# Removing the disguise: the matched guise technique and listener awareness

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# Author Note

# Abstract

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# Introduction

A great deal of attention has been paid in the phonetics and sociophonetics literatures to the perception of the voiceless fricatives [ʃ] and [s] in English. To a first approximation, these fricatives differ in the distance between the point of lingual articulation and the teeth, which give them their characteristic sibilance Shadle ([1991](#ref-shadle1991)). English [s] has a short resonating chamber behind the teeth; it is typically produced by holding the tongue blade near enough to the alveolar ridge to cause turbulent airflow. English [ʃ] has a comparatively larger resonating chamber; it is typically produced with a more posterior, palato-alveolar tongue position and lip rounding both of which serve to reinforce this posteriority. But listeners do not perceive via {++this type of++}{>>KM<<} first approximation{++; we are sensitive to fine phonetic details far beyond these gross, categorical, differences++}{>>KM<<}. Indeed, these two fricatives have been exciting to researchers precisely because of the sensitivity listeners bring to their perception and how that perception interacts with both linguistic and social knowledge.

## Coarticulatory and Social Information Influence [ʃ]-[s] perception

{>>KL: ok, this is the specific section the editors didn’t like I think vis-a-vis “rewriting the introduction to state more strongly why this study is important to sociolinguistics, and not mainly interesting to cognitive linguists”<<} Listeners are sensitive to articulatory mismatches between the fricatives [ʃ]-[s] and neighboring sounds. Whalen ([1984](#ref-whalen1984)) conducted a series of experiments to investigate listeners’ responses to articulatory mismatches in synthetic speech. Overall, the result of these investigations was that subcategorical phonetic mismatches slow phonetic judgments. In onset position, in isolation, or in coda position, misleading coarticulatory information inhibited reaction times. Listeners, Whalen cautions in the conclusion, are sensitive to articulatory patterns that are below the level of conscious awareness and not available to direct experimenter scrutiny. While listeners will readily fill-in missing or ambiguous information, the presence of actively *conflicting* articulatory information is inhibitory.

A commonly used methodology involves the creation of synthetic fricative continua. These continua have endpoints in prototypical examples of [ʃ] and [s] with some number of equal-sized acoustic steps generated, synthesized, or even mixed between these. Somewhere in the middle of such a continuum will be fricative-like noise that is ambiguous as to category membership: not clearly a [ʃ] and not clearly an [s]. May ([1976](#ref-May1976)) paired a continuum from [ʃ] (2.9 kHz) to [s] (4.4 kHz) with synthetic [æ] vowels to form CV pairs. May found that listeners perceived a higher proportion of the fricative continuum as [ʃ] when paired with vowel stimuli from a smaller vocal tract. The logic here is that smaller resonating chambers between the lingual articulation and teeth will have a higher mean frequency than larger resonating chambers. Listeners’ use of apparent vocal tract size in perception reflect their knowledge of this variation ([Munson, 2011](#ref-munson2011)).

Mann and Repp ([1980](#ref-MannRepp1980)) replicated this finding, extending it to natural productions of vowels spoken by a male or female-identified talker. Similar to May’s results with simulated vocal tract size, Mann & Repp found a higher proportion of the fricative continuum was heard as [ʃ] when paired with the speech of the female talker. This early work, like others of the period ([Ohala, 1984](#ref-ohala1984)), theorized size as being a relatively deterministic feature of talker sexual dimorphism. One consequence of this view is that gender-related variation in the speech signal is considered mechanistic, universal, and following from purely physical laws. Vocal tract size is presumably not available for individual performance and so listener knowledge of this variation can be correspondingly simple. Vocal tract size may influence perception, but it does so implicitly, automatically, and below the level of introspective awareness.

{++ Mann and Repp ([1980](#ref-MannRepp1980)) also replicated and extended previous work ([Kunisaki & Fujisaki, 1977](#ref-kunisakifujisaki1977); [Whalen, 1981](#ref-whalen1981)) demonstrating that listeners report hearing more of the synthetic fricative continuum as [s] when followed by a rounded vowel quality such as English [u] than when followed by an unrounded quality such as [i] or [a]. Listeners experience the fricative continuum differently in the presence of anticipatory coarticulation. The presence of nasal coarticulation on a vowel similarly allows listeners to make a lexical decision between words like *bend* and *bed* as soon as that information is present in the acoustic signal ([Beddor et al., 2013](#X461759748dc6d5ad6d078d8d0fc840233f13e27), [2018](#ref-beddorcoetzeestylermcgowanboland2018)). Mann & Repp’s participants in this study experienced auditory evidence of posteriority in the ambiguous portion of the fricative continuum as the presence of coarticulation with a following rounded vowel. As with vocal tract length, above, the behavioral result was a shift in the listeners’ fricative category boundary toward [s]. ++}{>>KM: clarifying and putting this back at least for now.<<}

Strand and Johnson ([1996](#ref-strandJohnson1996)) conducted a pair of experiments investigating the influence of purported gender of a talker on the perception of the [ʃ]-[s] boundary. In their experiment 1, listeners heard a [ʃ]-[s] continuum paired with voices previously normed as prototypical female, non-prototypical female, non-prototypical male, and prototypical male voices. The result replicates Mann and Repp ([1980](#ref-MannRepp1980)) and extends it to show that the influence of a gendered voice correlates with the protypicality of that voice (exp1). They then extend this research to show that presenting listeners with prototypically-gendered videos of their purported talker can, again, shift perceptions of the [ʃ]-[s] such that listeners report hearing a higher proportion of the continuum as [ʃ] when watching a female talker and a higher proportion of [s] when watching a male talker. The AV condition of their experiment 2 is reminiscent of McGurk and MacDonald ([1976](#ref-McGurkMacDonald1976)) and is presented in that context. A striking feature of the McGurk Effect is its automaticity; participants can not choose to perceive the two components of a fused percept independently. It is unclear from Strand and Johnson ([1996](#ref-strandJohnson1996)) and subsequent work whether the perceptual influence of visually-presented social information is implicit and automatic, like vocal tract size, the McGurk effect, etc., or whether the effect disappears when listeners are aware of the guise manipulation.

This is an incomplete sample of the literature on the perception of these fricatives. We hope, however, that the message is clear that even when arriving at a purely linguistic percept, listeners’ judgments depend on a rich constellation of evidence and expectation. Vocal tract size, formant transitions, following vowel quality ([Mann & Repp, 1980](#ref-MannRepp1980)), and coarticulatory cues, along with the acoustic properties of the fricative itself, can all shape how listeners report experiencing that fricative. Rather than relying on a single, invariant, phonetic cue, listeners take the entire fricative and context into account Whalen ([1991](#ref-whalen1991)).

{~~One imagines~> It is conceivable that~~} {>>KM<<} such exquisite sensitivity to the phonetic cues conveying linguistic category membership might restrict language users’ freedom to communicate and perceive social information via the same phonetic signal. This would be the prediction of a phonetic theory in which linguistic information and social information battle for control of the air waves –where listeners must normalize away social variation to recover linguistic information. Instead, with these fricatives, at least, we can observe the opposite. The fricatives /ʃ/ and /s/ often carry social meaning ([Mack & Munson, 2012](#ref-mackMunson2012b); [Podesva & Kajino, 2014](#ref-podesvakajino2014)) with /s/ being “perhaps the most iconic phonetic variable in the field” ([Calder, 2018](#ref-calder2018)). The implication is that the social and linguistic meanings of particular phonetic cues are not in competition with one another.

## Phonetics, Speech Perception, and the Social-Construction of Gender

It has long seemed normal in speech research to imagine that gender is a simple, binary projection from biological sex onto social identity ([Daniel et al., 2007](#ref-daniel2007); [Samoliński et al., 2007](#ref-samolinski2007)). However, if these biological tendencies were deterministic we would expect to see differentiation begin at puberty. It does not. In fact, prior to the onset of puberty, girls’ oral and nasal cavities tend to be larger than those of boys ([Samoliński et al., 2007](#ref-samolinski2007)). If anything, we should expect lower formants and lower center and peak frequencies for girls, inverting the adult pattern. Instead what we observe is that listeners can differentiate the voices of children as young as 4 years of age using vowel formant frequencies ([Perry et al., 2001](#ref-perryOhdeAshmead2001)). Schellinger et al. ([2017](#ref-schellingerMunsonEdwards2017))] report a pair of experiments in which participants heard words produced by children between the ages of 2 and 5, and provided continuous ratings identifying fricatives, vowels, and gender typicality. Children typically show gendered patterns in speech at age 4 and up despite vocal tract length being non-distinct for this cohort. It is critical to remember that formants and fricatives are the result of not purely vocal tract biology but also articulator coordination. Even without biologically-differentiated vocal tracts, people who identify as male or female can perform that identity through gestural style. Vowels, in both their linguistic and social aspects, are the acoustic consequence of gestural control.

Gender is more likely the product of, rather than an explanation for, linguistic variation ([Eckert & Podesva, 2021](#ref-eckertPodesva2021)). Just as with words, genders are arbitrary; both the category labels and their acoustic correlates are language specific ([Johnson, 2005](#ref-johnson2005); [Johnson, 2006](#ref-Johnson2006)) and the constellation of meanings are socially-constructed in interaction ([Eckert, 2008](#ref-eckert2008)). The formant ratios that distinguish male' fromfemale’ in Norwegian are markedly different from the formant ratios that do this in Danish ([Johnson, 2006](#ref-Johnson2006)); what it means to be male' versusfemale’ is quite different in Thailand than in Japan ([Alpert, 2014](#ref-alpert2014); [Käng, 2013](#ref-kang2013)). Children don’t perform adult-like vowel formant patterns because they were born tiny men and women, children perform adult-like vowel formant patterns because they identify as a gender and are participating in the sylistic bricolage ([Zimman, 2017](#ref-zimman2017)) available to communicate that gender to others. Humans are meaning-making agents, not deterministically resonating meat tubes and expert listeners of a language know this.

The existence of this knowledge questions awareness XXX control. In the earliest sociophonetic perception research it was still possible to imagine that the kind of knowledge listeners drew on to perceive gender was knowledge of primary biological traits. We now understand that, instead, the influence of gender-based expectations in speech perception like that investigated here is evidence of the influence of cultural knowledge on what are traditionally understood to be purely linguistic decisions ([Boyd et al., 2021](#ref-boydfruehwaldhall-lew_2021)). Just as vowel height, lip rounding, and syllable affiliation influence the perception of fricative place, so too do socially-constructed gender categories.

## Matched Guise

The Matched Guise technique (MGT) has been deployed in numerous configurations but, at its core, the technique pairs a single linguistic signal (identical recordings, an identical speaker, identical texts, etc.) with multiple purported social categories to elicit the influence of those cues on participants’ linguistic judgments ([Campbell-Kibler, 2005](#ref-campbell-kibler2005), [2007](#ref-campbell-kibler2007)) or language attitudes ([CHAN, 2021](#ref-chan2021); [Hadodo, this volume](#ref-hadodoVolume)). In their foundational use of the technique, for example, Lambert et al. ([1960](#ref-lambertEtAl1960)) found that bilingual Montrealer’s voices evoked quite different social judgments in French vs English guises, providing evidence that listeners are able to perceive and connect social information in the voice to ideological framing of social types. In social speech perception research, cross-modal audio/visual matched guise studies are common in which visual information serves as a ‘guise’ for identical voice recordings; researchers sometimes disregard that even so-called standard voices carry social information Rubin ([1992](#ref-rubin1992)) and sometimes take the combination of voice and visual stimuli into account ([Campbell-Kibler, 2016](#ref-campbell-kibler2016); [Gnevsheva, 2017](#ref-gnevsheva2017); [McGowan, 2015](#ref-mcGowan2015)).

This latter type of guise manipulation has been called ‘inverted’ matched guise [McGowan ([2015](#ref-mcGowan2015))} or, simply, ‘identification’ [Drager ([2013](#ref-drager2013))}. In this paper we intentionally conflate the two to focus on the guise manipulation itself rather than whether the goal is to elicit, primarily, a social judgment as in traditional matched guise or a linguistic behavior.

But uniting these linguistic researchers, and delineating them from colleagues in social psychology (for discussion, see [Rosseel & Grondelaers, 2019](#ref-rosseelGrondelaers2019)), is the methodological assumption that the connection of voice to social type happens below the level of conscious awareness. Awareness here, though generally not explicitly acknowledged, appears to be construed narrowly as participants’ ability to identify and comment on the existence of a guise manipulation. Researchers attempt to deceive participants about the intentional use of guise to elicit evidence of social evaluation in language attitudes, segmental speech perception, memory, etc.

It may be assumed that the matched guise technique works because listeners are unaware of the guise manipulation. Researchers go to great lengths to ensure this lack of awareness ([Grondelaers & Gent, 2019](#ref-grondelaersVanGent2019); e.g. [Pharao & Kristiansen, 2019](#ref-pharaoKristiansen2019)). However, the majority of studies cannot speak to this lack of awareness during phonetic perception because the data provided by the participants is relatively late in processing and involves layers of potential introspection and evaluation that block access to the initial online percept for listeners and researchers alike. McGowan and Babel ([2020](#ref-mcgowanBabel2020)) performed an audio/visual MGT with both a task designed to get at phonetic perception of individual segments and a sociolinguistic interview intended to investigate listeners’ judgements about the purported speaker. Every participant was shown both guises and while segmental and social perceptions were aligned with the identity of the purported talker in the initial guise presentation, these perceptions diverged in the second guise – with phonetic perceptions remaining unchanged and social evaluations tracking the change of guise. Of particular relevance to the present study, despite the fact that the fricatives used in McGowan and Babel ([2020](#ref-mcgowanBabel2020)) were not different across guises, participants often commented on how the fricatives participated in communicating the purported social identity. This work raises the likelihood of at least two levels of sociophonetic perception and suggests that further work is needed to understand the role of awareness, and the necessity of deception, for the ``complex, multi-layered process’’ of perception ([Babel, this volume](#ref-BabelVolume)).

This paper reports an audiovisual matched guise experiment with both standard ‘hidden’ and novel ‘unhidden’ instruction conditions. The basic task is a replication of Strand and Johnson ([1996](#ref-strandJohnson1996)). Listeners are asked to identify an ambiguous word as *sack* or *shack* on a [ʃ]-[s] continuum given manipulated beliefs about the gender identity of the talker ([Stecker & D’Onofrio, this volume](#ref-steckerDOnofrioVolume); [Tripp & Munson, 2022](#ref-trippMunson2022)). As described above, numerous previous replications have found that listeners perceive more of the ambiguous continuum as [ʃ] when they believe the speaker identifies as a woman and more as [s] when they believe the speaker identifies as a man and that, furthermore, this effect is bi-directional, with fricative type influencing perception of gender for an ambiguous voice ([Bouavichith et al., 2019](#ref-bouavichithEtAl2019)). Unusually, participants in the present study’s `unhidden’ instruction condition were briefed, in the instructions, about the guise manipulation. They were instructed that the man or woman in the photo was not associated with the voice they were listening to. ([Campbell-Kibler, 2021](#ref-campbell-kibler2020)), using a similar manipulation, finds that listeners have some ability to disregard social information when making accentedness or attractiveness judgments but that influence of available social information, particularly from the voice, is difficult to disregard completely. In the present study, participants were asked to provide a *sack*/*shack* lexical decision either with, or without, explicit instructions to disregard the visual stimulus.

# Method

## Participants

120 participants (self-identified 59 female, 61 male; ages 20 to 75) were recruited to complete the online experiment online. These participants were recruited through prolific.com and had provided language history and demographic data as part of Prolific’s general pre-screening questionnaire. Participation was restricted to a standard sample of desktop computer users located in the USA, , who spent most of their childhoods in the US, , with no known language or hearing difficulties. Additionally, due to an audio playback restriction imposed by Apple Computer, the Safari web browser could not be used. Participants were urged only to accept the task if they could do so in a quiet space, free from distractions and wearing headphones for the 6 to 10 minute duration of the experiment (average time 6:51). Headphone usage was not verified within the instrument. No participants’ data were excluded from analysis. Participants were paid $3 for their time, pro-rated from a projected rate of $20/hour (actual rate: $26.29/hour). This same instrument was piloted in the Speech Perception lab of The Ohio State University and, while reaction times online were generally slower than in-person, results from the online administration were generally consistent with results collected under laboratory conditions. Four participants were excluded for low accuracy rates (below 85%).

## Stimulus Materials

### Auditory Stimuli

The auditory stimuli used in this study are the same wav-format files used in . The stimuli, which were generously shared with us, contain two parts, both of which are drawn from synthetic continua: a fricative onset and a VC rime. The fricative onsets comprise a synthetic six step /-/ continuum. These steps were generated with the Klatt Synthesizer in Praat using parameters identical to ranging between the values of Munson’s second and eighth continuum steps (which were, in turn, based on the parameters used in ). Centers of Gravity ranged from 3.2 kHz (-like) to 7 kHz ().

For the VC rime, two additional continua were modified from natural productions of spoken by one male-identifying and one female-identifying talker in the carrier phrase ``Say sack again’’. These five-step continua were created by evenly spacing mean F0 across consecutive steps such that the male /k/ continuum increased F0 frequency and formant spacing from their unmodified values while the female talker’s /k/ continuum decreased both parameters from unmodified. each synthesized fricative token was concatenated with each CV rime of /k/ resulting in a total of 60 unique auditory stimuli. These manipulations are described in greater detail in Bouavichith et al’s section 2.1 and summarized visually in Figure [Figure 1](#fig-stimuli). Unlike MGT studies that ask a talented, multi-dialectal talker to consciously change their speech style , these stimuli were asked to . As these talkers were advanced doctoral students in a linguistics PhD program, some of the elements of such an identity are likely available to conscious reflection, but many of these indexical features are likely implicit even for them.

La Palma is one of the west most islands in the Volcanic Archipelago of the Canary Islands ([Figure 1](#fig-stimuli)).

[Figure 2](#fig-spatial-plot) shows the location of recent Earthquakes on La Palma.

## Data & Methods

## Conclusion

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Figure 1

Bouavichith et al. ([2019](#ref-bouavichithEtAl2019)) auditory stimulus continua. S1, S2, S3, S4, and S5 represent continuum steps from most *sack*-like to most *shack*-like fricatives. F0 and F1:F2 Ratio plots show the manipulations to the Male and Female voiced vowels.

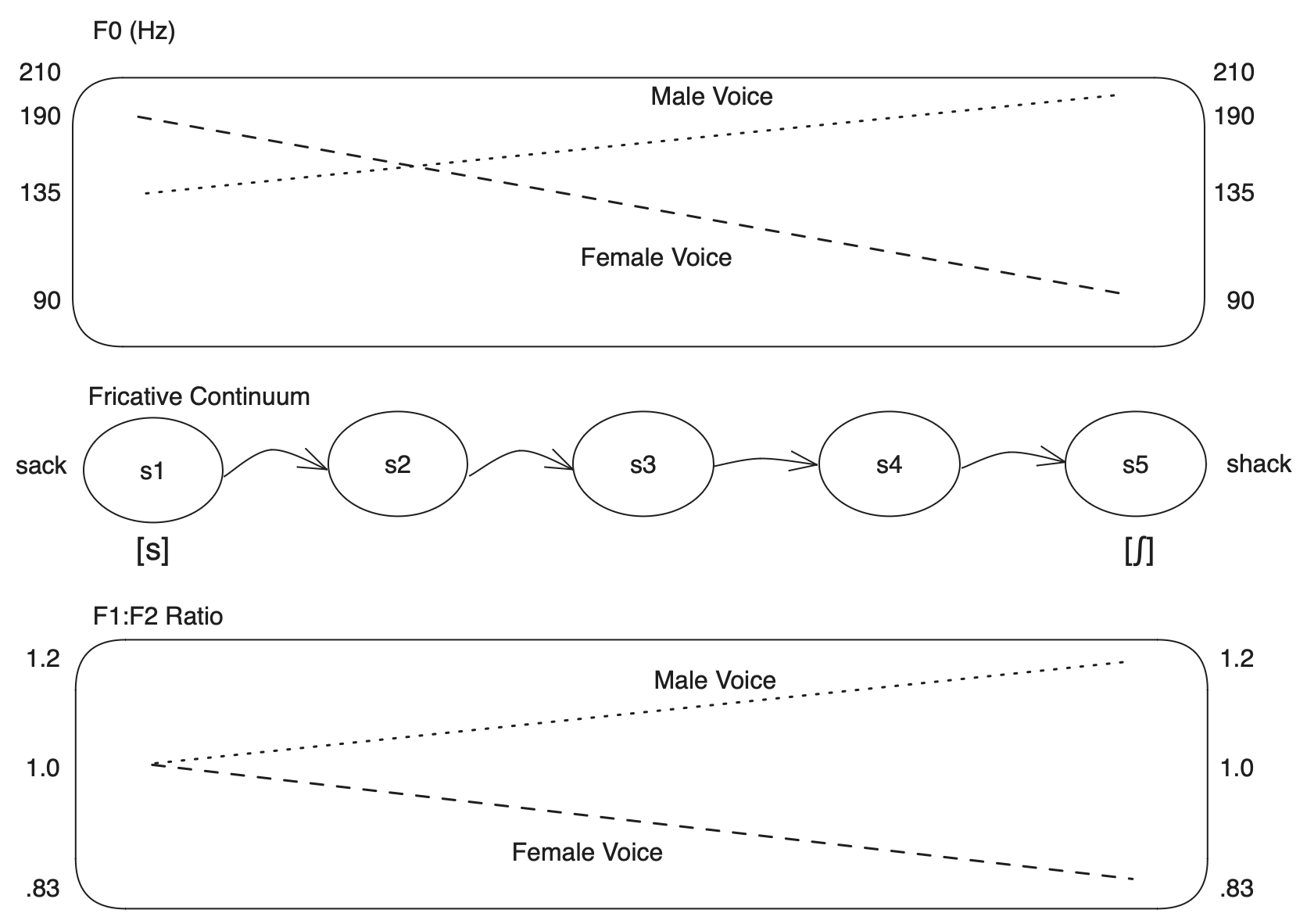
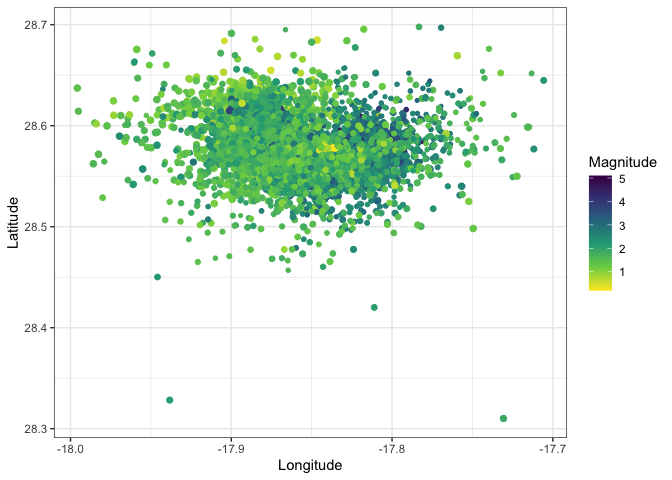


Figure 2

Locations of earthquakes on La Palma since 2017



Source: [Explore Earthquakes](https://kbmcgowan.github.io/play-manuscript/notebooks/explore-earthquakes.qmd.html#cell-fig-spatial-plot)