1.3.7 Application Activities Practicing Entering Data into R

1 Create a new data set called Count. Assume it has two variables, Score and Group, where Score is numeric and Group is a character variable. Randomly enter the numbers 1–9 for the score (create 10 entries). For Group label the first five entries "C" for the control group and the next five entries "T" for the treatment group. Click on OK to close the spreadsheet. When you are finished, type Count in the R Console to make sure your data frame looks good.

2 There is a .txt file that you will use later in this book called read.txt. (Download it onto your computer from the Routledge website.) Import this file into R, and call it read. These data have variable names in the file and the numbers are separated by spaces, so in the dialog box for importing, choose the "Field Separator" called "White space." Use the button along the top of the R Commander GUI that says "View data set" to make sure the data frame looks appropriate.

3 There are many SPSS files that you will need to import into R. Let us try importing the one called DeKeyser2000.sav. (Files labeled .sav are from SPSS; again, you will need to download this onto your computer from the Routledge website.) Name the file dekeyser and keep the other defaults for importing the same. After it is imported, either use the "View data set" button in R Commander, or type the name of the file in the R Console to see the data frame.

1.4 Understanding the R Environment

There are many excellent books you may want to read to help you learn more about R. I have read several of them (Crawley, 2007; Dalgaard, 2002; Verzani, 2004), and what helped me most was following along on my computer, doing in R what they showed on the page. These books all started with the process of helping the reader understand how R works by beginning to use R as a calculator. I will follow their example. In fact, if you should do nothing more than learn how to use R as a calculator, you will be happy you did. I do not use a calculator anymore for my monthly budget; I use R, and after learning R I hope you will see why! But my main point here is that in trying to understand how R actually works, you really need to dig in and copy what I am doing. Section 1.2 helped you get R and R Commander set up on your computer. You now need to continue being active by replicating on your version of R what I do in this book. To help you learn to manipulate variables in R the same way that they can be manipulated in SPSS, you will need to learn more about the basic nature of R and how it works, so this section starts by having you use R as a calculator and understand how data is arranged in R. Once you have understood the basics, it will become easier to see how to manipulate variables within your data set.

This section will not be very useful to you unless you actually work along with the book on a computer by yourself. But you can take this exercise a step further if you not only copy what I do, but if you also intentionally make mistakes and see what happens when you do so. Working this way you will learn a lot about R and how it works.

1.4.1 Using R as a Calculator

R can add up numbers. Type the following sequence and see what happens:

```
67+35+99+10308
```

R will follow your input line with an output line that looks like this:

```
[1] 10509
```

This is the sum of the numbers you just added up. The symbols for other basic mathematical functions are a dash for a minus sign (-), a star for multiplication (*) and a slash for division (/). A decimal point is represented by a period (.). Use parentheses to perform mathematical functions in a preferred order. Thus:

Training Japanese listeners to identify English /r/ and /l/: IV. Some effects of perceptual learning on speech production

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This study investigated the effects of training in /r/–/l/ perceptual identification on /r/–/l/ production by adult Japanese speakers. Subjects were recorded producing English words that contrast /r/ and /l/ before and after participating in an extended period of /r/–/l/ identification training using a high-variability presentation format. All subjects showed significant perceptual learning as a result of the training program, and this perceptual learning generalized to novel items spoken by new talkers. Improvement in the Japanese trainees' /r/–/l/ spoken utterances as a consequence of perceptual training was evaluated using two separate tests with native English listeners. First, a direct comparison of the pretest and post-test tokens showed significant improvement in the perceived rating of /r/ and /l/ productions as a consequence of perceptual learning. Second, the post-test productions were more accurately identified by English listeners than the pretest productions in a two-alternative minimal-pair identification procedure. These results indicate that the knowledge gained during perceptual learning of /r/ and /l/ transferred to the production domain, and thus provides novel information regarding the relationship between speech perception and production. [S0001-4966(97)02404-1]

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INTRODUCTION

The relationship between speech perception and speech production has been a long-standing issue in speech science and experimental phonetics. Some researchers have proposed a direct link between perception and production. For example, motor theorists (e.g., Liberman *et al.*, 1967; Liberman and Mattingly, 1985; Liberman and Mattingly, 1989) claim that listeners perceive speech in terms of their own articulatory gestures that would produce the perceived sound. A central tenet of motor theory is that there is a specialized phonetic module that represents speech units in terms of articulatory gestures, and that this module mediates both speech perception and production. Thus, motor theory supposes a single, shared representation for speech perception and production. Other theorists have viewed the two processes of speech communication as much more autonomous. For example, proponents of acoustic-auditory theories of speech perception (e.g., Stevens and Blumstein, 1981; Diehl and Kluender, 1989) have argued that the processes of speech perception operate on the acoustic medium independently of the articulatory gestures that produced it. In other words, this approach takes the acoustic signal as the object of speech perception, and makes no explicit claims about the perception–production relationship. However, this approach does presuppose that speech perception and production are indirectly linked via common acoustically defined targets and auditory feedback mechanisms that operate during speech production. A third theoretical position, the direct-realist approach to speech perception (e.g., Fowler, 1986; Best, 1995), proposes that the listener directly perceives the articulatory gestures of the speaker in terms of the structure they impart to the acoustic medium. According to this view which is also known as event perception, the objects (events) of speech perception are the articulatory gestures, and speakers aim to achieve gesturally defined targets during speech production. Thus, the direct-realist approach proposes that speech perception and production are inextricably linked by virtue of their common communicative goal. In contrast to motor theory, however, the direct-realist approach does not propose a specialized phonetic module that mediates the direct perception–production link. Rather, direct-realism proposes that the direct speech perception–production link, which helps to ensure speaker–hearer parity, is a specific case of generally integrated event perception and action systems.

Also of long-standing interest is the acquisition of novel phonetic categories by non-native speakers. Previous research has shown that foreign accents persist even for highly proficient speakers of a non-native language (e.g., Tahta *et al.*, 1981; Flege and Hillenbrand, 1987), and that non-native speakers have extreme difficulty with both the perception and production of certain non-native phonetic contrasts (e.g., Flege, 1988; Goto, 1971). Second-language learners thus present cases where certain aspects of speaker–hearer parity break down; that is, where there is a mismatch between the phonetic system of the language-user and of the target language community. For this reason an investigation of speech perception and production by these subjects, and of the changes that occur as a result of second-language

Iverson and Evans (2007) suggested that individuals with larger and more complex first-language vowel systems like German and Norwegian were more accurate at recognizing English vowels than individuals with smaller first-language systems like Spanish and French. Rauber et al. (2005) reported that Brazilian Portuguese learners of English had difficulty in the discrimination of /ɛ-æ/, /ɔ-ɑ/ and /ʊ-u/ contrasts. It was suggested this was likely because they had mapped these vowels into their L1 vowels /ɛ/, /a/ and /u/, respectively.

1.1. Limited exposure to L2

It has been reported that some late learners can achieve native-like pronunciation despite their late exposure to L2 (Flege et al., 1997; Flege et al., 1999a; Piske et al., 2002). Learning L2 sounds in instructional setting in an L2 speaking country is problematic in some respects. For instance, most of the teachers in these contexts are non-native L2 teachers who do not have native-like pronunciations. So, achieving the native-like pronunciation seems to be unlikely by students who are regularly exposed to foreign-accented speech. Some studies have shown that learning L2 in a non-naturalistic setting can make it difficult to reach ''native-like'' pronunciation. For example, the study by Flege (1987) showed that American English learners of French with different levels of experiences produced French /u/ vowel with higher F2 values than those of native L1 speakers.

Some other studies (Bongaerts, 1999; Birdsong et al., 2007; Rallo Fabra and Romero, 2012) provided some evidence that L2 learners who learned the target language mostly in a non-naturalistic setting might reach native-like pronunciation. Bongaerts (1999) study on Dutch learners of French showed that factors like high motivation, massive exposure to the L2, and intensive training in L2 perception and production skills could help some L2 learners in native-like production and perception of L2 sounds. Birdsong et al. (2007) studied the late learners of French on their ability to read aloud French words and sentences in a native-like fashion. Ratings by French judges showed that performance by some of these learners met native-like standards. Rallo Fabra and Romero (2012) found that Catalan learners produced some instances of the vowel /æ/ close to native-like; that is, the native judges heard those vowels as intelligible instances of the intended target vowel and, acoustically, they had spectral values that did not significantly differ from the native speaker values. However PAM-L2 predictions are based on learners in naturalistic setting, Rallo Fabra and Romero (2012) found that PAM-L2 predictions were also mostly valid for their group of learners in non-naturalistic setting. Since the studies of L2 learners in non-naturalistic setting are limited, it seems further study of PAM predictions for L2 learners in formal settings may help assess the predictive power of the PAM for these learners.

There have been contrary implications in previous studies about the use of temporal cues in distinction of L2 sounds. According to Flege (1995), it is predicted that success in using durational cues when acquiring L2 vowels will be related to previous experience with duration in L1 vowel distinctions. McAllister et al. (2002) showed speakers who are extremely experienced with duration distinctions in their L1 outperformed the speakers who use duration as a secondary cue in L1 vowel distinctions. Bohn (1995) 'desensitization hypothesis' suggests that because duration is a cue that is acoustically salient and easy to access, L2 learners will use durational information when spectral information is not available irrespective of whether duration is used in their L1 or not. Iverson and Evans (2007) provided further evidence that L2 vowel learning shows a high degree of uniformity in the use of secondary acoustic cues such as duration and intrinsic formant movement irrespective of L1 background.

1.2. Relationship between perception and production

The perception and production relationship in adult L2 acquisition has been one of the disputable issues in L2 research. In a study by Flege et al. (1997), a positive correlation between English vowel intelligibility and discrimination has been reported among native Korean and Mandarin speakers. Similarly, Flege et al. (1999a) found significant correlations between the intelligibility scores and the vowel discrimination scores, supporting the hypothesis that the ability to produce accurate instances of the target vowels was related to a parallel ability to discriminate these vowels accurately. Although the production errors of inexperienced learners can be predicted from perceptual errors, both skills might be uncorrelated for experienced speakers (Strange, 1995). Bohn and Flege (1997) argue that the production and perception abilities do not progress in parallel. According to Speech Learning Model (SLM) (Flege, 1995), accurate L2 production highly relies on accurate perception, and thus, perception development should precede production (Flege, 1995; McAllister et al., 2002). Flege (1999) claims that modest correlations can exist between L2 segmental production and perception for highly experienced speakers of an L2, but the link between perception and production may not be strong in L1 speech acquisition.

Previous phonetic training studies have shown that perceptual training improves not only perception but also production, supporting a link between the two domains. Bradlow et al. (1997) investigated the effects of training in /r/–/l/ perceptual identification on /r/–/l/ production by adult Japanese speakers. They suggested that the knowledge gained

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In most cases, researchers need to use some type of instrument (e.g., a language test, a rating scale, or a Likert-type scale questionnaire) to help them quantify a construct that cannot be directly seen or observed (e.g., writing ability, reading skills, motivation, and anxiety). When researchers try to quantify how well a student can write, it is not a matter of simply counting. Rather, it involves the conversion of observations into numbers, for example, by applying a scoring rubric that contains criteria which allow researchers to assign an overall score to a piece of writing. That score then becomes the data used for further analyses.

Measurement Scales

Different types of data contain different levels of information. These differences are reflected in the concept of *measurement scales*. What is measured and how it is measured determines the kind of data that results. Raw data may be interpreted differently on different measurement scales. For example, suppose Heather and Tom took the same language test. The results of the test may be interpreted in different ways according to the measurement scale adopted. It may be said that Heather got three more items correct than Tom, or that Heather performed better than Tom. Alternatively, it may simply be said that their performances were not identical. The amount of information in these statements about the relative abilities of Heather and Tom is quite different and affects what kinds of conclusion can be drawn about their abilities. The three statements about Heather and Tom relate directly to the three types of quantitative data that are introduced in this chapter: *interval*, *ordinal,* and *nomina/categorical* data.

Interval and Ratio Data

Interval data allows the difference between data values to be calculated. Test scores are a typical kind of interval data. For example, if Heather scored 19 points on a test, and Tom scored 16 points, it is clear that Heather got three points more than Tom. A ratio scale is an interval scale with the additional property that it has a well-defined true zero, which an interval scale does not. Examples of ratio data include age, period of time, height, and weight. In practice, interval data and ratio data are treated exactly the same way, so the difference between them has no statistical consequences, and researchers generally just refer to "interval data" or sometimes "interval/ratio data".

It is the precision and information richness of interval data that makes it the preferred type of data for statistical analyses. For example, consider the test that Heather and Tom (and some other students) took. Suppose that the test was composed of 20 questions. The full results of the test appear in Table 1.1.

The energy shock

The first big scare of the green era reveals grave problems with the transition to clean energy

NEXT MONTH world leaders will gather at the COP26 summit, saying they mean to set a course for net global carbon emissions to reach zero by 2050. As they prepare to pledge their part in this 30-year endeavour, the first big energy scare of the green era is unfolding before their eyes. Since May the price of a basket of oil, coal and gas has soared by 95%. Britain, the host of the summit, has turned its coal-fired power stations back on, American petrol prices have hit $3 a gallon, blackouts have engulfed China and India, and Vladimir Putin has just reminded Europe that its supply of fuel relies on Russian goodwill.

The panic is a reminder that modern life needs abundant energy: without it, bills become unaffordable, homes freeze and businesses stall. The panic has also exposed deeper problems as the world shifts to a cleaner energy system, including inadequate investment in renewables and some transition fossil fuels, rising geopolitical risks and flimsy safety buffers in power markets. Without rapid reforms there will be more energy crises and, perhaps, a popular revolt against climate policies.

The idea of such a shortage seemed ridiculous in 2020 when global demand dropped by 5%, the most since the second world war, triggering cost-cutting in the energy industry. But as the world economy has cranked back up, demand has surged even as stockpiles have run dangerously low. Oil inventories are only 94% of their usual level, European gas storage 86%, and Indian and Chinese coal below 50%.

Tight markets are vulnerable to shocks and the intermittent nature of some renewable power. The list of disruptions includes routine maintenance, accidents, too little wind in Europe, droughts that have cut Latin American hydropower output, and Asian floods that have impeded coal deliveries. The world may yet escape a severe energy recession: the glitches may be resolved and Russia and OPEC may grudgingly boost oil and gas production. At a minimum, however, the cost will be higher inflation and slower growth. And more such squeezes may be on the way.

That is because three problems loom large. First, energy investment is running at half the level needed to meet the ambition to reach net zero by 2050. Spending on renewables needs to rise. And the supply and demand of dirty fossil fuels needs to be wound down in tandem, without creating dangerous mismatches. Fossil fuels satisfy 83% of primary-energy demand and this needs to fall towards zero. At the same time the mix must shift from coal and oil to gas which has less than half the emissions of coal. But legal threats, investor pressure and fear of regulations have led investment in fossil fuels to slump by 40% since 2015.

Gas is the pressure point. Many countries, particularly in Asia, need it to be a bridge fuel in the 2020s and 2030s, shifting to it temporarily as they ditch coal but before renewables have ramped up. As well as using pipelines, most import liquefied natural gas (LNG). Too few projects are coming on stream. According to Bernstein, a research firm, the global shortfall in LNG capacity could rise from 2% of demand now to 14% by 2030.

The second problem is geopolitics, as rich democracies quit fossil-fuel production and supply shifts to autocracies with fewer scruples and lower costs, including the one run by Mr Putin. The share of oil output from OPEC plus Russia may rise from 46% today to 50% or more by 2030. Russia is the source of 41% of Europe's gas imports and its leverage will grow as it opens the Nord Stream 2 pipeline and develops markets in Asia. The ever-present risk is that it curtails supplies (see Europe section).

The last problem is the flawed design of energy markets. Deregulation since the 1990s has seen many countries shift from decrepit state-run energy industries to open systems in which electricity and gas prices are set by markets, supplied by competing vendors who add supply if prices spike. But these are struggling to cope with the new reality of fossil-fuel output declines, autocratic suppliers and a rising share of intermittent solar and wind power. Just as Lehman Brothers relied on overnight borrowing, so some energy firms guarantee households and businesses supplies that they buy in an unreliable spot market.

The danger is that the shock slows the pace of change. This week Li Keqiang, China's premier, said the energy transition must be "sound and well-paced", code for using coal for longer. Public opinion in the West, including America, supports clean energy, but could shift as high prices bite.

Governments need to respond by redesigning energy markets. Bigger safety buffers ought to absorb shortages and deal with the intermittency of renewable power. Energy suppliers should hold more reserves, just as banks carry capital. Governments can invite firms to bid for backup-energy-supply contracts. Most reserves will be in gas but eventually battery and hydrogen technologies could take over. More nuclear plants, the capture and storage of carbon dioxide, or both, are vital to supply a baseload of clean, reliable power.

A more diverse supply can weaken the grip of autocratic petrostates such as Russia. Today that means building up the LNG business. In time it will require more global trade in electricity so that distant windy or sunny countries with renewable power to spare can export it. Today only 4% of electricity in rich countries is traded across borders, compared with 24% of global gas and 46% of oil. Building subsea grids is part of the answer (see Business section) and converting clean energy into hydrogen and transporting it on ships could help, too.

All this will require capital spending on energy to more than double to $4trn-5trn a year. Yet from investors' perspective, policy is baffling. Many countries have net-zero pledges but no plan of how to get there and have yet to square with the public that bills and taxes need to rise. A movable feast of subsidies for renewables (see United States section), and regulatory and legal hurdles make investing in fossil-fuel projects too risky. The ideal answer is a global carbon price that relentlessly lowers emissions, helps firms judge which projects would make money, and raises tax revenues to support the energy transition's losers. Yet pricing schemes cover only a fifth of all emissions. The message from the shock is that leaders at COP26 must move beyond pledges and tackle the fine print of how the transition will work. All the more so if they meet under light bulbs powered by coal. ■

SPINAL COLUMN
MELANIE REID

MURDO MACLEOD

‘Our first holiday in years – a road trip to the edge of the world. How would I survive?’

To get to the Outer Hebrides, islands on the edge of the world, takes time, endurance and patience – even if you’re able-bodied. If you’re as crocked as me, it is only possible if you have a posse of good-humoured slaves and you enjoy jeopardy.

To be honest, Dave and I can no longer go on holiday anywhere without a helper or two. This trip has been years in the planning, but events made it ambitious. For a start, my new van wasn’t ready – Covid, Brexit etc – so I had to bring the old one out of retirement, but all its hand controls had been stripped out. Maddeningly, this meant I couldn’t share the mammoth, twisty, seven-hour drive. That was Slave No 1’s job.

It also meant I had too much time to become completely neurotic about mechanical breakdowns. Ostensibly my task was to sit up front in my wheelchair relaxing, enjoying the view and feeding Slave 1 good cheer. Inside, silently, I catastrophised non-stop about a) the van breaking down and missing the ferry, b) the ferry being cancelled, or c) the ferry not being cancelled but the van breaking down on board. Once upon a time, I reflected, I was so confident I never worried about anything.

In the back, meanwhile, Slave 2 dished out great snacks and Slave 3, aka my husband, serenely let her take responsibility for everything.

We had a mini-crisis on the ferry, when the ramp from the car deck – car decks kill me; they’re so stressy! – was too angled for my power chair, and it needed half the ship’s crew to hump me into the lift, which caused me to spend the first half of the voyage sobbing with self-pity on Slave 2’s shoulder. (Slaves 3 and 1 went to the bar.)

When Slaves 4 and 5 first mooted a reunion at their holiday house on a faraway island overlooking the cleanest turquoise sea in the world, there was no way we weren’t going to make it. We are, mostly, core members of a gang who went skiing together in the days when we were young and tequila slammers were cheap. We are better behaved now but the fun is just as good.

One by one my phantom terrors receded. We made it off the boat and arrived somewhere in the inky dark at the bottom of a hillside, the sea lapping nearby. The final challenge was a steep gravel and concrete footpath up to the house, newly laid with hairpin bends especially for me, but by now I was heady with relief. We’d made it.

Sometimes, since my accident, this happens. A kind of mad exhilaration will seize me: the sense that the worst has already happened, so who cares. (Dave doesn’t appreciate me in this mood.) I launched my chair off on that first precipitous night-time climb: just me and a panting Slave 4, who confessed later he’d been secretly terrified I wouldn’t get up.

That path became almost my favourite part of the holiday, a personal Cresta Run, dicing with gravity and sliding wheels, defying the maker’s instructions for every power wheelchair ever built. Going down was truly wild, with Slave 1 hanging on behind and Slave 4 grimly anchoring from the side. The best one was when an Atlantic gale blew in and the descent was like a scene from *The Tempest*, with me yelling, “This is fantastic!” above the howl of wind, rain, flapping hoods and the cries of anxious slaves.

I can’t really speak for my dear, overworked friends, but I had a wonderful time. You can’t beat having good slaves. We experienced every kind of weather, watched otters on the shore from the living room, and became blasé spotting sea eagles, gannets, curlews and lapwings close up. Slaves 4 and 5 were amazing hosts, Slaves 1 and 2 became impossibly smug after swimming without wetsuits, Slave 3 got much needed respite from me, and we ate huge freshly hand-dived scallops and drank lots.

A holiday for Dave must include retail therapy, and shortly before the ferry sailed he rushed to try on Harris Tweed jackets. When he saw the price tag he changed his mind and grabbed a £30 tub of men’s moisturiser, made from seaweed, which he claims will make him look young again. Me, I’m just thrilled to report nothing broke down on the journey home. ■

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