A Minimal Computational Improviser Based on Oral Thought

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Abstract

A prototype system for playing a minimal improvisational game with one or more human or computer players is discussed. The game, Chain Reaction, has players collectively build a chain of word pairs or solid compounds. With a basis in oral culture, it emphasizes memory and rapid improvisation. Chains are only locally coherent, so absurdity and humor increases during play. While it is trivial to develop a computer player using textual corpora and literature-culture concepts, our approach is unique in that we have grounded our work in the principles of oral culture according to Walter Ong, an early scholar of orature. We show how a simple computer model can be designed to embody many aspects of oral poetics as theorized by Ong, suggesting design directions for other work in oral improvisation and poetics. The opportunities for own our system's further development include creating culturally specific automated players and situating play in different temporal, physical, and social contexts.

1 Introduction

We have developed a prototype computer system to play the game Chain Reaction. This is both a memory game and an oral improvisational game, and may be the simplest such game. The game is best introduced with an example. Consider a group of four players sitting in a circle, with a designated direction for play, uttering the following:

- **Player 1,** beginning the game: Post office.
- **Player 2:** Post office chair.
- **Player 3:** Post office chair man.
- **Player 4:** Post office chair man child.
- **Player 1:** Post office chair man child labor.
- **Player 2:** Post office chair man child labor law.
- **Player 3:** Post office chair man child labor law school.
- **Player 4:** Post office chair man child labor law school boy.
- **Player 1:** Post office chair man child labor law school boy band.
- **Player 2:** Post office chair man child labor law school boy band ["banned"] book.
- **Player 3:** Post office chair man child labor law school boy banned book shelf.
- **Player 4:** Post office chair man child labor law school boy banned book shelf ... uh, I can't think of anything!
- **Player 2:** Shelf life!
- **Player 1:** Too late! Let's start again.

Each player's task is to continue the chain by reciting it quickly, without hesitation, and to immediately add a word that will create a coherent pair with the word before it. "Coherent" simply means that the pair must refer to a meaningful single item or concept. In written language we could call this a collocation or a bigram, but a pair could also form a solid compound such as "chairman" or "manchild." There is no requirement that the added word make any sense when joined together with any *earlier* words, only that the last word and the added word together constitute "a thing." As seen in the case of band/banned, words are considered to be oral units and it is fine to continue the chain while treating the previous word as a homophone. Typically, there is a prohibition on re-using words within the same game. Although this example doesn't show it, it's fine to use verb phrases (e.g., "slide off," "run up"), which also constitute "a thing." Many of these are easy to continue (e.g., "off brand," "up hill").

What exactly is "a thing"? Like obscenity, we know it when we see it, or in this case, when we hear it. "A thing" is determined by consensus. It is whatever the group accepts as a suitable two-word phrase or compound word. In the example given, Player 2 might have made a first move that involved uttering "post office plant" (an office plant being similar to a house plant, but for the office). This would have been a less obvious phrase, yet probably acceptable. Even so, the continuations "office

salad" and "office sky" would probably not have been accepted, even if the player could have spun a story about how there are such things (a salad stored in the office kitchen's fridge and consumed at one's desk or the view of the sky from one's office, for instance). If a player has to stop to explain the phrase, the game's continuity is broken, so such phrases are, at least, not *good* moves.

New players usually find it surprisingly easy to recite long chains. There are reasons for this related to oral practices. A fundamental reason involves shared cultural and linguistic expectations. Each word pair in the chain, after all, was almost instantly thought up by a player.

2 Why Build Computational Models of Oral Improvisation?

There has been intriguing work done to implement interactive improvisational games for language learning (Morgado da Costa and Sio, 2020). One game, Forced Links, is even related to chain reaction, in that it involves the formation of word chains, although not a word at a time. Our work differs from this project because it does not have any goal extrinsic to the game itself, and because it is strongly based on oral practices and principles.

Oral cultures and thought encompass a broad span of human history prior to the development of writing and the establishment of cultures grounded in literacy. Aspects of oral thought persist today, as do new oral practices that are now situated in a culture suffused with manuscript, print, and electronic practices. A prominent and innovative one, for instance, is freestyle rap.

There are many approaches to understanding complex phenomena such as orality. We chose the epistemological approach of developing a computational model. This allows us to explore the nature and consequence of orality in three distinct ways. First, in the process of building the system we can discover constituent elements of oral thought in accordance with the computational-imperative principle: "any model of human intelligence should introduce only computational capabilities that enable observed behaviors without enabling unobserved behaviors." (Winston and Holmes, 2018). Second, we can examine the system's functions and connections as a map towards understanding the functions and structures of orality in action. Last, by engaging with the built system, we can explore surprises and unexpected (yet sometimes positive) behavior, which can be used as further input to generate new questions to explore.

There have been remarkable systems for oral improvisation and poetics, including a physical robot which engages in an agonistic, improvised singing practice, bertsolaritza, that is traditional in the Basque Country. (Astigarraga et al., 2013) This "Bertsobot" does a complex sort of improvisation and is a multimodal system with an elaborate architecture, as opposed to the system we describe. The interface is speech-based. However the underlying generation of verses, based on a vector-space model of sentences, is not based on oral principles. The way language is characterized by researchers (as "sentences" rather than "utterances") indicates a literate-culture orientation in the system's design and development. Bertsobot's sentence selection is also based on a corpus that consists of some preexisting, transcribed bertsos, but mostly of text from a newspaper, *Berria* — a literate, written source.

More recently, a physical robot that can engage in freestyle rap battles, Shimon, has been developed (Savery et al., 2020). Again, this is an elaborate system that multimodally performs a complex type of improvisation. Shimon was trained on a database of rap lyrics (and, in a different condition, metal music lyrics), but these lyrics were composed rather than improvised. Researchers studied flow and drew on how-to books about rapping, but it not clear that the project was informed by the ethnographic literature on freestyle or a significant neuroscience study (Liu et al., 2012).

Both Bertsobot and Shimon were engineered to perform optimally and to be evaluated positively by people. They were developed with clear awareness of bertsolaritza and freestyle rap. Still, the language generation in these systems did not seem completely anchored to any explicit and general theory of oral poetics. While our project may seem trivial by comparison to these very elaborate ones, it does have such a basis. And by focusing on a minimal improvisational situation, and paring down our system to its essence, we hope to show what oral poetic design principles apply most widely.

3 Chain Reaction

3.1 History of the Game

More than 110 years ago the technique of word association was developed to allow patients to surface unconscious ideas. (Jung, 1910) The experimenter instructs the subject: "Answer as quickly as possi-

ble the first word that occurs to your mind." Then, a series of words are uttered and the response to each is recorded. In word association, it is not necessary to make a Chain-Reaction-style completion, a pair or "thing." The reply can be an antonym, a synonym, a hypernym, a hyponym, a meronym, or anything else. The relationship of this technique to Chain Reaction is that players in the game must also utter a continuation as quickly as possible, often the first thing that comes to mind.

The concept of word association is culturally understood as having incongruous and humorous potential and has been employed in comedy, for instance in the in the 1975 *Saturday Night Live* sketch "Word Association" with Chevy Chase and Richard Pryor (Saucier et al., 2016) and in the 1989/1990 *Monty Python's Flying Circus* sketch "Word Association Football" (Aarons, 2012). These are scripted performances, not improvisational verbal games, but help to illustrate that there can be humor in instantaneous responses to a word.

In January 1980 a game show devised by Bob Stewart premiered on US television. The show, hosted by Bill Cullen, was called *Chain Reaction* and required that players guess a chain of words connecting a given first word with a given last word. In early rounds, the chain was eight words long. (Nedeff, 2013) The first run of the show was short-lived, but it has been revived several times.

We do not find the first mention of the verbal game Chain Reaction, with rules similar to those we provided in the introduction, until the early 21st Century. It is described in a book of games to be played in the car by children. (Gladstone, 2004) While Gladstone (or whoever devised this game) likely had the game show in mind, contestants on TV had to find predetermined intermediate words in a chain of fixed length. The verbal game involves the same sort of chaining, but allows the continuations to be determined by players. In the verbal game, the chain is not of fixed length, but can grow indefinitely.

We have participated in many Chain Reaction games in different contexts, offering us a diversity of experience, although certainly not the distance for impartial observation. Fundamentally, our play of chain reaction serves as a "reality check" to demonstrate that the game as explained in this recent book is indeed playable and (for us and many participants) can be fun. Our informal but frequent experience of play offers us some insights as observers of others and allows us to reflect on our own cognition during play, as we discuss later.

3.2 Seemingly Competitive, but Cooperative

At first glance Chain Reaction seems like a competitive game. It is possible for a player to lose, as Player 4 did in the example game transcript. A player can lose by forgetting part of the chain or by failing to come up with a new word to extend the chain. In this case, we could say that everyone else in the circle gets a point for that game. If a group were playing like this, the group would want to ensure that a continuation of the chain actually existed, so the player that was unable to come up with a word might have the right to challenge the previous player (e.g., "... plastic spatula ... uh ... come on, spatula what? There's no way to continue that!"). The game as presented by Gladstone allows for a player to win by connecting the end of the chain to the first word uttered by Player 1. For instance, if playing with this rule, Player 2 might have said: "post office lamp" and Player 3 might have triumphantly declared "post office lamp post — I win!" Perhaps some number of points greater than one could be given to the player who achieves the rare loop of this sort.

While we can discuss fine details of how this game can be scored and thus won or lost, the truth is, in social circumstances observed by author-participants, the game is not really played competitively. It is a cooperative game such as footbag (the trademarked name of which is Hackeysack). In this game, a circle of players kick a small bag filled with sand into the air with their feet, trying to keep it from hitting the ground. In this social game, a good footbag player is one who keeps the bag in the air and makes it possible for others to also play, extending the fun of the game. The same is true in Chain Reaction.

3.3 Context, Individuality, Cultures

Much of the fun in Chain Reaction arises from the relationship between individuals, the cultural commonality in the group, and the cultural differences between players. Different players have some cognitive differences. They draw from varying life experiences and find different ways to continue chains.

Players can come from different cultures, which might influence the way they follow up particular words: American and Canadian players might choose "station eleven" (the name of an American

TV series based on a Canadian novel) while British players might be more inclined to say "station stop" (a chiefly British way to indicate a train station). Yet players do share a language, as well as the commonality of broadly defined human experience.

Gameplay is influenced by the embodied nature of the game. This brings the world of social interactions, context, and the physical environment of play into the dynamics of the game, whether consciously or unconsciously. A game may vary greatly, for instance, depending on whether it is played in a classroom, during dinner, or in a park.

4 Why the Obvious Approach Misses the Point

It would be simple enough to download a large textual corpus, create a list of word pairs from this data, then sample uniformly to create an automated player for Chain Reaction. The player so constructed could be given a higher or lower temperature parameter so that it utters more common or more unusual words to continue the chain. This player, however, would lack the nuance humans will have when playing, and would have no basis in the principles of orature or cognitive operational constraints.

Human speakers have not perfectly memorized libraries of digital and digitalized text, and even if they had, speech and writing represent different registers. A corpus will not represent how the a language is spoken unless it consists entirely of accurate transcripts, given the many differences between speech and writing noted and theorized by Ong, Halliday (1989) and others (e.g. Lukin et al., 2011). These have often been automatically distinguished using computational linguistics systems (e.g. Murata and Isahara, 2002; Ortmann and Dipper, 2019).

Additionally, humans do not uniformly sample from a fixed database of possible word pairs or compound words in their minds. Chain continuations are uttered based on common speech, idioms and expressions, individual backgrounds and history, cultural backgrounds, current events, the physical setting of the game, previous conversations players have had with each other, and so on. In addition to factors that are not conscious, explicit decisionmaking plays a role. Players may sometimes choose uncommon continuations as "curve-balls" to make the game more interesting. And finally, the store of pairs within the mind may be large, but certainly is constrained.

5 CRT, a Bot to Play Chain Reaction with Humans

Chain Reaction Time (CRT) is a simple prototype system, developed in Python, for playing Chain Reaction. In developing CRT we were not interested in providing a surrogate social environment and having a single human player use the computer as a partner in this game. The point of developing CRT, and any future automated players of games like Chain Reaction, is to be able to add these computer players to groups of several humans and make the dynamics of a multi-player game even more unusual and fun.

5.1 System Architecture

Readying CRT for play begins by formulating one or more lists of valid word pairs that can be used by computer players in-game. This is achieved via a learning submechanism that is responsible for finding word pairs from arbitrary textual corpora. As a data-transforming mechanism, the learning module has no innate preference toward textual or oral modes of thought. Although oral culture is primarily maintained in our system as discussed in the analysis of Ong's characteristics of orality, we have chosen to also embody this aspect by only using a casual spoken-word corpus, the Santa Barbara Corpus of Spoken American English (Du Bois et al., 2000). At the cost of omitting new and emerging word pairs, we use this method to ensure that pairs have a real-life oral basis and reflect the orally-based cognition used in casual daily conversations.

CRT has a model of pairs that allows for the system to treat words and symbols as oral tokens rather than textual ones. Given the present textual implementation of programming languages, the usage of written lexemes is unavoidable, and in any case (even if the system were programmed via speech or using a visual programming language) computers are inherently inscriptional, recording data. The interface can also highlight the lexical, written aspects of the system.

Nevertheless, the pairs model not only functionally achieves orally-based responses, but acts as a core component of the oral nature of the broader system. To achieve this, the pairs model first transforms the ending word of the chain into a list of all its possible phonetic representations given by the CMU Pronouncing Dictionary (Weide, 1998).

Pairs then uses a dictionary of homophones to find all lexemes of all pronunciations of the word in question. Lastly, a continuation is chosen from the list of all possible continuations found for all lexemes. This results in a system that is functionally ambivalent to the rigid textual representation of a word, and can naturally switch between word meanings, lexemes, and homophones in a fluid, oral way.

5.2 Player Interface

Traditional human-computer I/O follows almost exclusively our textual and literate traditions. (CRT was developed before the smart speakers became as pervasive as they are today, but even these systems only do a little to diminish the influence of literate culture in HCI overall.) One fundamental characteristic of orality is the ephemerality of the word and its inescapable attachment to the present moment. A spoken word can be heard for only the moment it sounds in the air. Textual systems embody the polar opposite of this characteristic: written or printed text (on paper or on a computer terminal) lasts for a finite yet practically unbounded period of time.

Although we have not released CRT yet, we wanted to build it on accessible free/libre/open source technologies, and sought to implement a minimum viable system. These inclinations led us, in our early work, to use the textual display of words on the screen and a keyboard interface for input. Although not ideal, we specialized this interface to present some of the most important features of oral exchange.

The Python curses library was used to achieve the key oral element of ephemerality as well as present-moment-attachment of the word, allowing us to emulate those aspects of speech. This interface is currently named OralTyping. Although text is still used, the timing and visual presentation of the text aims to recapture key elements of orality lost in standard textual displays. For interface systems without an auditory component, OralTyping performs well in its intended purpose of representing the ephemerality of oral poetic production in text. Of course, a two-way verbal interface would make for a better play experience, and we do plan to implement one.

As a step toward this, we developed a second interface using the pyttsx3 text to speech module. This allows CRT to speak the chain aloud when it is the system's turn to play. Without having conducted any formal evaluation, it is clear that this interface improves play in addition to being more faithful to the underlying oral principles of Chain Reaction. It is important to note that this system currently only provides speech output; human players must still inform computerized players of the latest chain additions before the computer can consider and output a continuation to the chain. In future versions of the system, we plan to use modern machine learning models for both speech synthesis (such as Tacotron 2), as well as speech recognition (such as wav2vec) in order to remove current text input limitations.

6 Principles of Oral Poetics as They Apply to Chain Reaction and CRT

In *Orality and Literacy,* Walter Ong outlines nine unique characteristics that distinguish primary oral thought processes from textually based cognition (Ong, 2002). While Ong is certainly not the last word on orality — he is, rather, the first major scholar and theorist of it — we believe his principles remain critical to understanding oral improvisation and oral culture. Our selection of Chain Reaction and development of CRT to play it embodies these characteristics as follows.

6.1 Additive rather than subordinate

Oral works tend to use linear, additive grammatical structures, whereas literate texts employ more complex structures to give contextual information that would otherwise be found in real-world oration. The Chain Reaction game is effectively the most direct functional implementation of additive structure, since its core mechanic is the retention of active chain followed by the addition of one word forming a new ending pair. CRT does not modify this mechanic, and thus exhibits this oral characteristic.

6.2 Aggregative rather than analytic

In orature, descriptive archetype pairs occur often as small-scale formulas. As Ong states, "The elements of orally based thought and expression tend to be not so much simple integers as clusters of integers, such as parallel terms or phrases or clauses, antithetical terms or phrases or clauses, epithets." Given that Chain Reaction is entirely founded on culturally memorable consecutive word pairs ("things"), the game prioritizes these pairs as the underlying root structure of thinking-in-play.

Although these pairs have greater constraints than called for by the general aggregative trait of orality, their existence as the cognitive root of Chain Reaction (and CRT by extension) indicate a strong oral foundation.

6.3 Redundant or "copious"

Oral works repeat many story elements previously stated including events, characters, and associated descriptions. The requirement that players orally repeat the entire chain is a direct example of this redundancy. Indeed, many of the underlying motives for this redundancy in oral cultures can be experienced firsthand in Chain Reaction gameplay. In particular, Ong states, "Not everyone in a large audience understands every word a speaker utters, if only because of acoustical problems. It is advantageous for the speaker to say the same thing, or equivalently the same thing, two or three times."

6.4 Conservative or traditionalist

A primary objective of oral works is to preserve the knowledge gained by the culture, given that in primary oral cultures the spoken word is the sole method of record-keeping. In Chain Reaction gameplay, the creation of truly novel word pairs is effectively prohibited, since one criterion for a pair to be valid is that it must be recognized as preexisting. This ensures that although *chains* created may be new, their constituent elements are conservative by definition and rule. From a different perspective, given that words in the chain need not have any logical relation other than being consecutive word pairs, this can result in chains that grow more bizarre and more amusing with each expansion, which can be seen as a source of novelty. Even so, this novelty is grounded in a locally conservative requirement.

6.5 Close to the human lifeworld

As Ong states, "In the absence of elaborate analytic categories that depend on writing to structure knowledge at a distance from lived experience, oral cultures must conceptualize and verbalize all their knowledge with more or less close reference to the human lifeworld, assimilating the alien, objective world to the more immediate, familiar interaction of human beings." Pairs that come to mind in Chain Reaction are likely to stem from everday human experience. While there is no design element of CRT that works toward this principle, the use of an orally-based corpus is meant to help address it.

6.6 Situational rather than abstract

Continuations are likely to draw on the immediate context of the player, with more abstract elements being less likely. Players' physical location, the time of day, the weather, the social setting, dynamics between players, and other factors will lead gameplay to be simultaneously grounded in the active, present lives of the players (6.5) and situationally based by context (6.6). We have observed players looking at and even pointing to others in the circle as they go around recalling words in the chain, and players have told us that they sometimes try to remember who said each word to aid their recollection. Although not presently implemented, we recognize this element of orality and intend to eventually model some aspects of it in CRT.

6.7 Agonistically toned

A distinctive signature of oral works, Ong states, is the embedding of the work and spoken word in an agonistic context of struggle. In Chain Reaction, the act of playing can be seen as a struggle between players to properly recite the growing chain while adding on to it. As discussed earlier, the strong formulation of agonistic struggle is tempered by the essential nature of this game as cooperative. Thus, there is an additional dynamic at play: An implicit goal of continuing the game as long as possible, rather than purposefully trying to gain an upper hand on other players. So while this game has an element of being agonistically toned (reflected in CRT as well), it is in the service of cooperation and group enjoyment.

6.8 Empathetic and participatory rather than objectively distanced

This characteristic ties in strongly with (6.5) Close to the human lifeworld, in that it indicates an innate connection between the work and the speaker or speakers. In the case of Chain Reaction, the participatory nature of the game itself, along with its human context, encourages empathetic response through the creation of additional pairs.

6.9 Homeostatic

Ong characterizes the homeostatic nature of oral cultures by stating that they "live very much in a present which keeps itself in equilibrium or homeostasis by sloughing off memories which no longer have present relevance." The nature of orality precludes the use of dictionaries or other written ref-

erences to learn about the past: All there is is the present. Chain Reaction is not played with reference books, of course. And our pairs knowledge bases derive not from such texts but from modern transcripts of oral conversations. It would work against this principle to use textual data derived from historical written books or dictionaries, which could result in anachronistic responses from computer players as well as an unrealistic store of information that would not accurately model the thought processes of human players in Chain Reaction.

7 Reflections on Play with CRT

An example transcript of a play session with two human players and CRT is given in Appendix A.

We have not undertaken any formal evaluation of CRT, but can share some reflections based on our informal participation in and observation of the game when CRT participates. The CRT system does work and can participate in play with human players. Including one or more computerized players in a group of human players can inflect gameplay in an interesting way, as the computer player is able to participate, but in a way that is sometimes noticeably nonhuman. Its pace of recitation is unusually regular. It is capable of forming good continuations, but currently, not ones that are influenced by pairs earlier in the chain or by the human context. Generally, the current system's ability to form continuations is not currently near a human level, so games often end with the automated players unable to find continuations that human players have in mind.

The limited but noticeable success of CRT proves that even a simple system can embody almost all major the aspects of oral poetics as theorized by Ong. It highlights the aspects that are most challenging to model, including those that rely on physical, temporal, and social contexts of play. We hope that this design directions for other work in oral improvisation and poetics, specifically, pointing out (1) what aspects of orature are easy to model and should be implemented in related systems, and (2) helping to show what aspects are more challenging and should be a focus for future research.

7.1 Improving Chain Continuation

We believe that learning from additional corpora and forming a larger pairs knowledge base would be the simplest way to address current limitations. A significant concern is how to integrate corpora of written texts in a way that is suitable for this orally-grounded project. We of course do not have access to the smart speaker recordings of human conversation collected by Amazon and Google — sparing us any ethical dilemmas regarding the use of this data. We may be able to use available written corpora that are contemporary and vernacular, and address the written origins of this textual data by filtering it so that offhand and more or less improvisational writings, rather than ones that involved the consultation of sources and revision, are emphasized.

7.2 Solid Compounds

One important limitation of the current learning mechanism is that of detecting valid pairs written as solid compounds, e.g., "signpost" and "newspaper." The learning submodule does not detect this. This highlights an underlying structural difference in how words are perceived orally versus textually. "Written words are residue. Oral tradition has no such residue or deposit."(Ong, 2002) Ong argues that in authentic oral cultures, "signpost" and "sign post" are delivered in the same way; even attempting to formulate a distinction between them is impossible within an oral framework. This is not an impairment of orality; this equality of word representation reveals some of the ontological commitments textual cultures have made in order to enable literate representation of the spoken word. From an a priori perspective, it is not evident which unitary ideas should be written separately and which should be written as compound words. Further evidence of this can be seen in the common shifting of these boundaries, in such cases as "to morrow," "after noon," "mail box," and "class room." This is one example of an element of orality directly encountered in the development of CRT, manifested as a concrete problem that must be solved. A partial solution to this problem may be to include a list of valid compounds (based on an auto-generated list, but edited) in the pairs model.

7.3 Making Memory Worse

Computerized players currently do not have a model of fallible memory; that is, an automated player can only fail by being unable to find a continuation. We plan to implement a temporal model whereby computerized players may forget parts of the chain as a function of increasing time as well as the difficulty or atypicality of pairs (judged by relative frequency of a given pair across learning

data). This would model the human tendency to forget, and thus provide a more accurate experience that can be tweaked via parameters.

Having the system forget a chain is not a high priority for us, even though memory is an important aspect of Chain Reaction. Generally, it is not fun for the game to end, and it may leave players disappointed if an automated player were to stumble and end the game. An exception to this may be when there is a very tenuous continuation at some point in the chain, or when the game is progressing poorly because many players have made obscure continuations. In this case, players can be relieved and appreciate the ability to start over, and to form a better chain. Still, it is not essential that an automated player be the one to end such a game.

7.4 Explaining Continuations

CRT could be developed to explain the reasoning behind a particular continuation after the end of a game, as a human would reasonably be expected to do if asked. Without developing general AI, it would be straightforward to implement a mechanism by which CRT could justify its chain continuations as influenced by categories such as "food," "furniture," and "expression." When questioned about a chosen continuation, a computer player could respond adequately by stating the association it was reminded of and the word that caused this association to activate. Work on this aspect of the system might help us develop better methods of continuing the chain.

7.5 Embodying Cultural and Individual Differences

Perhaps most interesting to us would be elaborating CRT to have custom pairs databases, with custom weights, to model of cultural and individual differences. In alignment with our earlier comments, the computational model of a Canadian or American player might give more weight to "station eleven" while a British player model gave more to "station stop." Such cultural differences would be the first step of in modeling different sorts of players. Beyond this, we might be able to model how certain individuals watched a good deal of TV and others none at all, which would affect the weighting of two-word or compound TV show titles. With these sorts of nuances, computer players could introduce additional interesting twists into games of Chain Reaction.

7.6 Allowing More Elaborate Improvisation

We have in mind ways to relax the constraint on what a pair can be and have played sample games with different rules. Even with a very minimal framework for oral improvisation and poetics, we are likely to determine a different game that allows for more types of creativity, and enhance our system to play this game.

From there, we could elaborate the system to utter rhymed couplets in response to previous utterances. This would allow it to participate in a minimal rap cypher. By building up from a seemingly trivial system and maintaining a connection to principles of orature throughout the process, we would be taking a very different approach from that of complex multimodal systems that devise lyrics as part of their improvisations.

Complex systems can be impressive, but they can also face difficulties. If they succeed, it is hard to know the basis for their success: Which of the many components of the system were crucial to the positive improvisational performance? If they fail, it is, similarly, hard to know why. By taking a bottom-up, step-by-step approach, we hope to be able to answer questions that more elaborate bots, although impressive and admirable in many ways, have not been able to address.

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A Chain Reaction Played with CRT

The following is a transcript of play undertaken by two human players and CRT on May 10, 2022.

- **Player 1:** new year
- **Player 2:** new year book
- **CRT,** as Player 3: new year book club
- **Player 1:** new year book club sandwich
- **Player 2:** new year book club sandwich bag
- **CRT:** new year book club sandwich bag clip
- **Player 1:** new year book club sandwich bag clip art
- **Player 2:** new year book club sandwich bag clip art studio
- **CRT:** new year book club sandwich bag clip art studio apartment
- **Player 1:** new year book club sandwich bag clip art studio apartment building
- **Player 2:** new year book club sandwich bag clip art studio apartment building code
- **CRT:** Hmm... Nope, I don't know