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Spontaneous face- and eye-touching: Infection risk versus potential microbiome gain

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ABSTRACT

The COVID-19 pandemic has piqued interest in spontaneous face-touch as a possible route of microbial infection, with eye-touch of particular importance since the ocular surface is a likely portal of human Coronavirus infection. Spontaneous face-touching is a poorly understood, ingrained habit for humans, who engage in this activity on average between 9 to 162 times per hour. Nearly half of spontaneous face-touches involve mucous membranes, and one third of those involve the eyes. The infective sequelae of self-touch are well documented in ophthalmological conditions such as infectious conjunctivitis, with risks for ocular surface disease beyond primary infection from pathogens such as human papillomavirus. Through tear film conveyance via the nasolacrimal duct, ocular surface pathogens may furthermore have access to the nasopharynx, oropharynx, and respiratory/gastrointestinal systems beyond. Ocular surface and face self-touch therefore represent a concerning possible method of not only local, but also systemic, self-inoculation. Conversely, microbial diversity in the mutualistic microbiome is being increasingly implicated as integral for developing immunity, and protecting against endocrinological and neurodegenerative disease, including those that affect the eye. Spontaneous face-touch brings the hands, the part of the body most in contact with the external world and with the highest temporal diversity, into direct contact with the body's multiple microbiomes. The authors hypothesise that spontaneous self-touch may represent an important mechanism by which the skin, ocular surface, gastrointestinal, and respiratory tracts maintains microbial diversity and prevents dysbiosis. It may be that whilst the eyes are at risk of infection through self-touch, they may paradoxically benefit through the acquisition of a mutualistic microbiome, protective not only for the eyes, but for the body as a whole.

Spontaneous self-touches are the contact movements of the body and face by the hands and fingers, not associated with deliberate decision-making processes [1,2]. Despite decades of research, they remain a poorly understood phenomenon, although in the last year they have piqued interest for their role in the spread of SARS-CoV-2 [3]. In the discussion surrounding improving infectious risk through reducing spontaneous face-touches (SFT), one question does not seem to have been asked: Why do we touch our face so often to begin with?

The infectious risk of SFT is not limited to COVID-19. SFT have been attributed to many diseases, as is well-documented in ophthalmology. Infectious conjunctivitis, the most common ocular infection, is believed to be spread most often through hand-eye touch following contaminated source exposure. Other pathogens, spread through SFT, such as the herpes simplex virus (HSV) and human papillomavirus (HPV), play a role in ocular surface disease beyond their primary infection, and can have blinding sequelae. HPV can infect the ocular surface from contaminated fingers, and has been implicated in a range of ocular lesions including conjunctival squamous papilloma, and ocular surface squamous neoplasia [4]. HSV is the leading cause of infectious corneal blindness in the developed world, with SFT of mucous membranes again implicated in pathogenicity, as virions enter the new host via the mucosal surfaces of the eyes, nose and mouth.

The infectious risk of SFT of the ocular mucosal surfaces is furthermore not limited to diseases of the ocular surface itself. Contaminated hands have been implicated in the dissemination of respiratory infections [1] including Coronavirus. Clearly, SFT plays an important role in respiratory disease, as hand-washing alone can reduce the risk of respiratory infection by 6–44% [5]. SARS-CoV-2 infects host cells through the Angiotensin Converting Enzyme (ACE)-2 receptors, which are present in the conjunctiva, cornea, nasal and oral mucosa [6].

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Through tear film conveyance via the nasolacrimal duct, ocular surface pathogens have access to the nasopharynx, oropharynx, and the respiratory and gastrointestinal systems beyond [6]. Ocular SFT therefore represents a concerning possible method of not only local, but potentially systemic, self-inoculation.

Despite their infectious sequelae, the published literature on frequency of face self-touching suggests that, on average, humans touch their face between 9.5 and 162 times per hour [3]. It is therefore reasonable to ask what evolutionary benefit SFT may offer humans, as humans so often carry out face-touching, almost always without ever thinking about it?

In the literature there are reported associations of SFT with underlying negative affect, anxiety, or discomfort, and they may serve to comfort and release emotional arousal [2]. They may also represent an attempt to shield the self from distraction, with associations to working memory and emotions [1,2]. In a literal sense, they increase 'brain power'. In one study of self-touching utilising electroencephalography (EEG), spontaneous self-touches changed the theta frequency above the parietal and occipital lobes, and increased the theta and beta power [2]. These EEG changes were only seen when self-touch was spontaneous; instructed touches did not have the same effect [2].

However, there may be a further significant benefit to SFT. The hands harbour greater bacterial diversity and have greater temporal variability in their composition than any other body site [7]. While SFT has previously been hypothesised as the cause of colonisation of healthcare workers with *S aureus* [1], we hypothesise that SFT may be important, or perhaps even essential, in developing and maintaining the diversity of the human microbiome. SFT brings the hands, the part of the body the most physically in contact with the external world and with the highest temporal microbial diversity [7], to the areas of the face where these microbes may access the mucous membranes, and the gastrointestinal and respiratory systems beyond. Diversity is integral in maintaining microbiota homeostasis, with self-touch potentially serving as a pathway to increasing diversity in the microbiome of the ocular surface, skin, gastrointestinal and respiratory tracts, as supported by the high percentage of touches involving mucous membranes.

If true, this would denote a significant impact of SFT on ocular, and even systemic, health and disease. Microbial symbiosis has been implicated not only in infectious disease, but also immunological, endocrinological and neurodegenerative diseases, including those that affect the eye [8]. Commensal and mutualistic microbiota, including those of the ocular surface, protect against foreign and opportunistic pathogenicity through competitive exclusion and antimicrobial substance production, and influence innate immunity [8]. Microbiome dysbiosis may occur through loss of beneficial organisms, excessive growth of potentially harmful organisms, or loss of overall microbial diversity. Dysbiosis leading to epigenetic reprogramming and inflammation has been implicated in autoimmune uveitis, age-related macular degeneration, and recently even open angle glaucoma [8].

Diversity of microbiota is paramount. In mouse models of Sjogren's syndrome, desiccating stress and antibiotics significantly increased dry eye phenotype, with severity inversely correlated to microbial diversity [8]. Mice typically resistant to *Pseudomonas aeruginosa*-induced keratitis became susceptible when raised germ-free, with the ocular microbiome by itself having a significant impact on resistance [8]. Perhaps the commensal microbial immunity benefit of SFT has, from an evolutionary perspective, balanced against its significant infective risk.

While the hypothesised effect on the microbiome represents a potential significant benefit of SFT on ocular and systemic health, in the current pandemic climate the potential risk of systemic disease through the ocular surface seems to have been largely ignored. Currently many cities and countries around the world are recommending or enforcing by law the wearing of face masks in public. However, the ocular surface and periorbital landing area unshielded by face masks, represents an absorptive area of up to ~10,000 mm^2 [6].

By means of a reduction in SFT, however, the protective benefits of wearing a mask may extend beyond barrier defence of the nasopharynx and oropharynx. Wearing a face mask is significantly associated with a decreased rate of SFT; in health professionals, SFT decreased, by an average of 20 times per hour without a mask, down to 5.4 times with one [9]. However, in studies to date the number of touches to the ocular surface was not reported, nor were the numbers of mask-touches. While this reduction in SFT is encouraging, it is important to note that with face masks alone, the ocular surface still remains at risk.

Touching behaviours are more complex than is usually appreciated in ophthalmological practice, yet they may play an unexpected role in both ocular and systemic health and disease. Whilst SFT may be important in mutualistic microbiota exposure, this also increases the risk of pathogen exposure. In high risk states such as during an infective pandemic, it becomes crucial to be able to take steps to defend against pathogenicity through auto-inoculation. While the principal mode of transmission for SARS-CoV-2 appears to be via droplet spread, contamination of the hands followed by inoculation of the mucous membranes could potentially provide alternative mechanisms of viral transmission. The challenge from a personal as well as population perspective is for everyone's protection to be improved and made more effective.

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