulated to minimize the risk of evoking opposition in nonconformist individuals. Nevertheless, experimental studies are needed to investigate how effective different messages are depending on the motive of the individual. The current findings also highlight the importance of continued research on health professionals' vaccine attitudes.

Sammanfattning

För att lyckas stoppa spridningen av sjukdomar som går att förebygga med vaccin, är det viktigt att så många människor som möjligt vaccinerar sig. Kunskap om vad som påverkar människors vaccinationsbeslut hjälper hälsovårdsmyndigheter att effektivt kommunicera med allmänheten om vaccin. I studierna som ingår i föreliggande avhandling undersökte vi psykologiska faktorer relaterade till vaccinationsbeslut genom att utföra enkätundersökningar i normalbefolkningen (Studie I–III) och bland hälsovårdspersonal (Studie IV) i Finland. Vi fokuserade på barnvaccin, influensavaccin, och ett hypotetiskt covid-19-vaccin (inget vaccin mot covid-19 fanns tillgängligt då undersökningarna utfördes).

Många tidigare studier har undersökt människors attityder till vaccin samt i vilken mån dessa attityder är kopplade till ifall människor beslutar att vaccinera sig eller inte. Få studier har dock undersökt möjliga faktorer som motiverar människor att ha negativa attityder till vaccin och neka vaccinering. Vi undersökte ifall en del människor uttrycker negativa attityder till vaccin för att kommunicera en icke-konformistisk identitet (Studie I), samt ifall attityder till vaccin och vilja att vaccinera sig hänger ihop med sådana psykologiska mekanismer som antas ha utvecklats för att de får människor att undvika sjukdom (Studie II). Resultaten från Studie I tydde på att personer som rapporterade större icke-konformistiska tendenser hade mer negativa attityder till vaccin. Sambandet mellan icke-konformism och tidigare vaccinationsbeslut var dock litet. Detta kan tolkas som att en del personer uttrycker negativa attityder till vaccin för att kommunicera en icke-konformistisk identitet, men att många av dessa personer trots allt beslutar sig för att ta vaccin. I Studie II fann vi att personer som rapporterade större benägenhet att under covid-19-pandemin reagera med aversion på potentiell smitta och kontamination, var mer villiga att vaccinera sig och ansåg i större utsträckning att vaccin är trygga att ta, än de med mindre sådan benägenhet. Dessa resultat står i konflikt med studier utförda innan pandemin, som tytt på att människor med större aversionsbenägenhet har mer negativa attityder till vaccin, möjligtvis på grund av att de är mer benägna att uppleva vaccin som potentiellt kontaminerande. En möjlig förklaring till skillnaden mellan föreliggande och tidigare resultat är att aversionsbenägna personer reagerar starkare på pandemin och att de således är mer motiverade att skydda sig mot sjukdom.

Att många sjukdomar som går att förebygga med vaccin inte är prevalenta i människors omgivning, och således inte upplevs som hot, nämns ofta som en orsak till att människor nekar vaccin. Covid-19 pandemin erbjöd möjligheten att undersöka människors vilja att vaccinera sig när sjukdomshotet är större. I Studie III undersökte vi hur stort hot människor upplevde att covid-19 utgör, hur stor tillit människor hade till att ett framtida covid-19 vaccin är tryggt att ta, samt ifall upplevt hot och tillit till vaccinets trygghet predicerade människors vilja att vaccinera sig mot covid-19. De som ansåg att covid-19 är en farlig sjukdom för andra människor var något mer villiga att vaccinera sig. Tillit till att vaccinet är tryggt att ta uppvisade dock det starkaste sambandet med vilja att vaccinera sig. Resultaten tydde således på att oro över att vaccin inte är trygga att ta kan få människor att inte vilja vaccinera sig, även under större sjukdomshot.

På frågan om varför man beslutat att vaccinera sig, svarar människor ofta att de rekommenderats av hälsovårdspersonal att ta vaccin. I Studie IV undersökte vi hälsovårdspersonals villighet att rekommendera vaccin till sina patienter. Trots att en övervägande majoritet av hälsovårdspersonalen hade positiva attityder till vaccin, tvivlade en icke-försumbar andel på att vaccin är nyttiga och trygga att ta. Jämfört med hälsovårdspersonal med positiva attityder till vaccin, var de med mindre positiva attityder oroväckande nog mindre villiga att handleda sina patienter till att vaccinera sig. Eftersom hälsovårdspersonal med högre utbildning hade mer positiva attityder till vaccin är det möjligt att mer vaccinrelaterad utbildning kan leda till större tilltro till vaccin, och vilja att rekommendera vaccin, hos hälsovårdspersonal.

Eftersom tilliten till att vaccinet är tryggt att ta uppvisade det starkaste sambandet med vilja att vaccinera sig, tydde resultaten av föreliggande avhandling på att hälsovårdsmyndigheter behöver fokusera på vaccinens trygghet i sin kommunikation med allmänheten—även i tider då sjukdomen är mer framträdande i samhället och utgör ett större hot. Det är möjligt att kommunikation gällande vaccin är mer effektiv ifall man beaktar de bakomliggande motiven för människors attityder till vaccin. Till exempel kan information formuleras på ett sätt som minskar risken för att den väcker motstånd hos människor med icke-konformistisk identitet. Hur effektiv olika sorters kommunikation är beroende på individens bakomliggande motiv behöver dock undersökas i experimentella studier. Föreliggande resultat understryker även vikten av att vidare undersöka hälsovårdspersonals attityder till vaccin.

1. Introduction

Vaccination is considered one of the greatest public health achievements. Since the introduction of vaccines, the prevalence of many dangerous infectious diseases has drastically decreased. The World Health Organization (WHO) estimates that vaccinations prevent 2–3 million deaths each year (WHO, 2021). In addition to protecting the vaccinated individual from disease, most vaccines also provide indirect protection to unvaccinated individuals by limiting disease transmission (Fine et al., 2011; Metcalf et al., 2015). This makes vaccination an important tool for reducing the burden of infectious diseases on society. In spite of this, some individuals are unsure about whether to accept vaccines for themselves and their children, and some decide to reject vaccines altogether (Brewer et al., 2017; Dubé et al., 2013). This phenomenon, often referred to as *vaccine hesitancy*, undermines the population-level protection of vaccinations and increases the risk of disease outbreaks (Omer et al., 2008; Phadke et al., 2016). Considering the serious consequences of insufficient population-level protection against diseases, WHO recently listed vaccine hesitancy as one of the top ten threats to global health (WHO, 2019). As public acceptance of vaccines is critical for vaccination programs to be successful, understanding the psychology behind vaccination decisions is of paramount importance. Knowing what affects these decisions helps health professionals and authorities to communicate effectively with the public to maintain protection against currently controlled diseases, intervene if the level of protection drops, and achieve sufficient protection against novel diseases. Given the current pandemic caused by the coronavirus SARS-CoV-2, public vaccine acceptance is a pressing concern and will play a pivotal role in how the pandemic advances.

In the present thesis, I investigated psychological correlates of vaccine acceptance among the general public and health professionals in Finland. I focused on childhood vaccines (i.e., vaccines administered to children before the age of 6), seasonal influenza vaccines, and COVID-19 vaccines. Childhood vaccinations are voluntary in Finland and the vaccines are administered free of charge in accordance with the national vaccination program (Finnish Institute for Health and Welfare, 2021h). Almost all childhood vaccines are administered at child health clinics by a public health nurse in connection with scheduled health checks (Ministry of Social Affairs and Health, 2021). Influenza vaccines are administered free of

charge to risk groups (including children under the age of 7 years and individuals aged 65 years or older) and health professionals (Finnish Institute for Health and Welfare, 2021g). Some employers also provide their employees free influenza vaccination. In other cases, individuals will have to pay for the influenza vaccines. Since March 2017, the Communicable Diseases Act 48§2 requires health professionals working with risk populations to get vaccinated against influenza every year (Communicable Diseases Act, 2016). Vaccinations against COVID-19 started in Finland during the last week of 2020. The vaccines were initially administered to health professionals working with COVID-19 patients, followed by older individuals and risk groups. At the time of this writing, COVID-19 vaccines are recommended for all individuals over the age of 12 years. COVID-19 vaccination is voluntary and free of charge for everyone (Finnish Institute for Health and Welfare, 2021a, 2021e).

1.1. Terminology

In the research literature on vaccination decisions, *vaccine acceptance* commonly refers to the behavior to take vaccines, whereas not taking vaccines is called *vaccine rejection* or *vaccine refusal*. The term "vaccine hesitancy" emerged to de-polarize the previous categorization of individuals as either pro- or anti-vaccination (Larson et al., 2014). The specific definition and use of the term has, however, been debated (Dudley et al., 2020). Vaccine hesitancy has been used to describe both behaviors (e.g., postponing or refusing vaccination) and attitudes (e.g., beliefs regarding the benefit and safety of vaccines; Bedford et al., 2018; Dudley et al., 2020; Peretti-Watel et al., 2015). The most cited definition of vaccine hesitancy is the one developed by the WHO SAGE vaccine-hesitancy working group. The working group defined vaccine hesitancy as a "delay in acceptance or refusal of vaccination despite availability of vaccination services" (MacDonald & the SAGE Working Group on Vaccine Hesitancy, 2015, p. 4163). This definition has been criticized for not recognizing that individuals who refuse vaccines might do so without hesitation, whereas those who take vaccines might hesitate in their decisions (Bedford et al., 2018; Salmon et al., 2015). The working group also mentioned the accessibility and affordability of vaccination services among the factors that affect vaccine hesitancy. Hence, the definition does not make a clear differentiation between unwillingness among the public to get vaccinated although vaccines are

available to them and failure by health services to provide easy access to vaccination (Bedford et al., 2018).

Because the term vaccine hesitancy does not allow for a differentiation between attitudes and behaviors, I have chosen not to use the term in the following sections. Instead, *vaccination behavior* will be used for actions such as taking, postponing, or not taking vaccines, and *vaccination intentions* will refer to an individual's willingness to get vaccinated in the future. The term *vaccine attitudes* will be used for individuals' beliefs about the benefits and safety of vaccines. *Vaccine uptake* refers to the proportion of vaccinated individuals in a given population.

1.2. Vaccine Uptake and Herd Immunity

In Finland, the uptake of most vaccines included in the national vaccination program is high (Finnish Institute for Health and Welfare, 2021j). For example, 95.8% of children born in 2017 have received the first dose of the MMR vaccine, which protects against measles, mumps, and rubella. Measles is a very infectious disease, and a vaccination rate of around 95% is required to achieve herd immunity. Herd immunity means that a sufficiently large number of individuals in a population is immune towards a certain disease, indirectly protecting those who are not (Fine et al., 2011; Metcalf et al., 2015). Although nation-level estimates of vaccine uptake are important indicators of the general vaccination status in a country, regional estimates are more important from a practical perspective. Regions where fewer individuals are vaccinated, also known as *pockets* in the vaccination coverage, are at higher risk for disease outbreaks.

Whereas some individuals are unvaccinated due to medical contraindications, low vaccine uptake also results from vaccine refusal or inaction. Complete vaccine refusal is rare; about 1–2% of parents in high-income countries refuse all vaccines for their children (Brewer et al., 2017). In Finland, 1% of children have not received any vaccines by the age of 3 (Finnish Institute for Health and Welfare, 2021i). More common than refusing all vaccines is that parents refuse some vaccines while accepting others. Studies conducted in the US indicate that 6–25% of parents have rejected at least one vaccine for their children (Brewer et al., 2017). Some parents also postpone vaccinations, meaning that they have their children vaccinated at older ages than recommended. In contrast to vaccines included in the national vaccination program, remaining unvaccinated is

much more frequent when it comes to vaccines that require individuals to actively seek out vaccination, such as the vaccines against seasonal influenza. For example, during the 2018–2019 influenza season, 50% of individuals in Finland who belonged to a risk group due to old age remained unvaccinated against influenza (Finnish Institute for Health and Welfare, 2021f).

Vaccination rates are informative for evaluating how well a population is protected against a disease. Nevertheless, such rates do not provide information about how many individuals are unsure in their vaccination decisions. Unsure individuals might be at a higher risk of choosing not to be vaccinated in the future. To be able to prevent drops in vaccine uptake, it is important to identify the prevalence of uncertainty in vaccination decisions as well as factors that are associated with whether individuals decide to be vaccinated or not.

1.3. Attitudes as Correlates of Vaccination Behaviors

Research seeking to describe the most important aspects of vaccination decisions has been inspired by theories of health-related behavior, such as the health-belief model (Carpenter, 2010; Rosenstock, 1966) and the theory of planned behavior (Ajzen, 1991). According to these theories, health behaviors result from weighing the consequences of different behaviors against each other, taking into account facilitators of and barriers to the behaviors. Put simply, these theories imply that individuals will engage in behaviors that promote health when they perceive that the benefits of the behaviors outweigh the costs.

Consistent with these theories, studies show that individuals who have positive attitudes to the benefits and safety of vaccines are more likely to accept vaccination (Betsch et al., 2018; Thomson et al., 2016). According to systematic literature reviews, concerns about vaccine safety is the most reported reason for why parents refuse vaccines for their children (Karafillakis & Larson, 2017; L. E. Smith et al., 2017). When it comes to influenza vaccines, both vaccine safety concerns and a lack of confidence in vaccine effectiveness are frequently mentioned reasons for refusing vaccination (Karafillakis & Larson, 2017; Schmid et al., 2017; Yeung et al., 2016). Furthermore, individuals who perceive that the vaccine-preventable disease poses a large risk are expected to find the benefits of vaccination to be greater. On the contrary, an individual who does not perceive that the

disease poses a risk might find the risks of vaccination to outweigh the benefits (Dubé et al., 2013; Karafillakis & Larson, 2017; MacDonald & the SAGE Working Group on Vaccine Hesitancy, 2015). Research shows that individuals who perceive the likelihood of contracting the vaccine-preventable disease as low, who do not perceive the disease as severe, or who do not worry about the disease, are less likely to accept vaccination (Betsch et al., 2018; Bish et al., 2011; Brewer et al., 2007; Schmid et al., 2017; Thomson et al., 2016).

Because of the relationship between vaccine attitudes and vaccination behaviors, attempts to increase vaccine uptake often include educational interventions aiming to increase vaccination-related knowledge (Sadaf et al., 2013). These interventions rest on the assumption that negative vaccine attitudes and vaccine concerns result from a lack of information or from being misinformed. Misinformation about vaccines spreads fast on online social forums and in news media, and anti-vaccination websites are easily encountered when looking for information on vaccines. These websites often portray vaccines as dangerous, ineffective, and causing illness (Kata, 2010; Moran et al., 2016). The effectiveness of educational interventions in changing vaccine attitudes and increasing willingness to accept vaccines has not received clear support in systematic literature reviews (for a review of reviews, see, Dubé et al., 2015). This is in line with the general literature on misinformation, which suggests misbeliefs are fairly resistant to correction and even when a false belief is successfully corrected, it does not affect people's attitudes and behaviors (Lewandowsky et al., 2012; Lewandowsky & van der Linden, 2021). Instead of changing attitudes along with evidence, individuals often interpret evidence to support their attitudes, search for information that confirms their already held beliefs, and reject information that does not (Douglas et al., 2019; Lewandowsky & Cook, 2020). This is because reasoning is affected by the conclusions one is motivated to arrive at (Kunda, 1990). Attitudes that conflict with scientific evidence can thus be a consequence of the individual being motivated to sustain such attitudes, rather than result from lack of accurate information (Hornsey & Fielding, 2017). From this perspective, merely trying to correct factual misbeliefs is unlikely to have any wider effect on people's attitudes and behaviors. Considering factors that motivate people to hold negative vaccine attitudes and reject vaccination can benefit health professionals and authorities when they communicate with the public about vaccination.

1.4. Motives for Holding Negative Vaccine Attitudes and Refusing Vaccines

Although many previous studies have investigated the extent to which vaccine attitudes are related to vaccination decisions, fewer studies have addressed the motives people have for holding certain vaccine attitudes and refusing vaccines. Individuals might be motivated to sustain anti-science attitudes for a variety of reasons, such as ideology, worldview, conspiratorial thinking, vested interests, personal identity expression, or fears (Hornsey & Fielding, 2017). In the present thesis, I investigated the role of two potential motives for negative vaccine attitudes and vaccine rejection: nonconformist identity and fear of disease due to evolved disease-avoidance mechanisms.

1.4.1. Nonconformist Identity

Anti-science attitudes have been proposed to serve as a mean through which individuals express their personal identity (Hornsey & Fielding, 2017). This identity can include opposition to general consensus, or "going against the herd" (Browne et al., 2015; Hornsey et al., 2018a; Hornsey & Fielding, 2017). Reacting with opposition when thinking that one's freedom to decide is threatened has been labeled *reactance* (Brehm & Brehm, 1981; Rosenberg & Siegel, 2018). Hypothetically, if holding negative vaccine attitudes and rejecting vaccines are ways for some individuals to express a nonconformist identity, then individuals who are more reactant should be more likely to oppose vaccination. Indeed, in a study conducted in 24 nations, Hornsey et al. (2018a) found that more reactant individuals were more likely to report that they perceive vaccines as unsafe and ineffective.

Possibly, negative vaccine attitudes among reactant individuals are a consequence of a broader opposition towards medical authorities and conventional, evidence-based medicine. As the term suggests, conventional medicine includes practices that conform to the dominant perspective on health, which might trigger opposition in reactant individuals. Practices outside this perspective have been labeled complementary and alternative medicine (CAM). CAM treatments are often described by their users as safer and more 'natural' than conventional treatments (Attwell et al., 2018). Research indicates that individuals who have less positive vaccine attitudes and who reject vaccines also have more positive CAM attitudes and more likely use CAMs (Browne et al., 2015; Bryden et al., 2018; Hornsey et al.,

2020; Lewandowsky, Woike, et al., 2020; Wardle et al., 2016). There is also evidence that the fact that individuals both hold negative vaccine attitudes and use CAMs can be explained by a general distrust in conventional medicine (Hornsey et al., 2020). Whether this preference of CAM over conventional medicine is for some individuals a way to express a non-conformist identity has hitherto not been studied. Furthermore, previous research has not investigated whether individuals who express negative vaccine attitudes as part of a nonconformist identity also refuse vaccines, or whether the need to oppose is satisfied by the expression of negative attitudes.

Studying the role of reactance in vaccination decisions is important for the development of effective health-communication strategies. If reactance is a motive behind negative vaccine attitudes, educational interventions by health authorities might be ineffective or even backfire and result in even stronger negative vaccine attitudes (Lewandowsky et al., 2012; Nyhan et al., 2014).

1.4.2. Evolved Disease-Avoidance Mechanisms

Although safety concerns are among the most common reasons for vaccine rejection, few studies have investigated why some individuals are more inclined to perceive vaccines as unsafe than others. One possible explanation can be found in the psychological and behavioral mechanisms believed to have evolved because they decrease the risk of disease. These mechanisms have been labeled *the behavioral immune system* (Schaller, 2006; Schaller & Park, 2011). Whereas the physiological immune system has evolved because fighting off infection has increased survival and the relative likelihood that genes underlying this effective immune response are passed on to following generations, the behavioral immune system has evolved because it decreases the risk of becoming infected in the first place.

The behavioral immune system makes individuals react with aversion to potential sources of pathogens. This aversion, commonly experienced through the emotion disgust, causes individuals to avoid contact with the sources, and they thereby avoid becoming infected. Most pathogens, such as viruses and bacteria, are not visible. As a consequence, the system responds to contamination cues. Contamination cues are sources or stimuli that in our evolutionary past have been associated with a higher risk of pathogens, such as spoiled food, the smell of biological decay, bodily secretions (e.g., saliva, nasal secretion, mucus), as well as wounds and defor-

mations (e.g., Oaten et al., 2009). These cues are not perfect indicators of whether pathogens are present or not, and the system will sometimes respond to sources that contain no pathogens and sometimes fail to respond although pathogens are present. In the latter case the individual risks falling ill, and not reacting is thus likely to have more negative consequences than being overly avoidant of potential contamination cues. The behavioral immune system is, therefore, believed to have evolved to be hypersensitive and respond to cues that *might* indicate the presence of pathogens (Ackerman et al., 2018; Schaller & Park, 2011). This can make individuals respond to unspoiled food that smells like spoiled food (e.g., fermented fish, aged cheese) or avoid social contact with individuals who have deformities that are not contagious. Avoiding sources also comes with costs, and an individual must balance between the costs (e.g., potentially missing an opportunity to get nutrition) and the benefits (e.g., potentially escaping illness) of avoidance. For individuals who are particularly vulnerable to infections, failing to avoid contamination is more costly. The behavioral immune system is, therefore, assumed to be flexible to situational differences in disease threat and individual differences in vulnerability.

The behavioral immune system has been found to be associated with a wide range of attitudes and behaviors humans display. Because vaccines protect against infectious diseases, individuals with higher propensity to be disgusted by potential sources of pathogens (hereafter, disgust sensitivity) and to react negatively to potential pathogen transmission (hereafter, germ aversion) could be expected to hold more positive vaccine attitudes. Paradoxically, several studies indicate the opposite. Individuals with higher disgust sensitivity and more germ aversion have been found to have more *negative* vaccine attitudes (Clay, 2017; Clifford & Wendell, 2016; Kempthorne & Terrizzi, 2021; Luz et al., 2019; Reuben et al., 2020), and be slightly *less* likely to have accepted vaccination (Luz et al., 2019). In an attempt to explain these surprising findings, Clay (2017) pointed out that vaccines are administered in ways that in and by themselves serve as contamination cues, such as puncturing the skin, and inhalation or ingestion of a foreign substance. Individuals who are more averse to pathogens and contamination are thus hypothesized to react to vaccination as a contamination cue and, as a consequence, develop more negative vaccine attitudes. In support of this, individuals more easily disgusted by needles and blood have been found to hold more negative attitudes to the safety and efficacy of vaccines (Hornsey et al., 2018a).

As mentioned above, the behavioral immune system is hypothesized to be flexible, and individuals are expected to react more strongly when they feel more vulnerable and when disease threat is higher (Ackerman et al., 2018; Oaten et al., 2009). In line with this, research indicates that individuals who perceive themselves as more susceptible to disease are more likely to accept vaccines (Luz et al., 2019). If disgust-sensitive individuals are less willing to get vaccinated also during increased disease threat has not been investigated prior to the COVID-19 pandemic. Whether the above-mentioned relationships hold true under higher disease threat is informative for health authorities aiming to communicate effectively about vaccines during the pandemic. For example, accompanying vaccine information with pictures of needles and injections might cause an aversive reaction in individuals with high germ aversion.

1.5. The COVID-19 Pandemic

Situational factors, such as sudden disease outbreaks, might affect vaccine attitudes and willingness to accept vaccines. The outbreak of COVID-19 was declared a pandemic by the WHO on March 11th, 2020 (WHO, 2020). Less than a year later, researchers had developed safe and effective vaccines against COVID-19 (Baden et al., 2021; Polack et al., 2020), and vaccination campaigns had been launched around the world. Health authorities now face the challenge to achieve and maintain high uptake of the vaccines.

A frequently mentioned reason for why individuals in developed countries hold negative vaccine attitudes and choose not to get vaccinated is that many of the vaccine-preventable diseases are not prevalent in these individuals' environment, and that they therefore do not consider the diseases as threatening. Because the low prevalence of the diseases to a great extent is the result of successful vaccinations programs, vaccines have been described as victims of their own success (Dubé et al., 2013; Larson et al., 2011; Miton & Mercier, 2015; Salmon et al., 2015). From this reasoning follows that sudden disease outbreaks should result in higher willingness to get vaccinated because the disease threat becomes more salient, but evidence for this is scarce. Some studies indicate that media attention given to regional outbreaks of measles or to severe influenza seasons is associated with subsequent increases in rates of measles and influenza vaccination (Arendt & Scherr, 2020; Ma et al., 2006). Presumably, when disease threat is high, individuals are more likely to decide to be vaccinated despite

vaccine concerns. The fact that disease outbreaks occur does, nevertheless, not necessarily mean that individuals perceive the disease to pose a threat. During the pandemic caused by the H1N1 influenza (swine flu) in 2009–2010, uptake of the vaccines against the influenza was suboptimal in most countries (Bish et al., 2011; Brien et al., 2012; Bults et al., 2015). This has been partly ascribed to the fact that many considered the swine flu a mild disease with low risk for infection. Information on how much risk individuals perceive COVID-19 to pose, whether they trust that the vaccines are safe, and if these factors are related to vaccination intentions, can aid health authorities to communicate effectively with the public about the COVID-19 vaccines.

1.6. The Role of Health Professionals

In contrast to the general public, health professionals are expected to have evidence-based knowledge on vaccines. Health professionals play a key role in maintaining and increasing vaccine uptake as they communicate directly with individuals about their vaccination decisions and can inform them about vaccines (Dubé et al., 2013). The majority of individuals perceive health professionals to be the most reliable source of vaccine information (Charron et al., 2020; Danchin et al., 2018; Eller et al., 2019; Napolitano, D'Alessandro, et al., 2018; O'Leary et al., 2018). When asking individuals about their vaccination decisions, a recommendation by a health professional is the most frequently reported reason for vaccine acceptance, whereas the lack of such a recommendation is mentioned as a reason for not accepting vaccines (Napolitano et al., 2017; Napolitano, D'Alessandro, et al., 2018; L. E. Smith et al., 2017; Song et al., 2017).

Because of the influence health professionals have on laypeople's vaccination decisions, it is worrying that studies show that some health professionals have negative vaccine attitudes and that these health professionals are less willing to recommend vaccines to patients (Collange et al., 2019; Morales et al., 2020; Napolitano, Navaro, et al., 2018; Paterson et al., 2016). Health professionals with negative vaccine attitudes have also been found less likely to accept vaccines for themselves (Dini et al., 2018; Wilson et al., 2020), which also puts their patients at a higher risk of some infectious diseases. Furthermore, some health professionals lack trust in the health system, even though they are a part of it themselves (Filia et al., 2019; Karafillakis et al., 2016). How this affects their willingness to take and

recommend vaccines has rarely been studied (Larson et al., 2018), but there is some evidence that lack of trust in official vaccine recommendations and scientific vaccine information is related to a lower willingness in health professionals to accept and recommend vaccines (Collange et al., 2019; Učakar & Kraigher, 2019).

Because of the central role health professionals have in informing about vaccines, it is important to map their vaccine attitudes. If health professionals with more negative vaccine attitudes are reluctant to recommend vaccines to patients, their attitudes might affect public vaccine uptake.

2. Aims and Expected Results

The overarching aim of the present thesis was to investigate psychological correlates of vaccination behaviors and intentions in the general public and health professionals in Finland. The thesis contributes to the literature on vaccination decisions in three main ways. First, previous research has largely focused on vaccine attitudes and how attitudes are related to whether individuals take vaccines or not. Fewer studies have focused on potential explanations for why people hold certain vaccine attitudes. We studied potential motives for holding negative vaccine attitudes, and the extent to which these motives are related to whether individuals accept vaccines or not. The second contribution is that we investigated correlates of intentions to accept a vaccine against COVID-19. Such information is of immediate interest for health authorities aiming at achieving high uptake of the novel COVID-19 vaccines. Also, the COVID-19 pandemic provides the opportunity to study vaccination intentions during increased disease threat. Most previous research on vaccination behavior is conducted in environments where vaccine-preventable diseases are controlled or not perceived to pose a large threat. Lastly, psychological correlates of vaccination decisions have rarely been studied in Finland, and, to the best of my knowledge, there is no previous study that has systematically investigated and reported on how common it is that Finnish parents hesitate in their vaccination decisions. Country-specific information about vaccination decisions is important because of cultural differences between nations and differences in vaccination practices (Dubé et al., 2014; MacDonald & the SAGE Working Group on Vaccine Hesitancy, 2015). The thesis includes four studies. Table 1 provides an overview of the studies. The aims related to each study are described below.

In **Study I**, we investigated reactance as a motive for negative vaccine attitudes and vaccine rejection. Reactant individuals have been found to have more negative vaccine attitudes (Hornsey et al., 2018b), suggesting that negative vaccine attitudes can be motivated by a need to express a non-conformist identity. Our first aim with Study I was to investigate whether such a need also manifests itself as actual behavior (i.e., vaccine refusal). We expected that reactant individuals are more likely to have postponed or rejected vaccinations. Our second aim was to investigate whether negative vaccine attitudes are part of a broader opposition to conventional medicine. We expected that a potential relationship between reactance and vaccine

attitudes and behaviors can be explained by reactant individuals having lower trust in medical doctors. We also expected that high reactance and a distrust in doctors explain associations between use of CAM and negative vaccine attitudes or vaccine rejection.

Study II was conducted during the first spring of the COVID-19 pandemic[1] (in 2020) and investigated the mechanisms of the behavioral immune system as motives behind vaccine attitudes and vaccination behaviors. This has previously been investigated only during normal disease-threat circumstances, and the behavioral immune system is believed to be sensitive to level of disease threat. Our aim with Study II was to investigate whether germ aversion and perceived infectability predict perceived vaccine safety and intentions to accept COVID-19 and influenza vaccines. Based on previous findings, we expected that individuals with more germ aversion have lower vaccination intentions and perceive vaccines as less safe. We also expected that individuals with high perceived infectibility have higher vaccination intentions.

Study III was also conducted during the pandemic spring of 2020. Our aim with Study III was to investigate the role of disease-risk perceptions, objective disease risk, and perceived vaccine safety in predicting intentions to get vaccinated against COVID-19—a disease likely perceived to pose a larger threat than vaccine-preventable diseases examined in previous research. We compared the perceptions of COVID-19 to those of influenza and measles and expected that COVID-19 is perceived to pose a larger risk. We expected that those who perceive the risk of COVID-19 as higher, who have a higher objective disease risk, and who report greater trust in the safety of a prospective COVID-19 vaccine have higher intentions to get vaccinated against COVID-19.

Our first aim with **Study IV** was to examine Finnish health professionals' vaccine attitudes and trust in the intentions and competence of their colleagues. Our second aim was to investigate whether vaccine attitudes and trust is related to the health professionals' own vaccination behavior and to

[1] The peak of the first pandemic wave in Finland was observed in the beginning of April, 2020, when the weekly incidence of COVID-19 cases was ~16 per 100,000 inhabitants (Finnish Institute for Health and Welfare, 2021b). Measures put in place by the Finnish government at that time included closing of schools and limiting public gatherings to a maximum number of 10 individuals (Finnish Government, 2020a). Unnecessary travel to and from Uusimaa—the region with the most rapid increase in COVID-19 incidence—was prohibited between March 25th and April 19th, 2020 (Finnish Government, 2020b). After this, the weekly incidence decreased, reaching ~3 COVID-19 cases per 100,000 inhabitants by the beginning of June. The incidence was low during the summer but started to increase again during the autumn.

their willingness to recommend vaccines to patients who are unsure about vaccination. We expected that health professionals who perceive vaccines as less beneficial and less safe, and who have less trust in their fellow health professionals, are more likely to have hesitated, postponed, or rejected vaccination for their children, are more likely to have rejected the influenza vaccine for themselves, and are less likely to recommend childhood and influenza vaccines to unsure patients.

Table 1

Overview of Studies

Study	Population	Vaccines	Main predictors	Outcome measures
I	General public	Influenza vaccine, childhood vaccines	Nonconformist identity	Vaccination behavior, vaccine attitudes, CAM use
II	General public	COVID-19 vaccine, influenza vaccine	Evolved disease-avoidance mechanisms	Vaccination intentions, perceived vaccine safety
III	General public	COVID-19 vaccine	Perceived disease risk, perceived vaccine safety	Vaccination intentions
IV	Health professionals	Influenza vaccine, childhood vaccines	Vaccine attitudes, trust	Vaccination behavior, vaccine-recommendation behavior

Note. Childhood vaccines refer to the vaccines included in the national vaccination program for children 6 years old or younger. CAM = Complementary and alternative medicine.

3. Method

3.1. Respondents

The present thesis is based on survey data collected from three samples from the general public (FinnBrain parents, Pietarsaari residents, and Facebook users) and one sample of health professionals. Below is a brief overview of the samples and data collections. Please see the original studies for more details.

3.1.1. FinnBrain Parents

We recruited parents of young children—a population for which vaccination decisions are of immediate relevance—from the FinnBrain Birth Cohort Study (Karlsson et al., 2018). The FinnBrain project investigates child development and collects longitudinal data from children and their parents in the Turku region and on the Åland Islands. For the purpose of the present thesis, we collected survey data from the parents at two time points. First, in 2018, we invited all parents in the project with at least one child younger than 4.5 years (N = 3401) to an online survey. In total, 770 parents (22.6%) responded and provided informed consent to participate. This was the sample of **Study I**. Second, in the spring of 2020, we invited 5103 parents from the FinnBrain project to participate in an online survey concerning the COVID-19 pandemic. **Study II** included 294 (5.8%) parents who had responded to relevant questions at both time points. **Study III** included 825 (16.2%) parents who had responded at the second time point. Ethical approval for both data collections was obtained from the Ethics Committee of the Hospital District of Southwest Finland.

3.1.2. Pietarsaari Residents

In the spring of 2020, we invited individuals who live in the Finnish region Pietarsaari to an online survey relating to the COVID-19 pandemic. The Pietarsaari region has a higher rate of unvaccinated children compared to most other Finnish regions (Finnish Institute for Health and Welfare, 2021i) and can be considered a vaccination pocket. We invited 335 Pietarsaari residents who had participated in a vaccine-related survey the preceding year and given their consent to being contacted again. In all, 205 (61.2%) individuals replied and are included in **Studies II** and **III**. The data

collection was approved by the Board for Research Ethics at Åbo Akademi University.

3.1.3. Facebook Users

In the spring of 2020, we marketed a Facebook post to recruit individuals aged 18 or older and living in Finland to an online survey concerning the COVID-19 pandemic. A total of 1325 individuals filled out the survey and are included in **Studies II** and **III.** The data collection was approved by the Board for Research Ethics at Åbo Akademi University.

3.1.4. Health Professionals

For **Study IV**, we sourced respondents from the Finnish Public Sector study—a large ongoing cohort study among municipal and hospital employees (Virtanen et al., 2011). In 2018, we sent an invitation to an online survey to 8770 hospital personnel in the regions of Forssa, Kanta-Häme, Pietarsaari, Vaasa, and Pirkanmaa. We received 4286 responses (48.9%). In the study, we included only those hospital personnel who might administer or discuss vaccinations, and excluded other health professionals (e.g., psychologists and physiotherapists) and other personnel working at hospitals (e.g., within administration and human resource management). The final sample of Study IV included 2962 health professionals (416 doctors, 263 head nurses, 1834 nurses, and 449 practical nurses). The project received ethical approval from the ethics committee of the Hospital District of Helsinki and Uusimaa.

3.2. Measures

All surveys were administered in Finnish or Swedish (the two main official languages of Finland) depending on the preference of the respondent. The respondents were informed that questions relating to childhood vaccines concerned the vaccines included in the national vaccination program for children up to the age of six, that is, the rotavirus vaccine, the chickenpox vaccine, the pneumococcal conjugate vaccine (PCV), the DTaP-IPV-Hib ("5-in-1") vaccine, the MMR vaccine, and the DtaP-IPV ("4-in-1") vaccine. Below is a brief overview of the measures used in each study. For more details, please see the original studies.

3.2.1. Study I

The measures of Study I were administered to the FinnBrain parents before the pandemic.

Reactance. We measured trait reactance with the Hong Psychological Reactance Scale (Hong & Page, 1989). The scale includes statements such as "When someone forces me to do something, I feel like doing the opposite", and respondents are asked to indicate whether they agree on a scale from 1 (*completely disagree*) to 5 (*completely agree*).

Trust in health professionals. We presented six statements to measure trust in doctors (e.g., "I trust doctors' ability to make correct diagnoses"). Respondents indicated their agreement on a scale from 1 (*completely disagree*) to 4 (*completely agree*).

Vaccine attitudes. We administered 15 statements on the benefit and safety of vaccines. We developed the statements based on a review of the literature and discussions with experts working in a nursing education program in Finland. The statements concerned childhood vaccines or vaccines in general ("Children need vaccines for diseases that are not common anymore"), and influenza vaccines ("The influenza vaccines are safe"). Respondents answered on a scale from 1 (*completely disagree*) to 4 (*completely agree*).

Vaccination behavior. We asked the respondents about their past childhood and influenza vaccination decisions. For childhood vaccinations, we asked whether they had hesitated in a vaccination decision, whether they had postponed a vaccination, and whether they had rejected a vaccination for their child altogether. For influenza, we asked whether they had taken the influenza vaccine the preceding season (2017–2018). The respondents could answer *yes* or *no* to each question.

CAM use. We measured CAM use by presenting a list of CAM items and asked the respondents to select the ones they had used during the past 12 months to treat an illness or to maintain good health. The list included 18 treatments and substances not included in the national guidelines for evidence-based prevention and treatment of diseases (The Finnish Medical Society Duodecim, 2021). Examples of items include colloidal silver, turmeric, aloe vera, reiki, and homeopathy.

3.2.2. Study II

Study II included the FinnBrain parents, the Pietarsaari residents, and the Facebook users.

Behavioral immune system mechanisms. We used the Perceived Vulnerability to Disease scale (Duncan et al., 2009) to measure behavioral immune system mechanisms. The scale consists of two subscales: one measures germ aversion (e.g., "I prefer to wash my hands pretty soon after shaking someone's hand") and the other perceived infectability (e.g., "I am more likely than the people around me to catch an infectious disease"). Responses are given on a scale from 1 (*completely disagree*) to 7 (*completely agree*). The FinnBrain parents were administered the scale before the pandemic. The Pietarsaari residents and Facebook users were administered the scale during the pandemic.

Perceived vaccine safety. We measured perceived safety of a prospective COVID-19 vaccine ("If a vaccine against COVID-19 became part of the recommended vaccines in Finland, I would trust that it is safe") and the influenza vaccines ("The influenza vaccines are safe"). These questions were administered to the Facebook users only. They answered on a scale from 1 (*completely disagree*) to 5 (*completely agree*).

Vaccination intentions. In all three samples, we measured the respondents' intentions to accept a prospective COVID-19 vaccine (e.g., "How likely do you consider it to be that you would take a vaccine against COVID-19, if such a vaccine was available, free of charge, and recommended to everyone by the authorities?") and influenza vaccination (e.g., "How likely do you consider it to be that you will take the influenza vaccine next season [season 2020-2021]?"). We also asked the Pietarsaari residents and the Facebook users about their willingness to take a test-phase COVID-19 vaccine. Responses were given on a scale from 1 (*very unlikely*) to 5 (*very likely*).

3.2.3. Study III

Study III included the FinnBrain parents, the Pietarsaari residents, and the Facebook users. All measures were administered during the pandemic.

Perceived disease risk. We measured the respondents' perceived risk of COVID-19. The Pietarsaari residents and Facebook user were also asked about the perceived risk of influenza and measles. For each disease, we measured three components of perceived risk: 1) perceived likelihood of infection (e.g., "I think that my likelihood of contracting COVID-19 during

the following 12 months is…"; 1 = *virtually non-existent* to 7 = *virtually 100%*), 2) perceived disease severity (e.g., "How severe would it be for your health if you contracted COVID-19?"; 1 = *not severe at all* to 5 = *very severe*), and 3) disease-related worry (e.g., "How much do you worry about falling ill with COVID-19?"; 1 = *not at all* to 5 = *very much*). For perceived severity and worry, we measured risk related to both oneself (or one's child in case of measles) and to others.

Objective disease risk. We used the respondents' gender and age as proxies for their objective risk of suffering severe COVID-19. COVID-19 has been shown to be more fatal for men (Galbadage et al., 2020; Griffith et al., 2020) and older individuals (Centers for Disease Control and Prevention, 2020). In the Facebook sample, we also included a measure of the individuals' objective risk of catching COVID-19. During the time of the data collection, the prevalence of COVID-19 was higher in Uusimaa compared to other Finnish regions and unnecessary travel to and from the region was prohibited by the government (Finnish Government, 2020b). We asked the respondents to indicate their region of residence and created a variable coded as 1 if they reported living in Uusimaa, and 0 if they reported living elsewhere.

Perceived vaccine safety. Study III included the measures of perceived vaccine safety described in relation to Study II. In addition, Study III included a measure of the perceived safety of the measles vaccine ("The measles vaccine is safe").

Vaccination intentions. Study III included the measure of intention to take a recommended vaccine against COVID-19 described in relation to Study II.

3.2.4. Study IV

We administered the measures of Study IV to the health professionals before the pandemic.

Vaccine attitudes. Study IV included the measure of vaccine attitudes described in relation to Study I.

Trust in health professionals. We administered four statements to measure the health professionals' trust in the intentions and professional competence of doctors and health professionals in general (e.g., "When healthcare professionals make medical decisions, they have the patients' best interest in mind"). Respondents answered on a scale from 1 (*completely disagree*) to 5 (*completely agree*).

Vaccination behavior. Study IV included the measures of vaccination behaviors described in relation to Study I.

Vaccine-recommendation behavior. We asked the health professionals two questions about whether they guide patients who are unsure about their vaccination decision. One of those questions concerned childhood vaccinations and the other one concerned influenza vaccinations. They could answer that they try to guide the patient towards getting vaccinated, that they do not try to guide the patient in any direction, or that they try to guide the patient towards not getting vaccinated. We administered these questions to those health professionals who reported discussing or administering vaccines to patients on a weekly basis.

3.3. Statistical Analyses

The main statistical method in **Studies I–IV** was regression analysis. Some of the constructs were represented by latent variables in the analyses, in which case we conducted structural regression analyses—a procedure belonging to the SEM family (Kline, 2016). Latent variables are constructs that cannot be directly measured but that are assumed to influence the responses to observed (measured) variables (Brown, 2015; Kline, 2016). Latent variables are estimated based on the correlations between several observed variables. In **Study II**, we combined the results from the regression analyses across samples and vaccines using meta-analysis. In **Study III**, we used one-way repeated measures ANOVAs and paired *t*-tests to compare COVID-19 to influenza and measles.

As the data used in the present thesis were cross-sectional (except for the FinnBrain sample) and nonexperimental, the analyses cannot establish causality between the variables. Nevertheless, the analyses allow us to test whether our data are consistent with causal models.

4. Results

4.1. Study I: Nonconformist Identity as a Motive for Vaccine Attitudes and Vaccination Behaviors

Of the FinnBrain parents, 93% reported that they had accepted all vaccines for their children (Figure 1), whereas 7% reported that they had rejected at least one childhood vaccine. Of the parents that had accepted all vaccines, 21% had hesitated in a vaccination decision and/or postponed a vaccination to a later time point. About half of the parents reported that they had gotten vaccinated against influenza the preceding influenza season.

The great majority of the parents held positive attitudes to childhood vaccines and vaccines in general (Figure 2). On average, 93% agreed with childhood vaccines being beneficial and safe. Negative attitudes to the influenza vaccines were more common, as only 73% on average considered influenza vaccines as beneficial and safe.

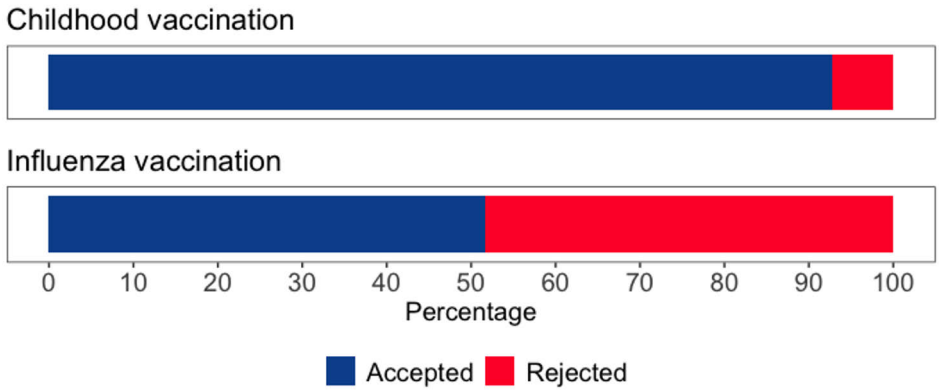

Figure 1. Past vaccination behaviors reported by parents of young children. For childhood vaccinations, the bar shows the proportion of parents who had accepted all childhood vaccines (blue) or rejected at least one (red). For influenza vaccination, the bar shows the percentage of parents who had been vaccinated against influenza the preceding influenza season (blue) and the percentage of those who had not (red).

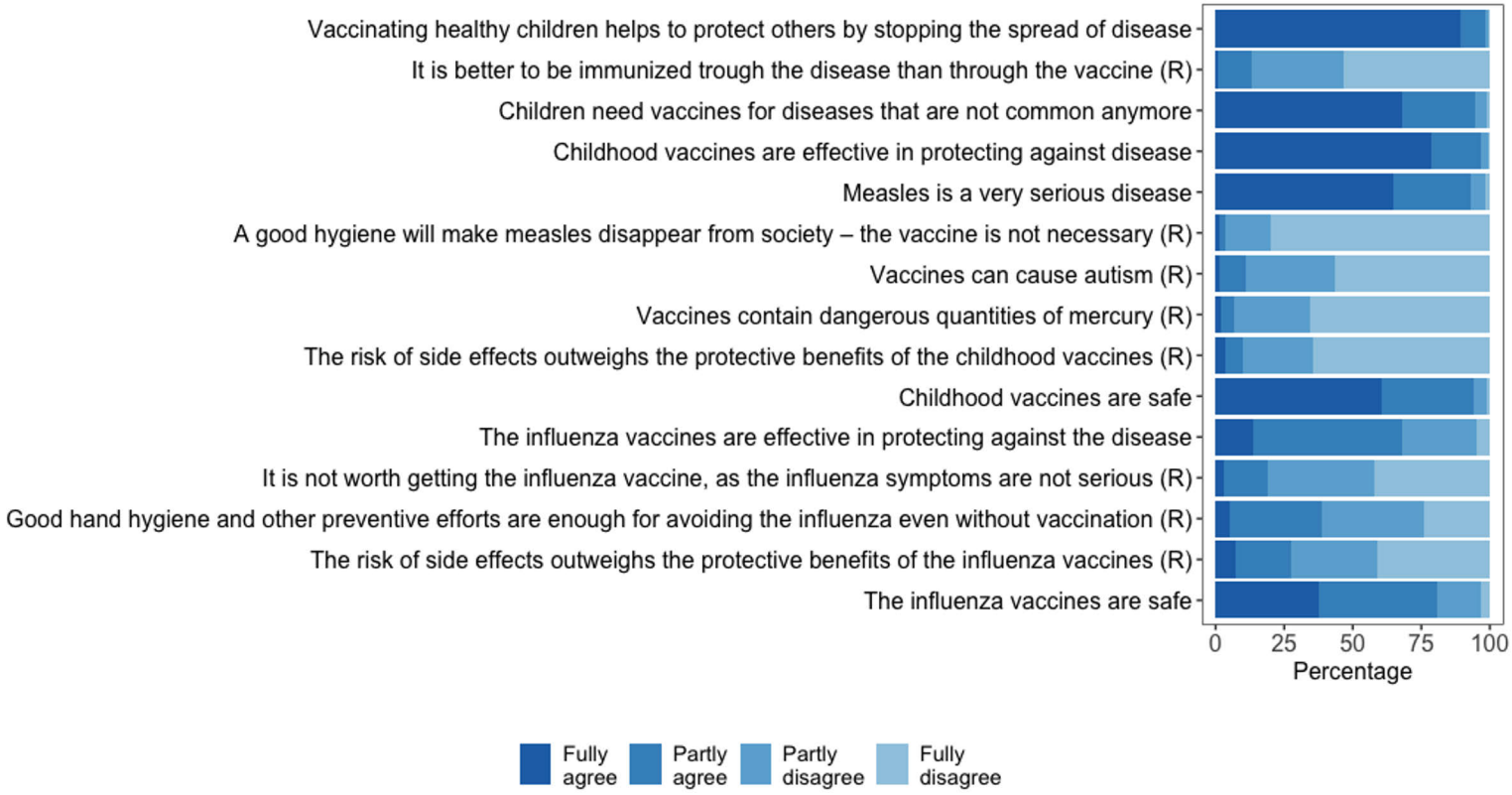

Figure 2. Vaccine attitudes among parents of young children. Note that for reverse-scored items (marked with R), stronger agreement means more negative vaccine attitudes.

To investigate whether reactance is related to vaccine attitudes and behaviors, and whether this relationship can be explained by trust in doctors, we conducted two analyses: one with vaccine attitudes as outcomes and one with vaccination behaviors as outcomes. The latter also included CAM use as an outcome. Figure 3 displays the results from these analyses, excluding paths between variables that showed no relationship.

Respondents who reported more reactance had more negative attitudes to childhood and influenza vaccines (Panel A in Figure 3). This could to a large part be explained by their lower trust in doctors, as the indirect associations between reactance and vaccine attitudes (β = -.16, SE = .03, p < .001 and β = -.15, SE = .03, p < .001 for childhood and influenza vaccine attitudes, respectively) were somewhat larger than the direct associations. Respondents with higher reactance were also more likely to have postponed or rejected childhood vaccines and to not having taken the influenza vaccine, and they were more likely to use several forms of CAM (Panel B in Figure 3). For childhood vaccination behavior and CAM use, the associations were completely indirect and mediated by trust in doctors (β = .15, SE = .03, p < .001 and β = .08, SE = .02, p < .001 for childhood vaccination behavior and CAM use, respectively). This means that these behaviors are only related to reactance to the degree that those who are more reactant trust doctors less. In contrast, most of the association between reactance and influenza vaccination was direct, as the indirect association was very small (β = .06, SE = .02, p = .006). Taken together, the results indicated that individuals who report high reactance are more likely to hold negative vaccine attitudes and postpone or reject vaccination. This could partly be explained by the fact that reactant individuals trust doctors less.

Lastly, CAM use was only weakly correlated with vaccine attitudes (r = -.24 and -.22, for childhood and influenza vaccines, respectively) and vaccination behaviors (r = .19 and .12). These correlations could only to a small part be explained by reactance and trust, and the uncertainty in the estimates was large.

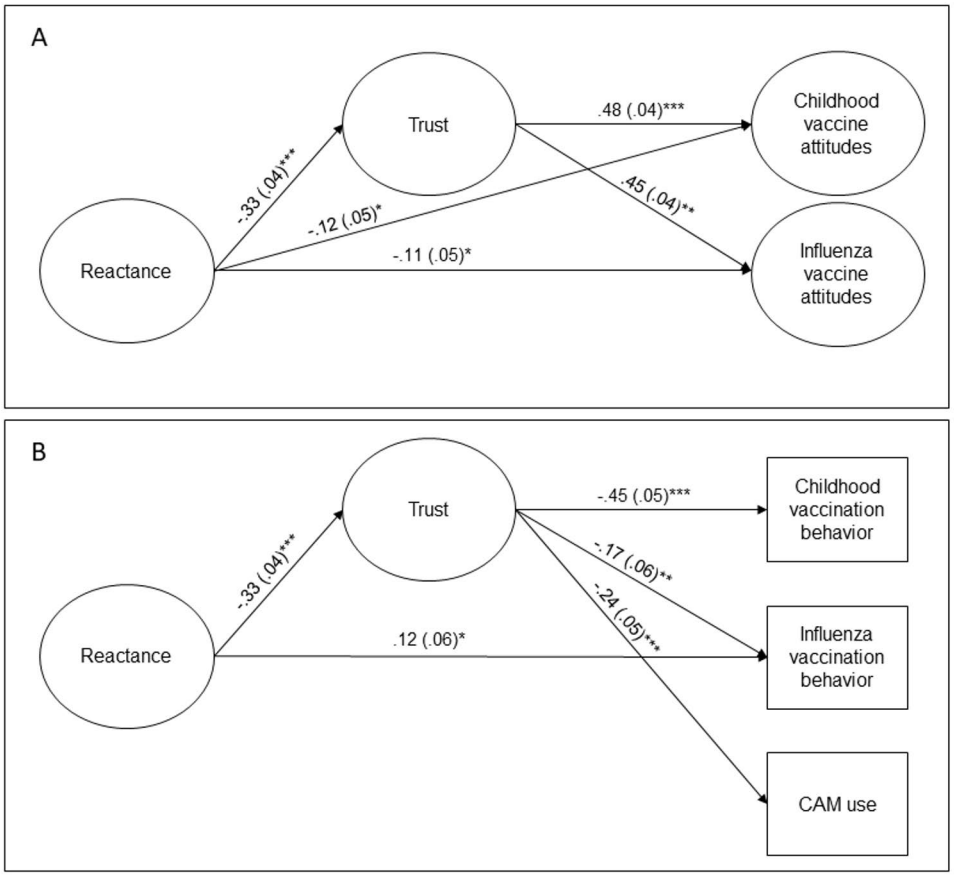

Figure 3. Results from the analyses on reactance. One model included vaccine attitudes as outcomes (Panel A), and one vaccination behavior and CAM use as outcomes (Panel B). Latent variables are represented by circles and observed variables by squares. Regressions between latent variables are standardized beta coefficients. Regressions relating to observed variables are standardized probit coefficients as observed variables were specified as ordinal. Correlations between outcomes are not shown in the figure. Higher scores indicate more reactance, greater trust, more positive vaccine attitudes, having postponed or rejected childhood vaccination, having rejected influenza vaccination, and using more forms of CAM.

4.2. Study II: Evolved Disease-Avoidance Mechanisms as Motives for Perceived Vaccine Safety and Vaccination Intentions

About ¾ of the FinnBrain parents, the Pietarsaari residents, and the Facebook users reported high intentions (i.e., chose the response alternatives 4 or 5 on the 5-point scale) to accept a COVID-19 vaccine if it was recommended by authorities and free of charge (Figure 4). Considerably fewer individuals reported high willingness to take a test-phase COVID-19 vaccine. Only just over ¼ of those living in Pietarsaari intended to take the influenza vaccine the next season, whereas most of the parents and the Facebook users intended to get vaccinated against influenza.

The results concerning germ aversion did not support our hypotheses that those with higher germ aversion would perceive vaccines as less safe and have lower intentions to accept vaccines. Figure 5 shows the results from the structural regression analyses relating to vaccination intentions, pooled across vaccines. For the mid-pandemic measures, the results were also pooled across samples (the Pietarsaari and Facebook samples). Pre-pandemic germ aversion was unrelated to vaccination intentions, whereas the result on mid-pandemic germ aversion was in the opposite direction of what we expected. Those with higher mid-pandemic germ aversion perceived vaccines as slightly safer and had higher intentions to be vaccinated. The effect sizes were similar across vaccines and samples. On the other hand, our hypothesis on perceived infectability was supported, as those with higher perceived infectability before and during the pandemic had higher intentions to accept vaccines. There was some variation across samples and vaccines in the strength of the relationships. Perceived infectability was most consistently related to intention to accept the influenza vaccine.

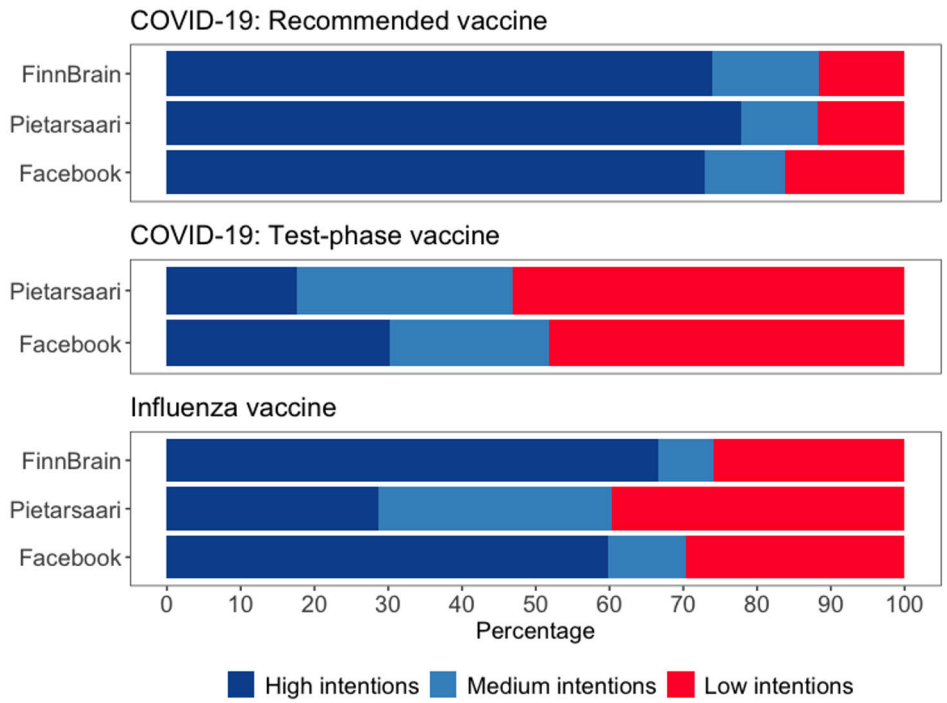

Figure 4. Vaccination intentions in the FinnBrain, Pietarsaari, and Facebook samples. Responses are coded as high intentions (response alternatives 4 and 5 on the 5-point scale ranging from *very unlikely* to *very likely*), medium intentions (response alternative 3), and low intentions (response alternatives 1 and 2). An exception to this is that influenza vaccination intention was measured on a 3-point scale in the Pietarsaari sample.

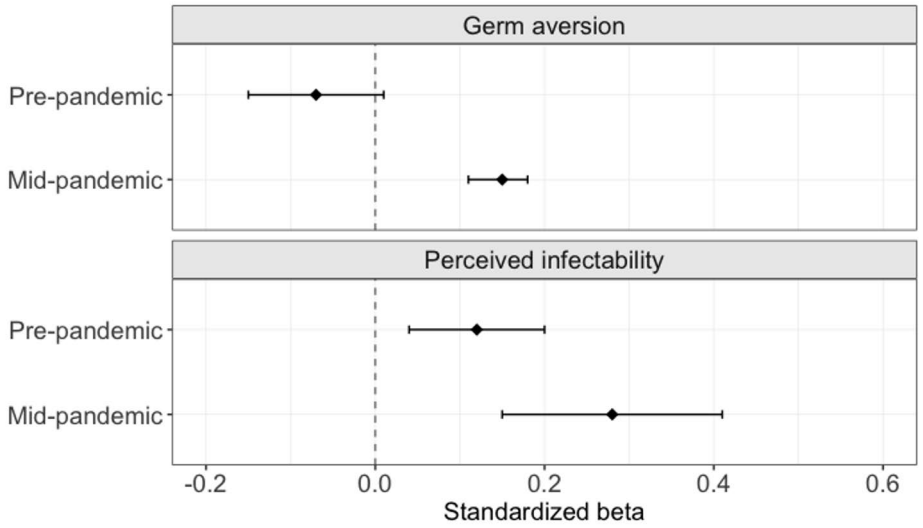

Figure 5. Germ aversion and perceived infectability as predictors of vaccination intentions. The standardized beta coefficients have been pooled across vaccines. Additionally, the mid-pandemic coefficients have been pooled across the Pietarsaari and Facebook samples. Higher scores indicate higher vaccination intention, higher germ aversion, and higher perceived infectability.

4.3. Study III: Perceived Disease Risk and Vaccine Safety as Predictors of COVID-19 Vaccination Intentions

Figure 6 shows how much risk the FinnBrain parents, the Pietarsaari residents, and the Facebook users perceived COVID-19, influenza, and measles to pose, as well as how safe they perceived the vaccines against the diseases to be. Visual inspection of the figure indicates some differences between the samples in the perceived risk of COVID-19 that might be explained by differences in sample characteristics. First, the Facebook sample included the largest proportion of older individuals (47% were over 50 years old) compared to the Pietarsaari (29% over 50 years old) and FinnBrain (1% over 50 years old) samples, which might explain the difference that can be seen in the perceived risk of COVID-19 for oneself. Most FinnBrain parents and residents in the Pietarsaari region considered it unlikely that they would suffer severe symptoms if they contracted COVID-19 and did not

worry much about falling ill. On the other hand, most of the Facebook users expected COVID-19 to be severe for their personal health and reported worry about contracting the disease. Second, the Pietarsaari residents and the Facebook users were surveyed in the beginning of April, at the peak of the first pandemic wave. The FinnBrain sample was surveyed in May, when the first wave was decreasing and more information about the risks of COVID-19 was available. Speculatively, this might explain the difference related to the perceived general severity of COVID-19: the FinnBrain parents considered COVID-19 as a slightly less severe disease for people in general.

The statistical analyses showed that individuals perceived COVID-19 to pose a greater risk than influenza. COVID-19 was also mostly considered a higher risk than measles, but the results concerning whether COVID-19 or measles was perceived as more severe were mixed. Respondents expected that a prospective vaccine against COVID-19 would be less safe than the vaccine against measles, but slightly safer than the influenza vaccine.

Figure 7 presents the results from the analyses on whether perceived disease risk, objective disease risk, and perceived vaccine safety predicts intentions to accept a COVID-19 vaccine recommended by authorities. Although the samples differed somewhat regarding the perceived risks of COVID-19, the regression results were similar across the samples. The perceived disease-risk measures were mostly unrelated to vaccination intentions. An exception to this was the perceived general severity of the disease, as those who perceived COVID-19 to be a potentially severe disease for others had slightly higher intentions to get vaccinated in all three samples. Concerning objective risk, neither disease prevalence nor respondent age was a reliable predictor of vaccination intentions, but men had somewhat higher intentions to get vaccinated than women. There was a strong relationship between how safe respondents expected that a prospective COVID-19 vaccine will be and vaccination intentions. Those with greater trust in the vaccine being safe had higher vaccination intentions.

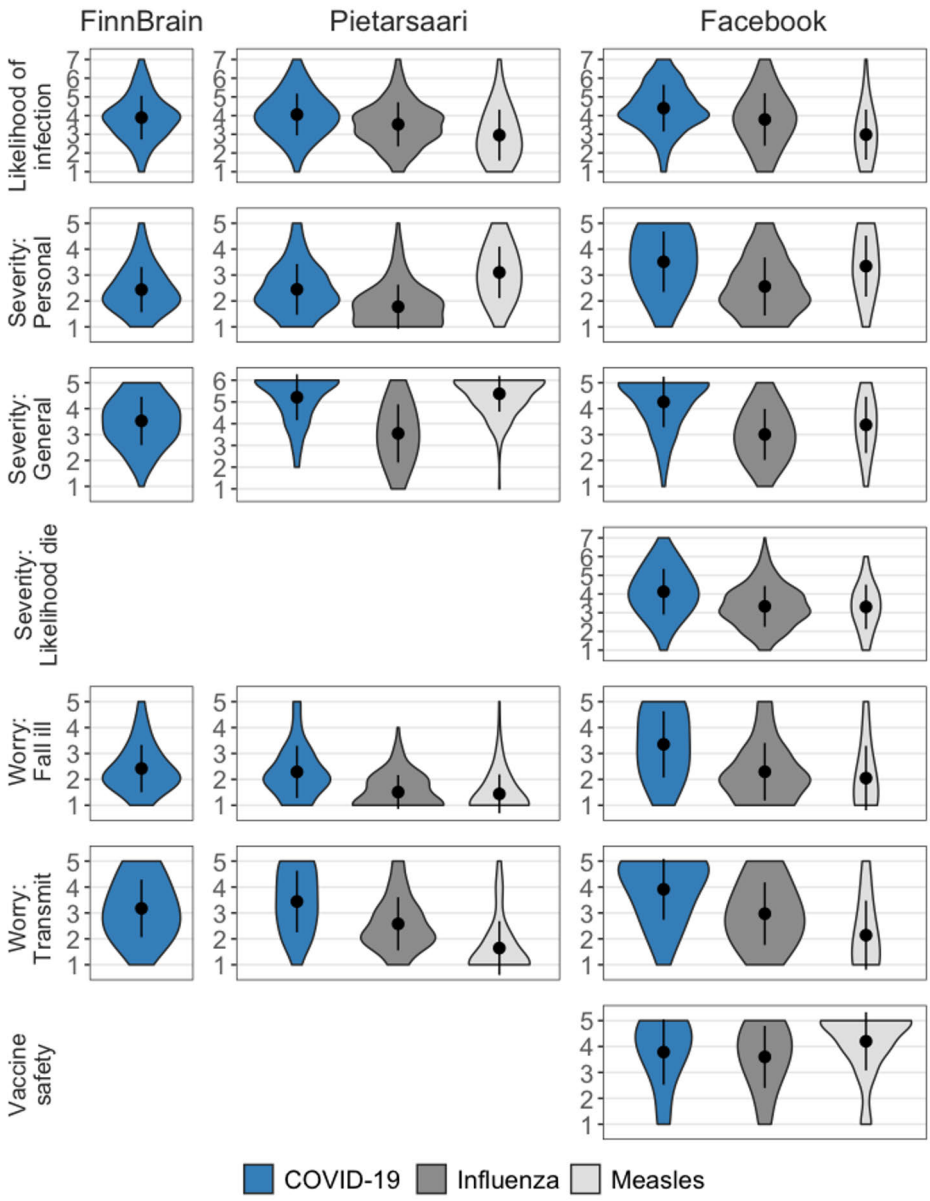

Figure 6. Perceived risk of COVID-19, influenza, and measles, as well as perceived safety of the vaccines. The outer borders of the violin shapes represent the frequency of responses. Dots represent means and bars standard deviations. High scores indicate high perceived disease risk and vaccine safety.

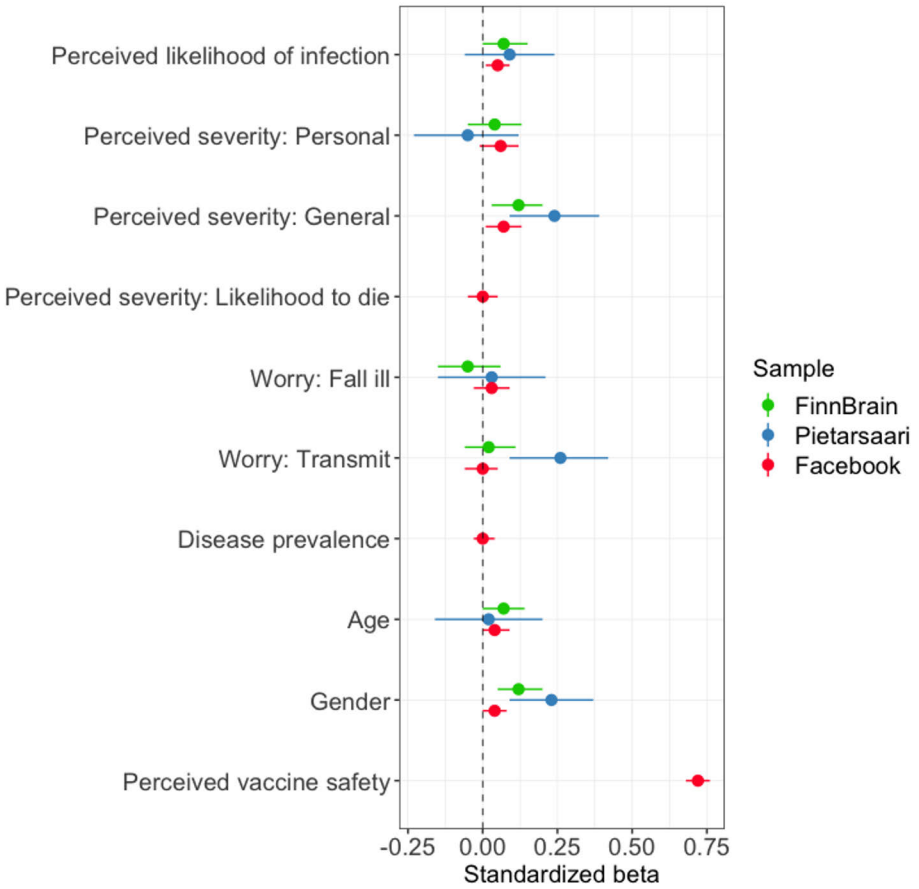

Figure 7. Standardized beta coefficients from the regression analyses on predictors of COVID-19 vaccination intentions. Higher scores indicate higher intention to take vaccine, higher perceived disease risk, higher objective disease risk, perceiving the vaccine as safer, and older age. Gender was coded as 0 = female, 1 = male. The analyses were conducted separately in each sample (sample is represented by color).

4.4. Study IV: Vaccination and Recommendation Behaviors Among Health Professionals

Four percent of the health professionals had at some point rejected a vaccine for their own child, whereas 96% had accepted all childhood vaccines. Of those who had accepted all vaccines, 11% had hesitated and/or postponed a childhood vaccination. Most health professionals (86%) had taken the influenza vaccine the preceding season (Figure 8). The majority of health professionals reported guiding unsure patients and parents towards vaccinating (Figure 9). The percentage of health professionals who reported that they do not guide unsure parents or patients in any direction was 13% for childhood vaccines and 26% for influenza vaccines.

Most health professionals perceived vaccines to be beneficial and safe (Figure 10) and reported trust in their colleagues. An average of 5% disagreed with childhood vaccines being safe and beneficial, whereas the corresponding percentage for influenza vaccination was 17%. The analysis on whether the health professionals' attitudes and trust predicted their own vaccination behaviors showed that health professionals who perceived vaccines as less beneficial and safe more often reported that they had hesitated in a vaccination decision or postponed or rejected a vaccine for their own children. They were also less likely to having taken the influenza vaccine the preceding influenza season. Furthermore, the health professionals with more negative vaccine attitudes were less likely to guide parents and patients who are unsure about their vaccination decision towards accepting vaccines. Trust in the competence and intentions of other health professionals was not uniquely related to the health professionals' vaccination and recommendation behaviors.

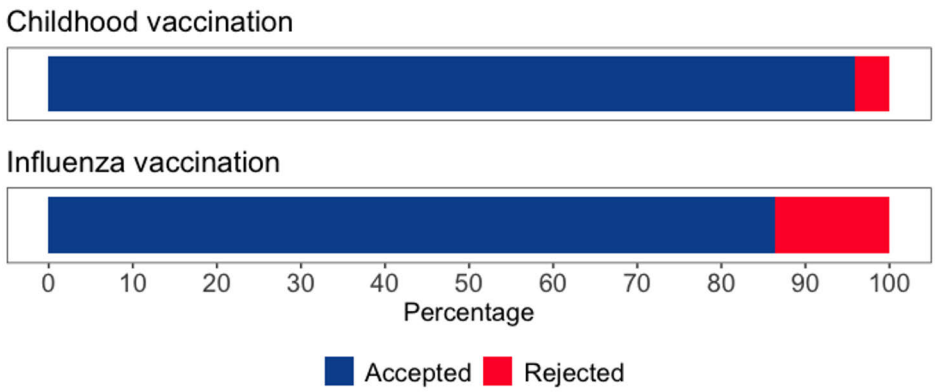

Figure 8. Past vaccination behaviors reported by health professionals. For childhood vaccinations, the bar shows the proportion of parents who had accepted all childhood vaccines (blue) or rejected at least one (red). For influenza vaccination, the bar shows the percentage of parents who had been vaccinated against influenza the preceding influenza season (blue) and the percentage of those who had not (red).

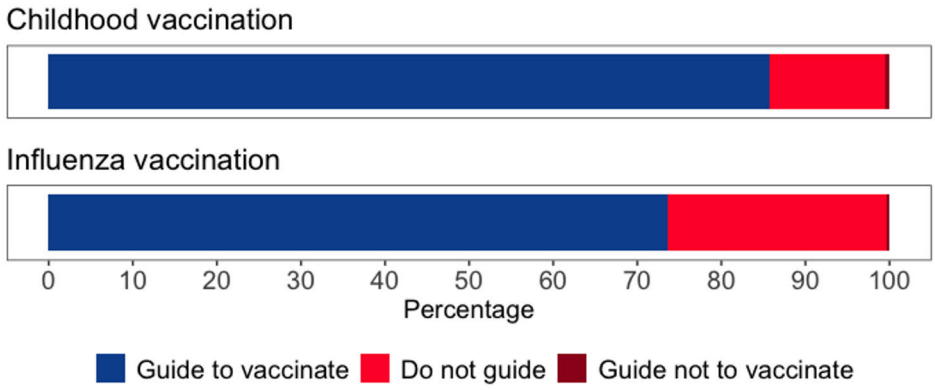

Figure 9. Health professionals' vaccine-recommendation behavior when they encounter parents or patients who are unsure about vaccination.

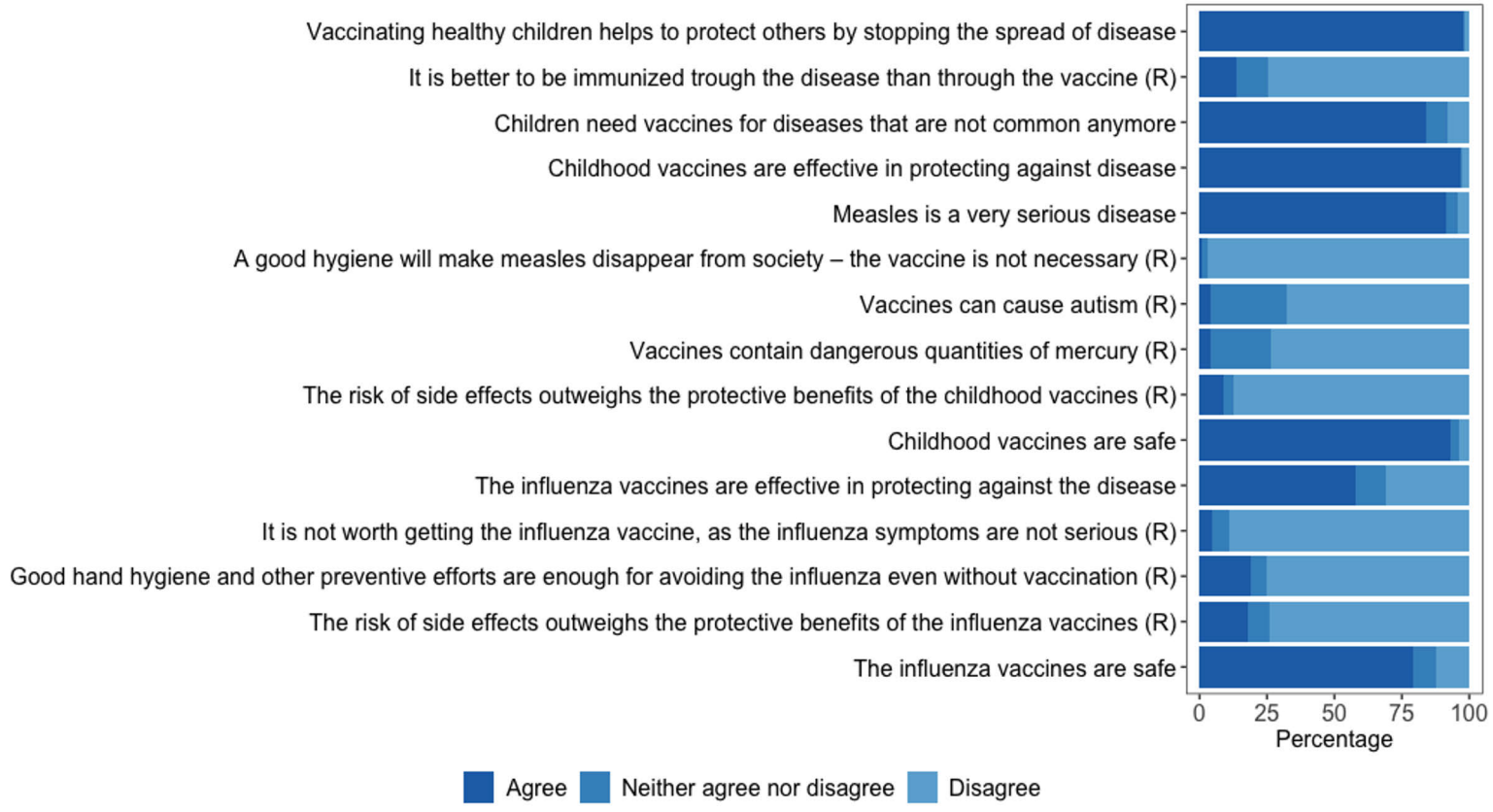

Figure 10. Vaccine attitudes among health professionals. Note that for reverse-scored items (marked with R), agreement means negative vaccine attitudes.

Because the health professionals' vaccine attitudes were related to their vaccination and recommendation behaviors, we further explored these attitudes by examining potential differences in vaccine attitudes between the professional groups. The results indicated that health professionals with a higher level of educational held more positive vaccine attitudes. Figure 11 shows the percentage of health professionals (averaged over the statements) that agreed with the statements concerning the benefits and safety of vaccines, separately for professional groups. The percentages are also shown separately for whether the statements require knowledge related to specific vaccines or diseases, or whether the statement queried general information about vaccines. Visual inspection of the figure suggests that the difference in positive vaccine attitudes between professional groups is most prominent for the statements concerning specific information.

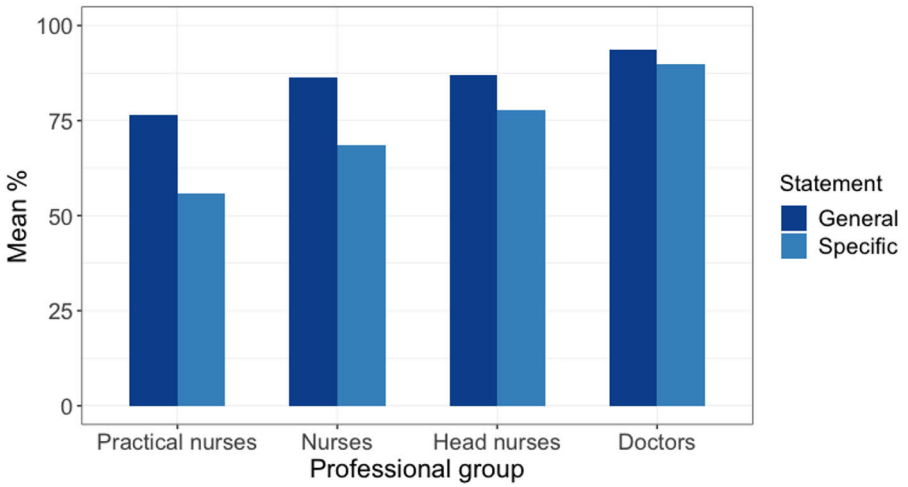

Figure 11. Percentage of health professionals agreeing with vaccine-attitude statements (disagreeing with reversed statements), averaged over the statements. The statements are categorized according to whether they queried knowledge about vaccines in general or knowledge about specific vaccines or vaccine-preventable diseases.

5. Discussion

5.1. Vaccine Attitudes, Vaccination Behaviors, and Vaccination Intentions in the General Population

5.1.1. Childhood vaccines

According to national statistics, only 1% of Finnish children are completely unvaccinated by the age of three (Finnish Institute for Health and Welfare, 2021i). The low number of unvaccinated children indicates that complete vaccine refusal by parents is very rare. In line with this, our results showed that the great majority of the parents of young children (the FinnBrain sample) had accepted all vaccines for their children and held positive attitudes to childhood vaccines. Nonetheless, 7% of the parents reported that they at some point had refused a vaccine for their child. In addition, 21% of those who had accepted all vaccines reported that they had hesitated in their decisions, or that they had postponed one or more childhood vaccines. Individuals who have hesitated in the past might be at a higher risk for refusing vaccines in the future. Misinformation about vaccines negatively influence individuals' vaccine attitudes and vaccination intentions (Featherstone & Zhang, 2020; Jolley & Douglas, 2014, 2017; Loomba et al., 2021). Individuals who are unsure about vaccinations might be especially vulnerable to vaccine-related controversies and false claims in news media and on online social platforms. Sudden drops in vaccine uptake following such media coverage have been observed in the past and can be long-lasting, even though false claims are refuted by scientific evidence and experts (Anderberg et al., 2011; Brilli et al., 2020; Gørtz et al., 2020; Hansen et al., 2019; M. J. Smith et al., 2008; Suppli et al., 2018). Reasonably, the larger the number of individuals who are unsure about vaccination, the larger the drops in vaccine uptake following vaccine controversies. Addressing parents' concerns at an early stage, preferably before exposure to misinformation, may serve to protect them from false information that they encounter (Lewandowsky & van der Linden, 2021).

5.1.2. Influenza vaccines

About half of the FinnBrain parents reported that they had been vaccinated against influenza the preceding influenza season. Intentions to take future influenza vaccines was lowest among the residents in the Pietarsaari

region, where only 29% reported that they plan to get vaccinated. The hospital district to which the Pietarsaari region belongs, is among those with the lowest influenza vaccine uptake nationally (Finnish Institute for Health and Welfare, 2021d [information available only for children and older individuals]). Among the FinnBrain parents and Facebook users, 67% and 60%, respectively, reported high intentions to accept influenza vaccination the upcoming influenza season.

As mentioned above, one reason for why uptake rates are lower for influenza vaccines than childhood vaccines, is that the influenza vaccines require individuals to actively seek out vaccination, whereas the childhood vaccines are offered in connection with scheduled checks of the child's health (Finnish Institute for Health and Welfare, 2021g; Ministry of Social Affairs and Health, 2021). Furthermore, the results of the present thesis showed that the general population held more negative attitudes to the influenza vaccines than to childhood vaccines. This might be a result of previous controversies surrounding the influenza vaccines. The Pandemrix vaccine that was administered against the H1N1 influenza during the pandemic in 2009–2010 was later found to increase the risk of narcolepsy, especially among children and adolescents (Sarkanen, Alakuijala, Dauvilliers, et al., 2018; Sarkanen, Alakuijala, Julkunen, et al., 2018). This finding received considerable media attention in Finland and is likely to have affected people's vaccine attitudes, especially those related to influenza vaccines. Nevertheless, most of the respondents in our studies held positive attitudes to the influenza vaccines, finding the vaccines beneficial and safe.

5.1.3. COVID-19 vaccines

Approximately ¾ of the respondents surveyed in the spring of 2020 considered the likelihood to be high that they would accept a prospective COVID-19 vaccine if it was recommended by authorities. The rate of individuals who intended to take the vaccine was similar across the samples. Most respondents also trusted that the vaccine would be safe. The respondents rated the safety of a prospective COVID-19 vaccine as slightly higher than the influenza vaccines, but lower than the vaccine against measles. Other studies surveying vaccination intentions during the beginning of the pandemic have produced similar results. In other European countries, 62–80% of individuals were found likely to accept a vaccine against COVID-19 (Murphy et al., 2020; Neumann-Böhme et al., 2020), whereas the rates were

62–69% in the US (Callaghan et al., 2021; Head et al., 2020; Malik et al., 2020; Ruiz & Bell, 2021), 76–86% in Australia (Dodd et al., 2020; Faasse & Newby, 2020; Rhodes et al., 2020), and 84–94% in Asian countries (Lin et al., 2020; Wong et al., 2020). At the time of this writing, COVID-19 vaccines have been administered in Finland for approximately nine months, and vaccines are given to individuals 12 years and older. The uptake of the first vaccine dose among these individuals exceeds 80% (Finnish Institute for Health and Welfare, 2021c), which is higher than the intention rates estimated in the beginning of the pandemic. Speculatively, one of the reasons for the higher uptake might be the increased knowledge about the disease and the safety and efficacy of the vaccines that has been accumulated during the past year.

5.2. Motives Behind Vaccine Attitudes, Vaccination Behaviors and Vaccination Intentions

Given the non-negligible proportion of individuals in the samples included in the present thesis that had hesitated in past vaccination decisions and who had low intentions to accept vaccines in the future, research on psychological correlates of vaccine attitudes and behaviors is well justified also in the Finnish context. In this section, I discuss our findings related to nonconformist identity and behavioral immune system mechanisms as motives behind vaccine attitudes and vaccination behaviors and intentions.

5.2.1. Nonconformist Identity

In accordance with previous research (Hornsey et al., 2018b), the parents who reported nonconformist tendencies in the form of reactance held more negative attitudes to childhood and influenza vaccines. This indicates that negative vaccine attitudes can be motivated by a need to express opposition to consensus views and communicate a nonconformist identity. In addition, we found that reactant individuals were more likely to have postponed or refused childhood vaccinations and to have remained unvaccinated against influenza the preceding season, but these relationships were small. Taken together, these results suggest that although some individuals might express negative vaccine attitudes to communicate a nonconformist identity, many of these individuals still choose to accept vaccines. This would mean that reactance does not affect vaccine uptake directly through

refusal of vaccines, but that reactance might indirectly affect vaccine uptake, if anti-vaccination attitudes expressed by reactant individuals influence others' vaccination decisions.

In line with what we expected, reactant individuals had lower trust in medical doctors, which partly explained the association between reactance and vaccine attitudes. Similar results were found in another recent study, which showed that more reactant parents rated the quality of their vaccine-related communication with their pediatrician as lower compared to less reactant parents (Finkelstein et al., 2020). Lower perceived communication quality was, in turn, associated with perceiving vaccines as less safe and reporting vaccinating one's child to be of lower priority. Together, the results of these studies suggest that vaccine attitudes expressed to communicate a nonconformist identity relate to opposition to medical doctors. When it comes to vaccination behaviors, our results indicated that reactant individuals only hesitate, or postpone or reject childhood vaccines to the degree that they distrust doctors. For influenza vaccines, there was an additional direct effect between higher reactance and not having taken the influenza vaccine, which means that some reactant individuals might reject influenza vaccination regardless of their trust in doctors. There are several differences between childhood and influenza vaccinations, which might explain the discrepancies between the results. For example, childhood vaccination decisions are made on behalf of one's child, whereas the influenza vaccination question presented in our study concerned the respondents' own vaccinations. There are also potential differences between the perceived risks of the diseases that the childhood vaccines prevent against and the perceived risks of influenza. Hence, deciding not to vaccinate for nonconformist reasons, despite trusting doctors, might be considered less risky when it comes to influenza vaccination for oneself than childhood vaccinations for one's children.

Reactance was also associated with the use of treatments outside conventional medicine, as individuals with high reactance were slightly more likely to use several forms of CAM. This association was very small, and completely explained by reactant individuals having lower trust in doctors. Nevertheless, we found no clear support for our expectation that reactant individuals who hold negative vaccine attitudes also turn to CAM. In other words, individuals who are nonconformists do not necessarily both reject vaccines and turn to CAM to express disagreement with medical consensus. One explanation for why CAM use was only weakly related to reactance,

trust, vaccine attitudes, and vaccination behavior might be that we did not separate between CAMs used as complements and those used as alternatives to conventional medicine. There might also be qualitative differences between the CAMs that were not captured with our measure. Furthermore, previous research indicates that attitudes to CAM are more strongly related to vaccine attitudes than CAM use is (Bryden et al., 2018; Lewandowsky, Woike, et al., 2020).

5.2.2. Evolved Disease-Avoidance Mechanisms

Previous research has suggested that individuals who are more disgust sensitive and germ aversive have more negative vaccine attitudes, potentially because vaccines are administered in ways that serve as cues to contamination (Clay, 2017; Clifford & Wendell, 2016; Hornsey et al., 2018b; Luz et al., 2019; Reuben et al., 2020). This was not supported by our study. On the contrary, we found that individuals with more germ aversion during the pandemic had slightly *higher* intentions to get vaccinated against COVID-19 and influenza, and perceived the vaccines as safer. Level of contamination aversion under non-pandemic circumstances did not predict intentions to get vaccinated.

Naturally, one potential explanation for our findings is that vaccines are not recognized as contamination cues. This, however, conflicts with the results of previous studies. A second potential explanation is the increased disease threat caused by the COVID-19 pandemic. As germ aversive individuals are more sensitive to contamination cues, they might be particularly responsive to the increased threat. For these individuals, the perceived pathogen threat posed by vaccines might pale compared to that posed by COVID-19. This is supported by other studies conducted during the pandemic, that have found that individuals with higher disgust sensitivity and germ aversion find it more important to engage in preventive behaviors such as handwashing and social distancing, and report higher compliance with recommendations (De Coninck et al., 2020; Díaz & Cova, 2020; Makhanova & Shepherd, 2020; Shook et al., 2020). Potentially, when disease threat is high, germ aversive individuals are more motivated than less germ aversive individuals to take preventive action. When disease threat is low, on the other hand, they are more likely than non-germ aversive individuals to perceive that the vaccines pose the larger threat. The fact that individuals who have high germ aversion did not only have

higher intentions to accept COVID-19 vaccines, but also influenza vaccines, would suggest that the increased threat generalizes across vaccines.

Another study conducted during the pandemic found that disgust sensitive individuals were more likely to hold anti-vaccination attitudes also under the increased disease threat caused by the pandemic (Kempthorne & Terrizzi, 2021). This study was conducted in the autumn of 2020. Hypothetically, habituation to the pandemic threat, together with an increased media attention and public discussion concerning the safety of the forthcoming COVID-19 vaccines, cause germ aversive individuals to be more reluctant to accept vaccination. Because neither we nor Kempthorne and Terrizzi (2021) investigated vaccination intentions under different levels of disease threat, the explanation related to level of threat is only speculative.

The combined results of the three samples supported our hypothesis that individuals with higher perceived infectability had higher vaccination intentions. Although the associations were weak, the results are in line with the theory of the behavioral immune system. When individuals perceive themselves as more vulnerable, they are expected to be more motivated to protect themselves against disease (Ackerman et al., 2018; Schaller & Park, 2011). In sum, the results indicated that behavioral immune system activation promotes acceptance of vaccines during more immediate disease threat.

5.3. Perceived Disease Risk and Vaccine Safety as Predictors of Vaccination Intentions During the Pandemic

Negative vaccine attitudes and vaccine rejection have been suggested to result from the fact that many vaccine-preventable diseases are not present in our environment and thus not perceived to pose a threat. Compared to such diseases, COVID-19 has since its outbreak been highly present in society. The virus has spread worldwide (Center for Systems Science and Engineering at John Hopkins University, 2021) and the pandemic has been extensively covered in news media (Krawczyk et al., 2021). A wide range of non-pharmaceutical interventions implemented by governments to limit the disease spread has affected daily life (Haug et al., 2020). The results of the present thesis also indicated that individuals perceived COVID-19 to pose a larger threat than the vaccine-preventable diseases influenza and measles. Regardless of this, approximately ¼ of the respondents surveyed

in the beginning of the pandemic reported that they had low intentions to accept a prospective COVID-19 vaccine recommended by authorities or that they were unsure about whether they would accept such a vaccine or not. By far, the strongest predictor of lower intention to accept COVID-19 vaccination was less trust in the vaccine being safe. Only one of the measures of perceived disease risk—the perceived general severity of the disease—showed a consistent relationship with individuals' vaccination intentions. This relationship was small and indicated that those who perceived COVID-19 to be a potentially severe disease for others had slightly higher vaccination intentions. Taken together, these results mean that individuals who perceive COVID-19 as a severe disease are still likely to choose not to get vaccinated if they consider the vaccine unsafe. On the other hand, individuals who perceive the vaccine as safe are likely to accept the vaccine even though they do not consider the disease as severe. Also other studies have found that worries about side-effects are more strongly related than perceived disease risk to intentions to get vaccinated against COVID-19 (Callaghan et al., 2021; Lin et al., 2020; Wong et al., 2020). Furthermore, studies that have asked individuals about their reason for being reluctant to accept a COVID-19 vaccine have found safety concerns to be the most frequently reported reason (Callaghan et al., 2021; Neumann-Böhme et al., 2020; Rhodes et al., 2020; Ruiz & Bell, 2021).

The perceived and objective risk of COVID-19 to one's personal health were not robustly associated with intentions to get vaccinated. An exception was the fact that men—who are at increased risk of suffering severe symptoms of COVID-19—had slightly higher intentions to take a prospective vaccine. This is in line with the findings of a meta-analysis of gender differences in COVID-19 vaccination intentions (Zintel et al., 2021). The relationship between gender, disease risk, and vaccination intentions is, however, not straightforward. Although the objective risks of COVID-19 are greater for men (Galbadage et al., 2020; Griffith et al., 2020), women have been found to perceive their risk of COVID-19 as greater (Galasso et al., 2020). This suggests that the relationship between female gender and lower vaccination intentions is caused by other factors than differences in objective disease risk. For example, women have been found more concerned about side-effects of the COVID-19 vaccines compared to men (Neumann-Böhme et al., 2020). When it comes to age, older age was not a robust predictor of higher vaccination intentions in the present study, although older individuals run a higher risk of suffering severe symptoms

of COVID-19 (Centers for Disease Control and Prevention, 2020). The findings of other research on the topic are mixed, but most often, older individuals have been found slightly more willing to accept COVID-19 vaccination (Daly & Robinson, 2021; Head et al., 2020; Lazarus et al., 2020; Paul et al., 2021; Rhodes et al., 2020; Vai et al., 2020). Actual COVID-19 vaccine uptake also indicate higher uptake in older age groups (Finnish Institute for Health and Welfare, 2021d).

In conclusion, unwillingness to accept vaccines was present also during more salient disease threat, and this unwillingness was mostly explained by vaccine safety concerns. Individuals perceiving COVID-19 as a potentially severe disease for others had slightly higher intentions to get vaccinated. Beyond that, perceived disease risk played little role for vaccination intentions. Although most individuals perceived COVID-19 as a serious disease and worried about transmitting it to others, many individuals (especially in the younger samples) considered it unlikely that they personally would suffer severe symptoms if they contracted the disease. It thus seems that COVID-19 was not experienced as threatening enough, especially to oneself, for disease threat to override vaccine safety concerns for some individuals.

5.4. Health Professionals' Vaccination and Recommendation Behaviors

Compared to the sample of parents drawn from the general population, the health professionals held more positive vaccine attitudes, were more likely to have accepted vaccines, and were less likely to have hesitated in their vaccination decisions. More specifically, 4% had rejected at least one vaccine for their own child, and 11% of those who had accepted all vaccines had hesitated and/or postponed a childhood vaccine. The majority (86%) of the health professionals had accepted the influenza vaccine the preceding season. The uptake of the influenza vaccine in the present sample of health professionals was high compared to uptake rates reported in other countries (Dini et al., 2018). This can partly be due to the Communicable Diseases Act (Communicable Diseases Act, 2016), but evidence suggests that influenza vaccine acceptance was high among Finnish health professionals (63% in 2015–2016) already before the act came into effect (Häggblom et al., 2019). In European countries where influ-

enza vaccinations are not required for health professionals, uptake rates are typically lower than 30% (Dini et al., 2018).

Although the vast majority of the health professionals held positive vaccine attitudes and most trusted the professional competence and intentions of their colleagues, a non-negligible proportion questioned the benefits and safety of vaccines and expressed distrust in their colleagues. Considering the fact that health professionals are perceived by laypeople to be the most reliable source of information about vaccines (Charron et al., 2020; Danchin et al., 2018; Eller et al., 2019; Napolitano, D'Alessandro, et al., 2018; O'Leary et al., 2018), it is alarming that many health professionals did not disagree with common vaccine myths, such as vaccines causing autism. This can give laypeople the false impression that the scientific evidence on such topics is inconclusive, when in reality, numerous studies have refuted that there would be a link between vaccinations and autism (DeStefano & Shimabukuro, 2019; Hviid et al., 2019; Taylor et al., 2014).

Negative vaccine attitudes among health professionals are not only a cause for concern when patients ask for information about vaccines. The results indicated that the health professionals who had more negative vaccine attitudes were less likely to guide individuals who are unsure about their vaccination decision towards vaccinating. A relationship between vaccine attitudes and recommendation behavior has been observed also in previous research on health professionals (Collange et al., 2019; Morales et al., 2020; Napolitano, Navaro, et al., 2018; Paterson et al., 2016). As receiving a recommendation from health professionals is the most frequently mentioned reason for vaccine acceptance (Napolitano et al., 2017; Napolitano, D'Alessandro, et al., 2018; L. E. Smith et al., 2017; Song et al., 2017), it is likely that lack of guidance from health professionals undermines vaccine uptake. Furthermore, the results from the present study showed that health professionals who perceived vaccines as less beneficial and safe were also less likely to have accepted all vaccines for their own children and to have taken the influenza vaccine the preceding influenza season, which is consistent with previous research (Dini et al., 2018; Wilson et al., 2020).

An important finding is also that the health professionals' vaccine attitudes were related to their level of education. Doctors had the most positive vaccine attitudes, followed by head nurses, nurses, and practical nurses. This pattern could be seen especially for statements that required specific knowledge (i.e., related to specific vaccines or diseases), whereas

the difference between professions was smaller for general statements (i.e., related to vaccines in general). This might indicate that the extent to which health professionals view vaccines as beneficial and safe is related to how much medical training they have received. If this is the case, providing health professionals with more vaccine-related education might have positive effects on their vaccine attitudes, vaccination behaviors, and willingness to recommend vaccines to patients. On the other hand, the relationship between vaccine attitudes and professional group can also be explained by other factors, such as differences in amount or type of vaccine-related work, differences in professional identity, or differences between individuals who apply to the different educational programs.

5.5. Limitations

First, the data in the present thesis are based on self-reports. Self-reports about past behaviors rely on memory, which makes the data vulnerable to forgetting. Respondents might also be inclined to respond in a way that they consider socially desirable. To decrease the risk that the data would be biased by social desirability, we informed the respondents in all data-collections that the data would be handled anonymously. Additionally, a recent study indicated that self-reports of compliance with government recommendations and restrictions during the COVID-19 pandemic are not affected by social desirability (Larsen et al., 2020).

Second, the cross-sectional data-collection procedures did not allow for robust conclusions concerning causality, and, hence, all causal interpretations are speculative. Furthermore, the studies relating to COVID-19 vaccines were conducted in the beginning of the pandemic. Intentions to get vaccinated against COVID-19 have fluctuated over time. Studies in the US observed a decline between the pandemic onset and the autumn of 2020 in percentage of individuals willing to accept COVID-19 vaccines (Daly & Robinson, 2021; Fridman et al., 2020). Analysis of how intentions to get vaccinated against COVID-19 developed over time in European countries indicated a slightly decreasing trend during 2020, but this trend turned in the last months of the year and vaccination intentions started to increase (John Hopkins Center for Communication Programs, 2021).

Third, we developed many of the administered measures for the purpose of the current studies, and the measures were not independently validated. Nevertheless, thorough literature review and discussions preceded the

formulation of the questions. For many of the constructs, we used factor analysis to evaluate the degree to which the questions loaded on the expected factors and to handle measurement error. Furthermore, the questions we administered to the sample of health professionals were assessed by vaccination experts working in a nursing education program before data collection.

Fourth, it is important to note that our sample of health professionals did not include public-health nurses working at child health clinics, although these administer most childhood vaccines. This limits the applied importance of our findings when it comes to the recommendation behavior related to childhood vaccines. Furthermore, practical nurses do not have the right to administer vaccines in Finland. However, some of them reported discussing vaccinations with patients on a weekly basis. Excluding the practical nurses from the sample did not change the conclusions of the analyses.

Lastly, there are some sample-specific limitations relating to generalizability. The FinnBrain parents take part in a longitudinal project that measures health-related aspects at multiple time points during several years. It is possible that these parents have more positive attitudes to conventional medicine and doctors compared to the population in general. Although the Pietarsaari sample was collected in a vaccination pocket, the sample did not demonstrate a consequently higher rate of negative vaccine attitudes or vaccine rejection compared to the other samples. This might be due to the recruitment procedure, and that those in the first data collection who consented to being contacted again have more positive vaccine attitudes than those who did not. The sample might therefore not be representative for the region of Pietarsaari. Although all samples might suffer from sampling bias due to self-selection, this might be especially relevant for the Facebook sample. Whereas survey invitations were directed to the individuals personally in the other samples, the individuals in the Facebook sample entered the survey through clicking an ad in their Facebook feed. It is possible that individuals with certain characteristics, such as very negative or very positive vaccine attitudes, are more interested in vaccine-related surveys and hence are more inclined to interact with the ad.

5.6. Conclusions

Although most individuals had accepted vaccines in the past and intended to accept vaccines in the future, the results of the present thesis showed that vaccine attitudes and vaccination behaviors and intentions varied between vaccines. Attitudes towards childhood vaccines were mostly positive, whereas negative attitudes regarding the benefits and safety of the influenza vaccines were more common. COVID-19 vaccines were expected to be slightly safer than influenza vaccines. The pattern was the same for vaccination behaviors and intentions. Few individuals had rejected vaccines for their children (although some had hesitated in their decision to vaccinate their child), whereas about half of the individuals had remained unvaccinated against influenza the preceding influenza season. Individuals had higher intentions to get vaccinated against COVID-19 than against influenza.

The two potential motives that we investigated both showed to be related—although weakly so—to vaccine attitudes and vaccination behaviors and intentions. First, the results indicated that some individuals are motivated to hold negative vaccine attitudes by the need to express a nonconformist identity, partly because they have lower trust in medical doctors. Sometimes, but more rarely, the need to express a nonconformist identity might also result in vaccine rejection. Second, our results indicated that behavioral immune system activation promotes vaccine acceptance during higher disease threat. Because some of the relationships between behavioral immune system mechanisms and vaccine attitudes and vaccination intentions were in the opposite of those obtained before the pandemic, the immediate disease threat caused by the pandemic might play a role in behavioral immune system response. Taken together, personal identity needs and fear of disease due to evolved disease-avoidance mechanisms might motivate individuals to hold certain vaccine attitudes, and to accept or reject vaccines.

The results of the present thesis showed that some individuals had low intentions to get vaccinated against COVID-19, also during the more salient disease threat caused by the pandemic. The by far strongest predictor of having low vaccination intentions was not trusting the vaccine to be safe. This indicates that the potential risks of COVID-19 are not considered serious enough to override vaccine safety concerns for some individuals. That some individuals did not expect the vaccines recommended by medical authorities to be safe also reveals issues with trust in the authorities.

Although HCPs predominantly held positive vaccine attitudes, some questioned the benefit and safety of vaccines. As these HCPs were also less likely to guide their patients towards accepting vaccines, negative vaccine attitudes among HCPs might negatively affect vaccine uptake in the public. Because of the important role HCPs play in informing patients about vaccines and addressing patients' concerns, it is alarming that relatively many HCPs did not take a stand against common vaccine misperceptions.

5.7. Practical Implications and Recommendations for Future Research

Vaccine uptake is high in Finland (Finnish Institute for Health and Welfare, 2021j). Nevertheless, the results of the present thesis showed that a non-negligible number of individuals have hesitated in their vaccination decisions, and that some have low intentions to accept vaccines in the future. This underscores the importance of health professionals and authorities communicating with patients and the public about vaccines although vaccination rates are high. Such communication is most likely to be effective if it is guided by research. The present thesis identified several correlates of vaccination behavior. Whether targeting these correlates in vaccine communication and interventions increase vaccine acceptance should be investigated in experimental studies. Because educational interventions have hitherto proved to be largely ineffective in changing people's vaccine attitudes and vaccination behaviors, and because the motives behind negative vaccine attitudes and vaccine rejection vary between individuals, future research should investigate whether tailoring communication according to individual motives is a more effective strategy.

Based on the results of the present thesis, one factor that might affect how vaccine communication by health professionals and authorities is received, is reactance. Individuals with high reactance might benefit from different kinds of vaccine communication than those with low reactance. Previous research conducted on other topics than vaccination indicates that communication that uses controlling language—indicating what a person must or should do—evoke more reactance than communication that restores the individual's autonomy (Rosenberg & Siegel, 2018). Furthermore, highlighting the individual's freedom to make their own decision and using narratives and empathy-evoking communication has been shown to elicit less reactance (Rosenberg & Siegel, 2018). As the

results of the present thesis indicated that reactance might be a reason for why some individuals hold negative vaccine attitudes, it is possible that communication techniques such as the ones mentioned above, are beneficial in vaccine communication as well. Future research should investigate whether this is the case and examine how such communication should be formulated to minimize the risk of evoking opposition in highly reactant individuals. Nevertheless, it is important to note that reactance was only weakly related to vaccine attitudes and vaccination behavior in the present thesis. This means that most individuals who hold negative vaccine attitudes and reject vaccines do so for other reasons than socially establishing themselves as nonconformists. The main focus when trying to increase vaccine uptake should thus be on individuals who are not reactant.

The results of the present thesis further indicated that behavioral immune system activation promotes acceptance of vaccines when disease threat is high. However, the associations were weak and in conflict with other studies on the topic. Future research is needed to investigate whether level of disease threat moderates the relationship between behavioral immune system mechanisms and willingness to get vaccinated.

That perceived vaccine safety was very strongly related to individuals' willingness to take a COVID-19 vaccine suggests that health authorities should focus their communication on the safety of the vaccines to ensure sufficient vaccine uptake. Misinformation and controversies related to vaccine safety might have detrimental effects on vaccine uptake if they increase concern about the safety of COVID-19 vaccines. Warning and informing people before they are exposed to misinformation has been found to be a more effective way to protect individuals from the misinformation than trying to correct misperceptions when they have already been acquired (Lewandowsky & van der Linden, 2021). Thus, health authorities should try to predict what kind of misinformation about vaccine safety is likely to emerge and plan communication accordingly. When misperceptions has already been acquired, larger refutational efforts are likely to be needed (Lewandowsky, Cook, et al., 2020). When it comes to disease threat, reminding the public about the fact that COVID-19 can have detrimental health consequences for those infected might also positively affect vaccine uptake. The magnitude of that effect might, nevertheless, be smaller, as the relationship between perceived disease severity and people's willingness to be vaccinated was weak. As the current data collections related to COVID-19 were conducted during the early phase of the pandemic, when COVID-

19 vaccines were highly hypothetical, research on correlates of COVID-19 vaccine acceptance should be conducted when the vaccination decision is of more immediate relevance to individuals. Additionally, whether the pandemic has affected people's attitudes to vaccines against other diseases than COVID-19, is an important topic for future research. Both the experience of the consequences of an uncontrolled pandemic disease, as well as the increased media attention and public discussion concerning vaccines might have affected individuals' general vaccine attitudes and willingness to get vaccinated.

Lastly, future research is needed to expand the knowledge on why some health professionals hold negative vaccine attitudes, and whether more vaccine-related training can increase their confidence in vaccines and willingness to recommend vaccines to patients. Also other potential reasons for the differences in vaccine attitudes between professional groups should be examined, such as their type of vaccine-related work, or professional identity or culture. To increase the possibility to inform training practices, studies investigating vaccine attitudes among HCPs could use survey items pertaining to more specific knowledge about vaccines and common, context-specific vaccine misperceptions. Studies should also include additional vaccine-related constructs, such as trust in health authorities and official vaccine recommendations, confidence in discussing vaccines with patients, and practical barriers to recommending and administering vaccines. Future research should also develop techniques for building health professionals' resistance to misinformation and provide tools that help them refute misinformation when discussing with patients. That health professionals communicate the benefits and safety of vaccines, combat misinformation, and recommend vaccines to patients are key elements for ensuring high vaccine uptake and protecting the public against infectious diseases.

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Linda Karlsson

Psychological factors associated with vaccine attitudes and vaccination behaviors

The present thesis investigated psychological correlates of vaccine attitudes and vaccination behaviors among the public and healthcare professionals in Finland. The results showed that vaccine attitudes are related to vaccination behaviors and intentions, and that personality-related factors and psychological disease-avoidance mechanisms might motivate individuals to hold certain vaccine attitudes, and to accept or reject vaccines. Most healthcare professionals held positive vaccine attitudes, but those who doubted the safety and efficacy of vaccines were less likely to guide patients towards accepting vaccination.

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