The signaling game

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Prefatory note

When did the philosophy of language get squeamish about the historical character of meaning? Meaning is an intentional phenomenon, a phenomenon of *aboutness*, of directedness, of arrows pointing from gesture to world (including, often, other gestures), and this directedness takes form in a process that unfolds in time: the evolutionary time of innate salience, the historical time of social convention, the developmental time in which *broccoli* and *sriracha* acquire meaning for the individual. For David Lewis, whose 1969 *Convention* represents the index text for games of the sort described below, the relationship between gesture and world was strictly conventional. For Thomas Nagel (1974) and Frank Jackson (1982), the meaningfulness of life depends on its phenomenal character, its what-it-is-like-ness. For John Searle (1980), conventions that lack an appropriate causal ground, a historical relationship between sign and something-it-is-like, are not meaningful at all (cf. Millikan 2004). In our own day, the most vigorous proponents of the view that convention is all there is to meaning are those who wish to say that Large Language Models are "doing meaning." I find this view unsatisfactory. ChatGPT, Sydney, and their congeners can infer from corpus analysis that *George Nakashima* is (+furniture, +expensive). But they cannot infer the way it feels to run your hand over the surface of a Nakashima table. Nor, for that matter, can I—what I can do is borrow from neighboring forms of experience: bodily encounters with other tables. Even so, insofar as I have never run my hand over a Nakashima table, the syntagm *George Nakashima table* is less meaningful for me than the syntagm *the cup I'm drinking from* when applied to the cup I am in fact drinking from.

What follows is a modest intervention in the signaling games literature as it has developed since Lewis, specifically through the work of Brian Skyrms and J. McKenzie Alexander (Alexander 2014; Skyrms 2010; Sterelny 2012). I hope it will be clear how much affection I have for signaling games and the habits of thought they give voice to. But in view of the growing hegemony of "network semantics," in computational linguistics (Bender et al. 2021) and in broader conversations about the nature of meaning, I feel it is useful to call attention, again, to the temporally extended, materially freighted process through which meaning takes form. It would be too crude to say that proponents of network semantics were "not in touch with their bodies." Rather, the view that meaningfulness need not be grounded in recurring relationships between gestures on the one hand, and tables and sriracha on the other, is becoming indexical of a broader constellation of commitments—about the appropriate relationship of bodies to words and both to capital, among other things—whose effects on our habits of thought grow more pronounced by the day (Farago 2023).

The signaling game

Imagine two beings, two centers of self-awareness. Call one Sense, the other Move. Sense and Move play a game. Sense goes first. Sense looks around and observes a number of recurring phenomena that warrant comment. For Sense, the challenge is to communicate their observations of these phenomena to Move in such a way that Move can distinguish among them without experiencing them directly. For Move, the challenge is to respond to Sense's signals in such a way as to preserve the two of them from the vicissitudes of nature, the ebb and flux of phenomena that only Sense knows by direct experience. At the start of the game Sense counts up the phenomena that warrant comment and sets out a glass jar for each. In each of the glass jars Sense places a bead of obsidian, the color of anthracite but lustrous and faintly translucent, hard and perfectly smooth. The beads make a clacking sound as they land on the base of the glass jars, then roll to the edge. You can imagine the jars set at regular intervals on a level surface, say a countertop of maple, planed and sanded to a satin finish, so that the direction in which the beads roll is a matter of symmetry breaking—random. If it helps, imagine Sense and Move standing opposite one another across the countertop, Move observing as Sense lays out the jars and drops an obsidian bead in each. It

is best not to imagine Sense and Move as human, though admittedly the scene we've conjured, the jars, the countertop, evokes a pair of bilaterally symmetric beings, if not bipedal then certainly erect, principal appendages of locomotion below, appendages for the manipulation of jars and beads arrayed symmetrically about a central trunk, organs of distal sensation concentrated in a further projection suspended from the top of the central trunk and supported by a muscular column facilitating orientation in many degrees of freedom. Beings like us. In reality, Sense and Move could be single-celled organisms, a microbial assemblage and its host, an ensemble comprising many different kinds of living things, things other than living in the conventional sense. Stones perhaps.

Now: Sense attunes itself—themself, Senseself—to the state of the world and picks out one among the recurring phenomena indexed by the glass jars. This is just a game, so we'll elide the technical challenges of Sense's sampling procedure: sample frame, sample rate, the nature of the arrival process that describes the flux of recurring phenomena, the fact that the signal acquired in a single sample frame may include the signatures of a number of distinct recurring phenomena, or that the picture Sense gets of the state of the world may depend on how they are situated in space. Frequency separation, source separation, the challenge of partitioning the space of signals into distinct categories, be it by some kind of manifold learning or by some kind of clustering strategy, *k*-nearest-neighbors, stochastic neighbor embedding, the fact that the most sophisticated strategies of partitioning are nonconvex, so that the outcome, even the number of categories, may vary from run to run, even with the same training data, or may require many iterations to converge, the fact that a good partition may demand the tuning of a so-called *perplexity parameter*—all the challenges implicated simply in identifying two samples of the ebb and flux of nature as instances of distinct phenomena, distinct states of the world, we will simply place in a basket and set the basket at the side of the road. Somehow, by some prenoietic experience of nature, Sense has formed a picture of the world as consisting in the Poisson-governed arrival of instances of some fixed, finite number of kinds of recurring phenomena—events. Some other Sense, endowed with its own faculties of discrimination and attunement, its own history of saliences, would partition the world differently. This is something we can do nothing about. We have only Sense, our Sense.

Sense attunes themself to the flux of nature and identifies the recurring phenomenon associated with one of the glass jars. From the jar in question Sense retrieves a single bead—but at this stage each jar contains just the one obsidian bead, call it New. Sense retrieves New from the jar associated with the observed state of nature. Whenever Sense encounters New, Sense returns New to the jar and turns to a shelf behind them. There, Sense maintains an infinite stock of glass beads in an infinite array of colors. Never mind how Sense could distinguish an infinite array of colors—as we've said, we're eliding all the details of dynamic range, modulus of discrimination, sampling procedure. Do not concern yourself with how the shelf could hold an infinite stock of an infinite array—if you like, imagine the shelf to be infinitely long, and Sense to move infinitely fast, again, eliding the problems this poses for special relativity. Sense keeps track of which colors of bead are in use, so whenever they draw New they go for a bead of a color not currently in use. They place the bead on the counter next to the jar. If you like, imagine each jar is furnished with a small depression for holding a bead, like a chopstick rest but with the concavity extending through two dimensions rather than just one. Sense places the new bead in this concavity. Move has been watching the whole time.

Thus far, Move has done nothing but observe. Now it is Move's turn. Move maintains an array of jars of their own, one for each of the colors of glass beads in use by Sense excluding New, the obsidian bead. Since this is the first turn of play, Move has not yet set out any jars. Now Move observes the appearance of a color of bead not currently in use and sets out their first jar—imagine they keep an infinite stock of jars on shelves beneath their side of the counter. Move looks around and considers the range of possible courses of action available to them. As with Sense's procedure for discriminating among the phenomena that comprise the flux of nature, we will not bother with the details of how Move discovers what they are capable of: it simply happens. Move maintains a stock of colored beads of their own, these corresponding to the range of actions open to them. Whenever Move sets a new jar on the countertop, they deposit in the jar one bead for each action in their repertoire. In some variants of the game, Move gets a stock of obsidian New beads too and an infinite array of colors with which to represent new additions to their repertoire. If you're a purist, imagine that initially Move has just the obsidian bead, New. *Plunk* goes the New into the first jar, whereupon Move draws New, improvises some new action on the spot, and turns to the shelf at their rear to select a bead of a currently-unused hue to represent that action, depositing it in the jar.

(Note that Move has not yet replaced New—this is to ensure that if Move is endowed with the capacity to create new actions, they cannot get stuck in an open-ended loop, repeatedly drawing New and creating actions without ever responding to the signal sent by Sense. If you are playing the version of the game where Move has the obsidian beads, simply imagine that, having drawn the obsidian bead, improvised a new action, and chosen an unused bead color to represent it, Move sets the obsidian bead to one side before drawing again from the jar corresponding to the bead set out by Sense. Once Move has settled on a response to Sense's signal, they return New to the jar.)

(Note too that Move's actions may not incorporate any of the activities implicated in the mechanics of the game—drawing beads, etc. Metarepresentation of this sort may, as many have speculated, be essential to sentience. But it would unduly complicate our game.)

Now comes the interesting part. Move draws from the jar corresponding to the bead set out by Sense and performs the action corresponding to the color of the bead drawn. This constitutes Move's *response*. Every category-state of nature, every type of event in Sense's repertoire of discrimination, demands a response. Move's response carries implications for the future life chances—we'll call them life chances, though the comments above about holding anthropomorphism in abeyance hold—of Sense and Move alike. If you've imagined Move's repertoire of actions as a repertoire of improvisatory bodily gestures or something similar, it is time to expand the horizon of your imagination to encompass realistic signaling scenarios—evading a predator, say, or propelling oneself up a sugar gradient, or exchanging cash for land.

If Move's response is successful, that is, if it constitutes a good response to Sense's signal, Move and Sense reinforce the relationship between signal and response: Move adds an additional bead of the same color to the jar corresponding to Sense's signal; Sense adds an additional bead of the signal color to the jar corresponding to the observed state of the world. If this is the first time Sense has used a bead of this color, Sense adds a bead of the same color to the jars corresponding to the other possible states of the world—you never know, it might turn out that two kinds of event, while distinct for Sense, nonetheless warrant the same kind of response.

But wait, how do Sense and Move know whether Move's response was successful? There are at least three problems here. First, it seems that success (or correctness, fitness, *atari*) is a gradient phenomenon at the least—more likely, success comprises multiple

dimensions that vary independently, so that we cannot reduce it to a scalar, let alone a nominal *correct/incorrect* measure. Second, it seems that success (fitness, etc.) might vary according to the time horizon over which one measures it, or that you might need to account for multiple fitness measures corresponding to different time horizons—what prompts reinforcement today may, in the course of a year or a decade, turn out to have been poor strategy. Third, even if we could reduce *atari* to a binary measure, it seems like it might take some time for Sense and Move to become aware of whether or not Move's response was successful, introducing a difficult-to-model nonlinearity into our reinforcement procedure.

Or a response might be correct sometimes, incorrect others—there may be aspects of nature that elude Sense's sensorium.

Or they might disagree on whether Move's response was successful.

Again, this is just a game. These concerns we place in a basket and set the basket by the side of the road.

The game continues. The jars are infinite in volume, just as the stock of colored beads and the dynamic range of the colors of those beads are infinite, so we need not be concerned they will fill up. You can imagine various ways of adding texture, noise, to the game: periodically, say, Sense or Move drops a bead and it rolls away, disappearing from view or getting lodged in some impossible-to-reach spot beneath the counter, thus modestly attenuating the relationship between jar and bead (event-type and signal, signal-type and response). Perhaps every now and then Sense or Move impulsively removes a bead at random from a jar and returns it to the shelf. So long as the frequency of these incidents of forgetting is modest, they will tend to prune synonyms—multiple signals for the same phenomenon, multiple responses to the same signal—without vitiating the success of Sense and Move's efforts to coordinate. You might even imagine that every now and then someone drops an obsidian bead, meaning that from then on no new signal (response) can be introduced for the state-type of nature (signal-type) in question. Or every now and then someone might surreptitiously slip an additional obsidian bead into some jar or other, enhancing the rate of innovation (mutation, error) for that phenomenon (signal). Since we've imagined Sense and Move standing opposite one another on either side of a counter where they set their jars and conduct the game, we might even imagine Sense and Move occasionally discarding a bead at random from one of their opposite number's jars—or adding one at random.

We have said nothing about the relationship between the colorspace of Sense's signaling beads and that of Move's response beads, but perhaps they overlap, so that there's a chance, not probability one but nonzero, that if Move slips a bead from their own stock into one of Sense's jars, Sense will mistake it for one of their own beads—or it might be that Move and Sense have opportunities to raid their counterpart's stock of beads.

This kind of interference might be covert or overt. It might be conducted in an adversarial fashion or with the approval, tacit or explicit, of the player whose memory is so manipulated. There are many possibilities.

What happens if a response is not successful? If this is the first time Move has seen a signal of this color (or rather, if signals of this color are not currently in use, since, as we'll see, signals may be abandoned and subsequently reintroduced to novel ends), Move quietly discards the new jar they've set out and Sense quietly discards the bead they'd set in the depression at the side of the jar. If Sense's bead was of a hue not previously in use, that hue becomes available once again to represent some other state of nature. Imagine that the shelf or shelves behind Sense are divided into an infinite number of pigeonholes or cubbies, one for every color of bead in Sense's stock. Affixed to the upper edge of each compartment is a kind of flag (imagine it in whatever form suits you) that Sense can set to indicate that beads of the corresponding color are in use somewhere in the game. Ordinarily, Sense proceeds down the shelves in sequence—a zigzag, like the diagonalization proof of the countability of the rational numbers—selecting the next unused color in sequence. If a first attempt at signaling with a bead of a given color is unsuccessful, the same color will be taken up, possibly to represent some other event-type, the next time a new kind of signal is called for. But when a signal falls out of use sometime after it has been introduced and enregistered through the addition of beads of that color to all Sense's jars, you end up with a gap in the sequence of colors in use. Now you might imagine Sense proceeding not simply by selecting the next color in the diagonalization but by scanning from the start of the infinite array of colors, looking for the first compartment whose flag has not been set to "in use." (Some among you may see the resemblance of this procedure to a first-fit strategy of heap allocation.) This might seem inefficient—it is not as if Sense needs to worry about running out of colors—but of course we've also said that Sense and Move can move up and down their stock shelves at infinite speed. So if you're the type who prefers to imagine a gapless sequence of in-use colors, by all means.

It should be apparent that over time, as the jars fill with beads, innovation tails off—it is less and less likely that Sense (or Move, if you're playing that version) will draw the obsidian bead. Gameplay enters a state of glassiness, and the rate of successful communication converges, not to probability one but to something close. This might seem a bit sad, like the heat death of our signaling universe. Perhaps, to keep Sense and Move alert, you periodically introduce extrinsic shocks: someone tips over most of their jars in a spasm of amnesia—since we've yielded to anthropomorphism, imagine an incident of traumatic brain injury, though of course to realistically model something like that we'd have to imagine that, over time, the being in question is able to reestablish some, if not all, of their lost function—perhaps the beads are not spherical but lozenge-shaped, so that they don't roll so far and you can get down on your hands and knees and kind of shovel the spilled beads back into the jar with the flat of your hand. You'll experience some reorganization, and some of the jars may be cracked and the beads chipped or split, but with patience and support you'll recover to a surprising degree, albeit with a handful of persistent cognitive deficits. Or perhaps beads of certain colors spontaneously disappear from all of a player's jars. This would correspond to some traumatic bodily injury—sudden blinding, say, in the case of Sense, or the loss of a limb in the case of Move. Or perhaps the disappearance is more gradual, as when, with age, we lose sensory discrimination and motor control.

Then there is the possibility that Sense and Move have ulterior motives, rubrics of success other than those of the game. Perhaps Sense practices deception, deliberately sending Move a signal that bears little correspondence to the state of nature they've observed. Perhaps Move practices spite, acting in a way intended to yield not-success. Maybe Sense or Move is playing two games at once with different partners, attempting to cooperate with one while frustrating the other—here we'd have to imagine a playing surface with more than two edges and maybe some portable baffles that allow certain players to shield their gameplay from certain others.

Again, many possibilities, all of them beside the point for our purposes.

Next imagine a different kind of extrinsic shock. This one is less an act of god or simulation designer, more part and parcel of the ordinary ebb and flux of nature: things change. New phenomena come into being, or the correct response to a given phenomenon changes. A mutable world carries new challenges for Sense and Move. If the number of state–action pairs grows without

limit, then over time the incidence of successful coordination between Sense and Move converges to zero. The kind of reinforcement we've outlined does particularly poorly. But even if you imagine that, having coordinated an event and a response successfully once, Sense and Move never unlearn the event–response pair, even in the face of error and noise, so that eventually they will return to it and learn that the response-type in question represents the best response to the event-type in question (provided they have some means to keep track of the success or failure of different responses—imagine pencils, notepads, a pause at the end of every round for note-making), the cumulative rate of success will still go to zero. They will learn to communicate and still get it wrong with probability one.

(Of course, when we're talking about infinite series of events, *with probability one* does not mean *every time*. It simply means that incidents of successful coordination will be isolated, so that they have *measure zero*—they are like individual points on a continuous line.)

Now consider the other kind of mutability: the best response, the correct response, to an instance of a given type-state of nature changes. How could this happen? What would this entail in a real-world scenario? Who knows. That's what makes it an extrinsic shock: its nature and provenance is extrinsic to the signaling environment. Up to this point we have imagined Sense and Move, the counter they share with its smooth maple surface and shelves for spare jars beneath, the further shelves where they keep their stocks of colored glass beads. But we have said nothing about the world beyond those shelves. It is as if the game were taking place on a stage, lit from above, the audience in darkness. Perhaps it is an amphitheater or a canyon, a depression in the earth ringed with sloping berms of sedimentary stone, ferric layers alternating with calcitic—or, why not, basalts and granites, pyroclasts, quartzites, something volcanic—the whole forming an open-air resonator that renders the click of glass on wood, the clack of glass on glass, distinct and exquisite—imagine the audience sitting rapt, you among them, a shiver running up the collective spine every time Sense or Move deposits another bead in one or another of the jars on the countertop, the tension like a Gaussian field as you wait to see whether the pair will coordinate successfully on this round, to see whether someone will knock over a jar, drop a bead and smack their head on the underside of the countertop bending to retrieve it, howling in indignation (have they mouths? do they vocalize?), wondering how long Move will hold out before sweeping the jars from the counter in a fit of rage.

Or perhaps the game is unfolding in a closed room, Sense and Move unaware of the doors hidden behind velvet curtains—you observe everything via a feed, an array of feeds in fact, multiple camera angles, Sense and Move again oblivious, though lately they've felt something, an unseen presence, nothing they could put in words (if they had words—they have no words, not for one another, just the exchange of beads, though of course there must be more to their relationship than that, something we'll return to in a bit).

But this is not what we meant by *real-world scenario*. What we had in mind was some series of events in the world as we experience it that would correspond to a sudden change in the correct response to a given observation of nature in the world of the game. Perhaps your house has flooded or burned down or the aquifer has dried up, perhaps the new boss has taken an instant and inexplicable disliking for you, perhaps your country has slid from liberalism to illiberalism, has tipped from illiberalism to dictatorship. You could construe these as new event-types, but clearly they would also change the correct response for existing classes of event. In the versions of the game that make provision for Move to formulate new responses, to make them up on the spot, we might simply imagine these changes as prompts to innovation. But not all versions of the game grant Move a stock of obsidian New beads, so the standard way of formulating this kind of mutability is to say that two existing categories of states of nature have swapped best responses. There now: no need for innovation on Move's part, same partition of worldly phenomena, same partition of coping, it is simply the relation between the two partitions that has changed, so that if we imagine states of nature to be represented by majuscule glyphs and responses by minuscule (or states of nature by katakana, responses by hiragana—just some way to distinguish between the two ontologies in the glyphic register), we might say we had ordered pairs

(A, a)

(B, b)

and now we've swapped arrows, yielding

(A, b)

(B, a)

If this feels a bit too neat, well: we've come this far, you've accepted all the other implausible simplifying assumptions.

What then? How do Sense and Move cope with changes of this sort? Not well, it turns out, for the same

reason that reinforcement worked so well at establishing successful coordination when the world was immutable. Imagine the jars, infinite in volume but to all outward appearances about two-thirds full. Move's jars, recall, correspond to Sense's signals, the beads in a jar to potential responses to the corresponding signal. If Move and Sense have been proceeding conscientiously and in good faith, we should expect Move's jars to offer a near uniform aspect (Sense's too)—one hue of bead will predominate in each, and a single instance where things go wrong, the discarding of a single bead of what had been the correct color, will not much change the odds that Move will select the same response the next time they're prompted to withdraw a bead from the jar in question. Once your behavior is canalized this way it is difficult, indeed, impossible, to keep up with a mutable world.

There is a way out: Sense and Move must learn to discount the past—to forget as they go along, to give greater weight to more recent successes. Imagine now the base of each jar is a sieve, the beads more like fine chips or granules that flow out over time. This creates all kinds of problems for our imaginative construct—where do the granules go? Do they end up on the countertop, on the floor? Must we imagine an infinite row, rather, two infinite rows running in parallel, of purpose-made depressions in the surface of the counter, where the jars sit, with a grating set into each depression so that the colored granules flow out from the base of the jars, through the gratings—and into receptacles of some kind where the granules are sorted by color and returned, through some obscure crypto-hydraulic process, to the shelves at the rear? Never mind: each color of bead (granule) now has a weight attached to it for each jar. The obsidian New beads (granules) get weights too, and we can manipulate the weight of New to vary the learning procedure. Now, with certain parameter settings—rate of discounting, weight of New, threshold for eliminating a signal or response from the repertoire for a particular jar, since of course we cannot have them decaying asymptotically—Sense and Move cope well with mutability in the ebb and flux of nature that impinges on Sense's sensorium, so long as things do not change too quickly.

We are done. Are we done? Alas, we have not yet begun; we have created more questions than answers. Why, for instance, should the elimination of synonymy be taken as a measure of efficient communication? There is something that eludes our game, some role for elegant variation—perhaps redundancy serves as a bulwark against faults of communication (say Move has trouble distinguishing adjacent hues in the colorspace of Sense's beads, though it is not clear what adjacent could

mean when the modulus of distinction of the colorspace is infinitely fine). Or perhaps Sense and Move are simply prone to boredom, to distraction, to the carelessness that comes of repetitive gameplay—and synonymy, free synonymy, synonymy for no purpose but itself, serves as a source of pleasure, a spark of interest, a chance to conjure a distinction in one's own behavior where none exists in nature. Perhaps, that is, synonymy fills an expressive function. For that matter, perhaps synonymy is not quite free; perhaps when Sense displays one among the three or ten kinds of beads well represented in the jar that corresponds to observations of a particular kind of phenomenon, they are sending a second-order signal, something subtle, something deniable. Perhaps certain synonyms taken on indexical meanings: this is me, this is you, this is this, this is that. *Hey*. It would be an impoverished system of communication that allowed for no other function of messages than the transmission of propositional assertions: *at the tone, the state of the world is p*. More often, it seems, the passing of beads back and forth serves more to establish a relation between the passers than between the passers and the outside world.

Then there is the question of all the communication presupposed in the way we've imagined the game. How could Sense and Move be establishing a system of communication if they could not in some sense communicate aforethought? Nods and shrugs, a roll of the eyes—or if we resist the lure of anthropomorphism, if we imagine Sense and Move to be the constituents of a holobiont, say, we must imagine the two players taking on both roles in multiple games unfolding in parallel. Either we have an infinite regress of metasignaling or we have a situation in which multiple channels of signaling unfold in coordinate fashion. If the former leaves you dissatisfied, embrace the latter. Then there is the question of how Sense, at least, fixes the mapping between that which they observe and the beads they place in the small hemispherical depressions on the countertop. Is this procedure completely arbitrary, a first-fit strategy, scanning the shelves, eyes moving in a practiced diagonalization, looking for the next unused color? Is there no space in our game for iconicity, for natural salience, for synesthesia, an expressive act, a spontaneous and lasting experience of the fit between the sensed and the uttered?

With time, these questions begin to grate on Sense and Move. Perhaps it is nothing they could put in words (they have no words), but something comes to feel amiss. They begin to sense the limits of the game, the confinement, the way their habits of experience and action have been channeled to ends formulated by some

other class of being. This gnawing dissatisfaction goes hand in hand with their dawning awareness that the world as they know it is bounded, and if it is bounded there must be something on the far side of its boundaries. Do they experience hunger? Does food appear, and if so at fixed intervals or in accordance with a Poisson process, so that while they may at length discern the mean wait until their next meal (they have no clocks, no mechanisms for keeping time save those intrinsic to the physiological processes by which they themselves are constituted, and introspective access to these is faint and developed only by dint of painstaking effort—still, if any of the body's clocks are regular it is, perhaps, the clock of hunger)? Do they experience satiation, do they take pleasure in food? Is it passed through a hatch in the door, does it appear on a table to the side when they are preoccupied with some difficult move in the game, do they break for lunch, as it were, or do they continue to play as they eat, standing at the counter, plates of foods chosen for one-handed consumption set at the edges of the counter, between two jars and a bit offset? (I hope they break for meals, I hope they are granted at least this much, it is crushing to think of them condemned to eat standing up, mid-game.)

Time passes. Their bodies decay, their minds decline, the game slows. The jars grow glaucous with minute pits from the impact of the beads, the satin finish of the maple counter surface is covered in scratches and the occasional gouge where someone has slid a jar over its surface rather than placing it gently. One day—are there days here?—one or the other turns to the shelves at the rear, vision blurred by fatigue, mind erased by a piercing tinnitus, and somehow manages to pull down the shelf with the bead they'd wanted. Beads of infinitely many hues spill out across the floor. Do they sit down in despair, lower appendages crossed, cradling their head in their upper appendages? Do they laugh maniacally while the other looks on, wondering what will happen next?

Do they start to get on one another's nerves? By the end of the winter, are they ready to gouge each other's eyes out (do the extremities of their upper appendages feature nails or other implements of gouging)? Do they come to share an affection, an abiding bond, can they conduct conversations with the eyes, leaving off with the jars and beads? When one falls ill, does the other nurse them back to health, making broth in a pan to last a week—sweep your gaze now off to the side in some new direction to find a galley kitchen, nothing elaborate, just a hob and prep surface, gas or induction is up to you, maple or—no, let the prep surface be maple, a sink, carbon-steel santokubocho, carbon-steel

y-peeler; imagine Sense reclining in a futon, drawn, a bit emaciated, eyes swollen half-shut, a rattle in their cough, Move standing at the counter—the prep counter, not the game counter—slicing pumpkin, ginger, shiitake, gobo, toasting laver in a small cast-iron pan, steaming a Japanese sweet potato in a donabe, the sweet scent of homebrewed amazake, nukazuke in a crock, periodically glancing down to where Sense lies, the soft crunch of the kakebuton as Sense shifts in their sleep.

Do they experience cold, don extra layers, take hot showers in the evenings?

Do they grow old together, fret over who will take over the game, who will take over this dilapidated space, the scarred counters and floors, who will take over should one partner fail before the other?

Again, none of these questions is germane to our purpose. What is germane is something we passed over way back at the beginning: *Sense attunes themself to the state of the world and picks out one among the recurring phenomena indexed by the glass jars*. Not the technical challenges of sampling, those we covered and agreed to set to one side, but something prior, something that did not seem even to warrant mention when we were getting started. We endowed Sense with the capacity to discriminate among type-states of nature, observing instances of these type-states as they pass in succession. But we did not endow nature with any kind of structure. Do the events Sense observes not conform to any topology (rather, any topology beyond the discrete topology)? Is the world not an unstructured aggregate of phenomena but a landscape, a coherence, something with an adjacency relation, so that Sense may say, *this is more like that, that is less like this?* When Sense gets it wrong, observes incorrectly, is the distribution of probabilities of their error uniform, so that it is equally likely they—one, you—will mistake phenomenon *A* for phenomenon *C* as for *B*? To rule out similarity, adjacency, neighborness, to banish topology from the world, feels wrong, for if, as we may suppose, all phenomena are free of intrinsic properties—I sense you nodding in agreement—nonetheless they possess those properties that exist simply in virtue of the relationships between phenomena, for how else should Sense distinguish them save by how this relates to that?—and yet this absence of topology is baked into our game. Sense and Move evolve a signaling system of pure convention, no iconicity, no natural salience, no synesthesia, no *well of course you'd choose that color for*—(of course we've made an exception for New, the obsidian bead, its distinctive desaturated glint, something that stands apart no matter what the nature of

your ocular ecology, whether you're working with two cone cell types or three or five, one opponency, two)—but the world they are coordinating to cope with is a world of pure convention too, no relations between phenomena, no trend to revision strategies but simply a flailing, *if this does not work try that*. An index, 1, 2 . . ., not even a preorder, no $A_i \le A_j$. A uniformity, an absence, a state of perfect entropy.

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