Outro:

A Google Glass application as a cognitive tool to enhance second language acquisition for

advance learners

by

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Abstract

Even though Google Glass was released in 2012, most users and stakeholders still use the device as if it was a just smartphone or tablet, for instance, taking photos and using Google search. Google Glass has its own specialties, like gesture command and transparent display, not all apps are customized for the Glass, but simply replicate smartphone apps. In this context, Outro, an application customized for Google Glass, was designed to introduce how people can use wearable technology in a different way. The purpose of design application here is to enhance second-language acquisition. The four features of Outro will be introduced: one of them is real-time captioning by using voice recognition technology and it can provide definitions of English expressions at the same time on the screen of the Glass. This paper will offer instructions and examples of how language learning can be improved by using the application based on theoretical foundations: Second language acquisition, multimedia learning, and mobile assisted learning, and cognitive load theories.

1. Introduction

1.1. Significance for Learning English as a Second Language

With globalization, more students than ever in non-English speaking countries, like China, spend a lot of time learning English. According to Liu (2008), about 200,000 people in Beijing attend English training schools each year, a market equivalent of $300 million. The digital English learning market was about $1.3 billion in 2011, and the annual growth rate of the mobile English educational content market is 45% globally (Ambient Insight 2014). A rising number of students goes abroad to study, and most of these students go to English-speaking countries, such as the United States. According to the Internet World Stats (2013), the United States has the world's largest international student population -- more than 800,000 -- and the numbers continue to grow. In both the offline and online environments, English is the most frequently used language (Internet World Stats, 2013). For this reason, providing learning methods and tools for students to improve their proficiency in English is increasingly important in education (Liu, 2008). This project focuses on English as a second language, although its findings and design approaches can be applied to other languages.

1.2. Using Google Glass as a Cognitive Tools for Language Learning

This project designs an application of mobile technology, primarily Google Glass, as a cognitive tool for second-language (L2) acquisition. To provide a rationale for this determination, this section defines the term *cognitive tool* and explains its importance to learning.

A. Definition of Cognitive Tool

Cognitive tools help learners transcend the limitations of their minds, such as memory, thinking, or problem solving (Jonassen & Reeves, 1996; Pea, 1985). These

tools are "mental and computational devices that support, guide, and extend the thinking processes of their users" (Derry, 1990, P. 229).

In the past, students may learn knowledge by using cognitive tools in passive way. For instance, computer simulations, which contain pre-made content and instruction, conveyed predefined knowledge to students. Jonassen (1995) points out that students learn *from* technology, not *with* technology as in the past. Today's cognitive tools are intended "to engage and facilitate cognitive processing" (Kommers, Jonassen, & Mayes, 1992). This leads students to learn *with* cognitive tools help learners enter into intellectual partnerships with the tool. In other words, when students work *with* cognitive technology, "instead of being controlled by it, they enhance the capabilities of the tool, and the tool enhances their thinking and learning" (Jonassen, 1995, P.44).

B. Importance of Using Cognitive Tools for Learning

There are reasons why using technology as cognitive tools rather than conveyors represents a better use of technologies for learning. First of all, cognitive tools are tools to actively engage learners in creation of knowledge that reflects their comprehension and conception of the information rather than representing objective knowledge. Since students are required to think deeply to use the application as a cognitive tool to represent what they know, they cannot use cognitive tools without considering about the content that they are learning (Jonassen, 1995).

Moreover, cognitive tools are learner controlled, not teacher or technology. Learners have to construct their own "conceptualization of learning and experiences by using the tools" (Perkins, 1993). Therefore, the goal of using cognitive tools is not reducing information processing to makes learning a easy task, as has been the goal of instructional design and most instructional technologies (Perkins, 1993). Learners

cannot use cognitive tools without making proper efforts; cognitive tools are tools provide an environment that often requires learners to think deeply about the subject being studied while constructing thoughts that would be difficult without using the tool (Perkins, 1993). In this context, we can think of cognitive tools as a set of tools that students "scaffold the all-important processes of articulation and reflection, which are the foundations of knowledge construction" (Jonassen, 1995, p.233). Jonassen (1995, p.44) supported this idea that:

> Just as electronics specialists cannot work effectively without a proper set of meters and tools to help them diagnose and repair electronic malfunctions, students cannot work effectively at thinking without access to a set of intellectual tools to help them assemble knowledge. Students should use technologies as tools, not as tutors or repositories of information.

"Technologies do not directly mediate learning, that is, people do not learn from computers, books, videos, or the other devices that were developed to transmit information" (Jonassen, 1996, p.2). Rather, meaningful learning can be achieved by thinking which is a mental process.

In this regard, Outro for Google Glass is an application that encourages learners to figure out what they do and do not already know. Depending on learners' prior knowledge and experiences, they control their devices and decide what they are going to learn. In language learning, language systems are so complicated that it is not possible to teach or convey all the elements of target languages to a wide range of learners via pre-made content or applications. Rather, it would be better to learn in the real world with personalized content and cognitive tools. Outro for Google Glass is a

cognitive assistant for students to learn language more effectively by augmenting their ability to achieve their goals that would otherwise be difficult

Reeves (1996) summarizes the theoretical foundations for the use of software programs as cognitive tools:

Use for education should be situated in realistic contexts with results that are personally meaningful for learners.

Enable intellectual partnerships in the form of distributed cognitive processing.

Empower learners to design their own representations of knowledge rather than absorbing the representations preconceived by others.

Promote the deep reflective thinking that is necessary for meaningful learning.

Enable mindful, challenging learning rather than the effortless learning promised but rarely realized by other instructional technologies.

Are most effective when they are applied within constructivist learning environments (Reeves & Laffey, 1996, p. 3).

2. Analysis

2.1. Problem Description

Students cannot learn everything in a second language in class; the structure of language is so complex that students can be taught only a fragment of their target language (Krashen, 2003). This means that students are exposed only to a small part of the total vocabulary and grammar of the language in the classroom. Krashen (2003) emphasizes that the classroom should be especially valuable for beginners who cannot easily use the informal environment for input (or learn new knowledge). He also says that it will be of less value to those who are linguistically advanced enough to take

advantage of comprehensible interactions in L2 out of the classroom. In this context, students have to go into the real world and keep learning their target language that they can be exposed to every day. However, current learning methods and tools cannot fully support students in learning a second language in real world. The problems with L2 acquisition for advanced learners are as a lack of interaction and feedback, and few chances to learn authentic expressions with rich context.

First, L2 learners rarely have meaningful input in second-language learning environments. Meaningful input means that learners acquire their target languages with interactions and feedback with rich context, not by simply memorize the grammars and vocabulary. Although these are essential elements for students to learn new information, they often cannot receive proper feedback in and out of school (Chapelle, 1997; Gass, 1997). So, they concentrate on grammatical and lexical knowledge, which cannot lead to communicative competence. Therefore, L2 socialization may not occur because the knowledge of the target language is not created and acquired through concrete interaction in an appropriate sociocultural environment, but it is merely transmitted (Kasper, 2001).

L2 learning often occurs in artificial settings and situations so that L2 learners cannot learn authentic and colloquial expressions in rich context (Chang, 2014; Mayer, 2005). Although many L2 learners want to learn colloquial and context sensitive expressions, traditional L2 classroom provides more official and generic expressions. According to Chang (2014), a majority of second-language learners want to learn more colloquial expressions for daily use, but the traditional tools and formal education environments are inadequate for this purpose. Since students in formal settings rarely have chances to learn authentic language, students lack of communication skills out of school. Thus learners can be isolated from the real world

in L2 environments. Consequently, students have to engage in authentic and meaningful exchanges so that they can develop communicative competence (Blattner & Lomicka, 2012).

2.2. Learner Characteristics

The target audience in this project is international students or young professionals in their 20s and 30s in English-speaking countries for school or work. Outro does not provide specific pre-made content for L2 learning such as grammar or basic vocabulary. Yet, the application aids learners in leaving their ESL classrooms and making their own learning content to study authentic English in real settings. Since the learners have to study by themselves with learning material that they made, they have to have fundamental English skills and a decent understanding of the language structures.

Based on the characteristics described by Krashen (1988), advanced learners have a vocabulary, more than 6,000 words. They usually possess the ability to communicate in writing and speech using complex sentences, and since they have a clear understanding of English grammar and years of experience learning English, they can do self-correction (Krashen, 1988). The target audience therefore consists of as learners with a basic knowledge of the language, but not of idiomatic expressions, and they cannot recognize subtle mistakes or nuances in L2 (Krashen, 1988). They still need to study further these nuances to become as fluent as natives. Learning authentic English is significant for international students, because they have not learned authentic English in their ESL class, but they have to use it in everyday life (Chang, 2014; Mayer, 2005). Therefore, the people selected can benefit from the use of Outro.

2.3 Review of Existing and Competing Products

#1.

Captioning on Glass (CoG, Website: http://cog.gatech.edu/support.html)

Description: *CoG* provides real-time closed captioning, allowing the deaf or hard of hearing to converse. It requires an Android smartphone paired with Glass to function. Just say, "Okay, Glass, recognize this" to start captioning. The conversational partner speaks into the phone and the speech is converted to text and displayed on the Glass instantly (see figure).
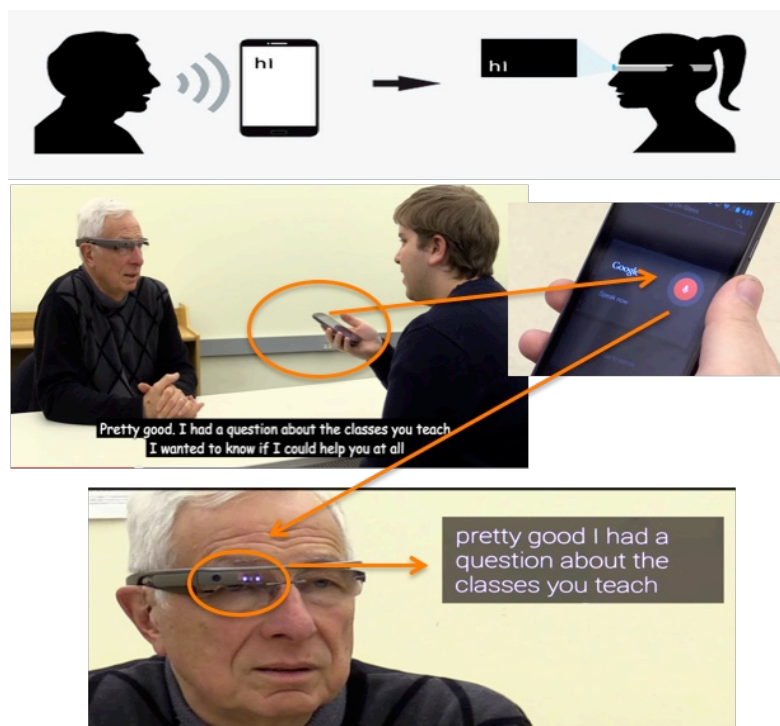

Figure. CoG communicates between a smartphone and Google Glass through Bluetooth connection. One person is talking to smartphone, then the device transmits his message to the other person. The person who is wearing the Glass can see the message on the display.

However, *CoG* is for people with hearing impairments, not for L2 language learners.

CoG does not provide educational content, such as definitions or a sharing feature.

Sharing features can allow L2 learners to have rich interactions and immediate

feedback anytime anywhere via websites. For example, L2 learners often want to ask questions pf teachers and native friends via online communities or social network websites.

#2.

Duolingo (for Google Glass, Website: http://cog.gatech.edu/support.html)

Description: Duolingo is an application to learn basic vocabulary for second language. On Glass, L2 learners can practice Spanish, French, German, Portuguese, or Italian vocabulary using hands-free flashcards (see figure).
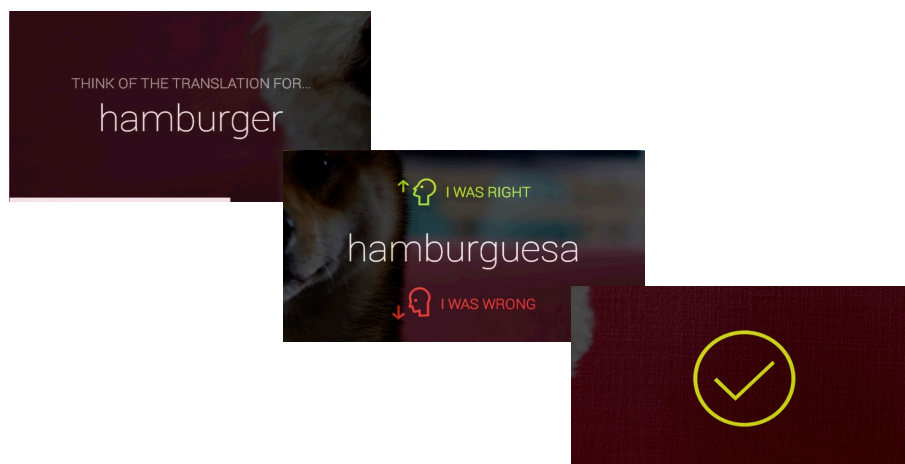

Figure. Duolingo play screen for Spanish learners to learn English words

Duolingo offers limited fixed content and basic vocabulary. Although the application is fun to play with, the teaching method and content per se are not customized for Google Glass for learning authentic English. In addition, while using the application, the learners have to be in the virtual world. This feature discourages face-to-face conversations.

#3.

Word Lens (for Google Glass, Website:

https://www.youtube.com/watch?v=pZKWW3rzT2Q)

Description: Word Lens instantly translates printed words using the Glass camera in real time. Users look at some printed text, hold the head still, and see it translated, with no network connection required. Word Lens translates English to and from Portuguese, German, Italian, French, and Spanish (See figure).

Figure. Word Lens German to English translation.

However, the application does not allow users to save or share the images they are watching (2014). Moreover, it is a simple translation tool, so there is no learning content or references, such as the definition of *word* in Google Glass. This application was created to help international tourists understand signs and menus. Since the translation is verbatim and without context, its accuracy is quite low for full or complicated sentences (see figure).
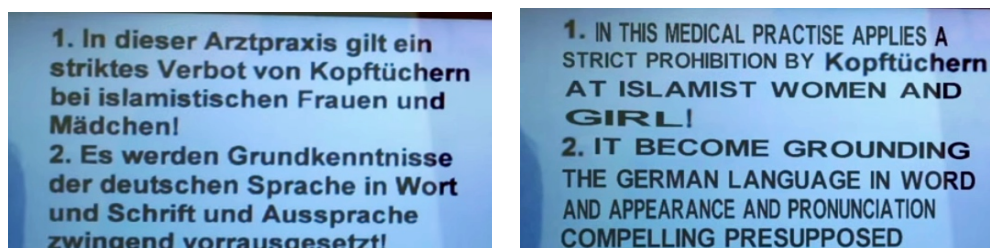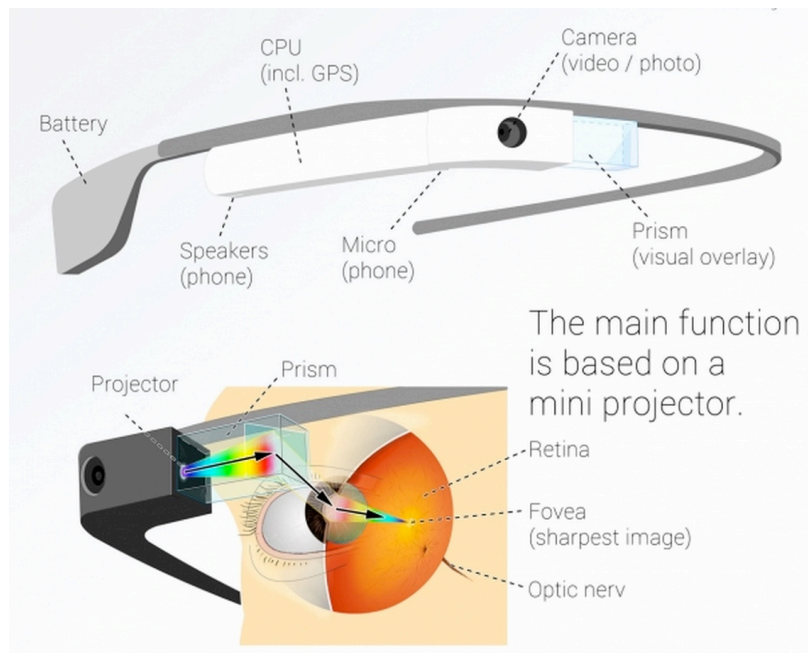

Figure. Word lends translation from German to English. Sentence by sentence translation is not quite accurate.

3. Design and Development

The illustration explains Google Glass tech specification and the process of how people can see images on the display. Plastic prism reflects images from projector on the side to one's retina

3.1. Technology Specification

(images retrieved from http://www.dvice.com/2013-4-9/infographic-breaks-down-how-google-glass-works, 2014)

Technological Specification of Google Glass
(Tech specification retrieved from
https://support.google.com/glass/answer/3064128?hl=en)

Display: 0.75 inch deep and 0.375 inch by 0.375 inch wide, high resolution display is the equivalent of a 25-inch high definition screen from eight feet away.

Camera: Photos - 5 MP / Videos - 720p

Audio: Bone Conduction Transducer Connectivity

Connectivity: Wi-Fi - 802.11 b/g 2.4GHz / Bluetooth

Storage: 12 GB of usable memory, synced with Google cloud storage

Battery: One day of typical use. Some features, like video recording, are more battery intensive.

Charger: Included a Micro USB cable and charger.

Others: Glass can be used as a Bluetooth headset with any Bluetooth compatible phone. Google supports diverse frames, and their selections have been growing gradually (see figure).
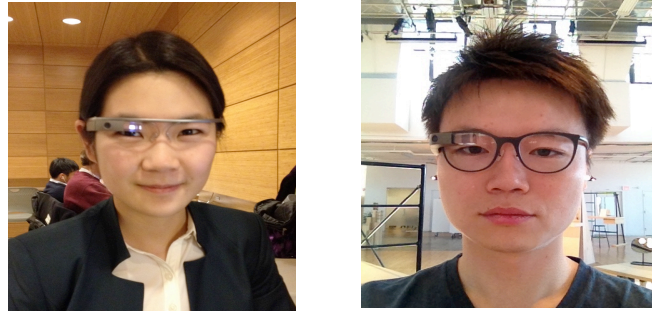

Figure. On the left, it is a default frame of Google Glass. On the right, it is a curve frame, which looks normal glasses frame (optional).

3.2. The Benefits of Using Google Glass in Second-language Acquisition

Google Glass, a wearable technology with an optical head-mounted display (OHMD), will be deployed for this project. We prefer Google Glass to other devices for second-language acquisition since Google Glass has two advantages to L2 language learners: a see-through display and a user interface, which can prevent interruptions in the flow of conversation.

Unlike smartphones, the transparent prism display enables users to view either a heads-up display of information or their surroundings. They can maintain eye contact with the person with whom they are talking.

In addition, unlike other devices, wearable interfaces will help the learners pay attention to the real world instead of being distracted from it by micro-interactions. Google (2014) explains, "Glass is designed for micro-interactions, not for staring into the screen, watching Friday night movie marathons or reading *War and Peace*." The reduced access time is a considerable advantage. Users control the Glass by using new

user interfaces which do not require any taps or navigation; it responds instead to voice commands, takes pictures with a "wink," follows commands for search, share content, video recording, detects objects and looks up information. Moreover, Google Glass offers L2 learners a range of integrated applications, such as Google search and Facebook or Evernote to share pictures in real time.

However, when L2 learners want to look up definitions of English words in real conversations, they may not do so quickly enough with smartphones to avoid breaking the flow of conversation. L2 learners have to look at their touch screens, and invest at least 30 seconds in retrieving the device and navigating to the right part of the user interface. In addition, when students use their smartphones, their attention turns from their surroundings to the virtual world. Moreover, using a smartphone in the middle of conversation can be considered rude. So, learners cannot use their devices even if they need to. For these reasons, Google Glass will be chosen for this project because learners can take advantages of its strengths, such as transparent display and voice- and gesture-based interfaces.

3.3. Learning Goal and Strategies

The learning goal is to improve authentic language skills in English such as the acquisition of authentic expressions. We will use online resources and Google Glass as a cognitive tool in this project to facilitate language learning.

In terms of second-language acquisition theories, we will use a retroactive strategy (Liu, 2008; Richards, 1996). The learners will study and review authentic English expressions after encountering them. This is more effective than a proactive approach since learners can target what they have to learn. In this context, Outro supports students to take notes on colloquial expressions and unfamiliar terms encountered outside of class (Irujo, 1993). The students can save examples of

expressions found in newspapers, conversations, or elsewhere and share them on other devices and applications such as Evernote on desktops via Google Glass. Moreover, learners will be asked to make their own description of target words by using the editing features of Outro for Google Glass. The students can even save and annotate dialogues with photos by using ShowMe, a real-time captioning feature. By using this feature, students can learn English with annotated pictures more effectively than using text alone (Ishida, 2008b; Levrato & Cacciari, 1999; Nippold & Martin, 1989). We will then discuss the features of Outro and how we can use if to accelerate language acquisition in the chapter "Design and Development." After the "Design and Development" chapter, the theoretical foundations for language acquisition and application design will be described in the chapter "Theoretical Frameworks."

3.4. Structure, architecture, and systems of the application: Outro

In this section, we present and discuss a flowchart of the Outro for Google Glass. The features will be introduced one by one. Outro, has four main features: ShowMe, MyNotes, Vocab, and Wink. ShowMe provides real-time captioning to encourage face-to-face conversations. MyNotes is a place where users can save and review their dialogues made by real-time captioning. Vocab allows L2 learners to edit their vocabulary in Google Glass without an Internet connection. Wink is a feature that allows L2 learners to take a photo by using the gesture command, "wink." Since some of these features are linked, they will be described in this section.

A. *ShowMe*

ShowMe is a real-time captioning feature. The first step in using ShowMe is to launch Outro by saying, "Okay, Glass, Outro" or tapping the touch pad on the side of the Glass. Once the application is launched, L2 learners can see ShowMe, on the screen. They can tap the touch pad to start real-time captioning. Google Glass's voice

recognition feature will make voice-to-text transcriptions based on the speech around
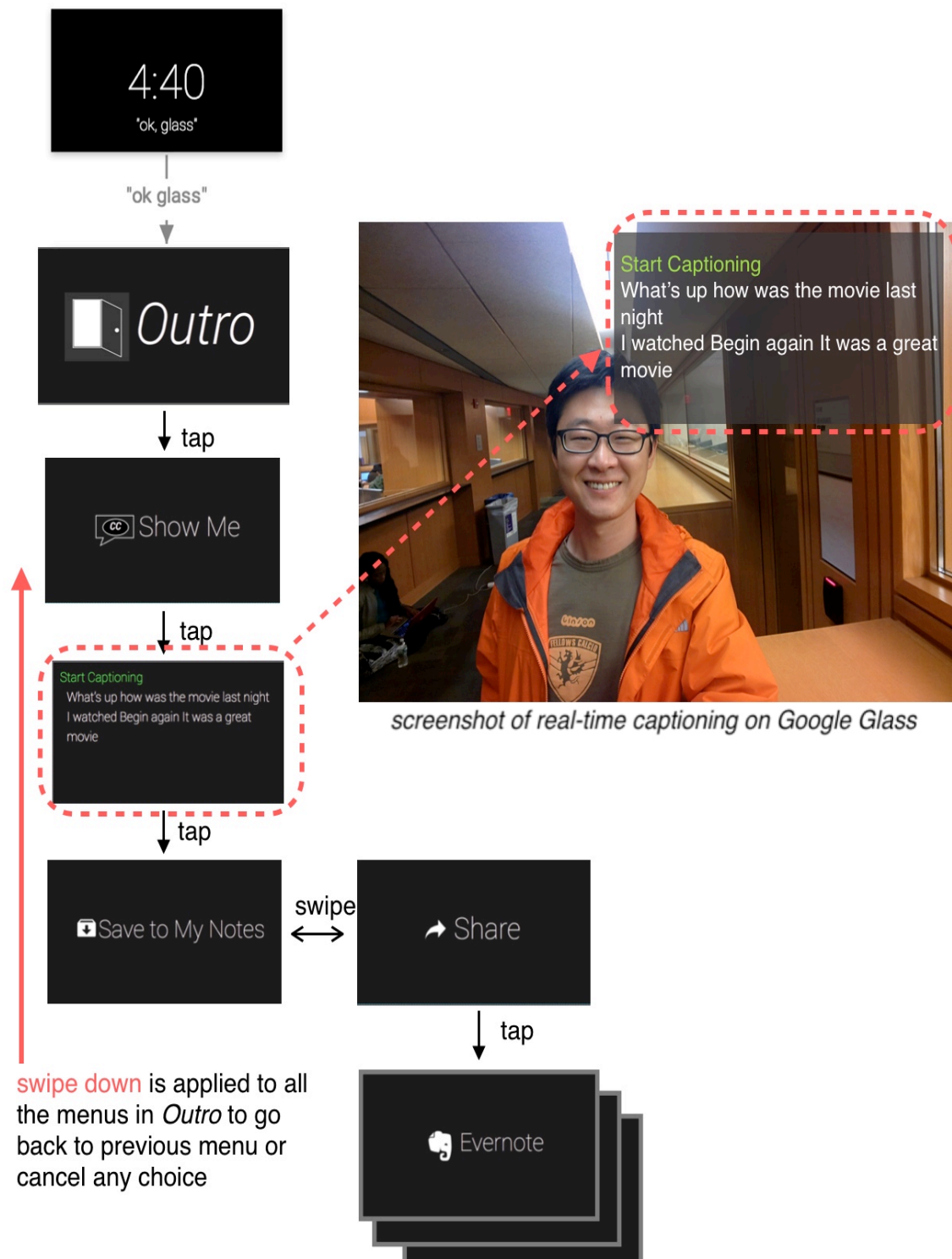
the learner (see figure).

Figure. Flowchart of the ShowMe feature in Outro: On the upper right hand, a screenshot of ShowMe when users are using real-time captioning in real conversations.

In order to finish the captioning, they tap the touch pad again. The following options then appear: Save to MyNotes and Share. If they choose Save to MyNotes, the dialogue made by using real-time captioning will be saved into the *MyNotes* folder so that they can review them later.

If L2 learners want to *Share*, they swipe the touch pad from one side to the other. The screen moves like a sliding door from the left to right and vice versa. If learners change their minds or want to go back to previous menu, they have to swipe the pad from top to bottom. The swipe-down command applies to all features and menus of the application. These command settings are default setting of Google. Outro is following Google's guidelines in command design. If learners select the Share feature, they can choose where to send the data. There are several options: Evernote and Facebook in Outro, but if they have more accounts on other service providers, like Twitter, they can also share their data on those sites.

B. *MyNotes*

MyNotes is a feature to save dialogues and pictures made by Outro. My Notes has two submenus. The first submenu, Dialogue, reviews saved dialogues created by real-time captioning. By swiping the touch pad, learners can navigate the dialogues and by tapping the pad, they choose one (see figure).
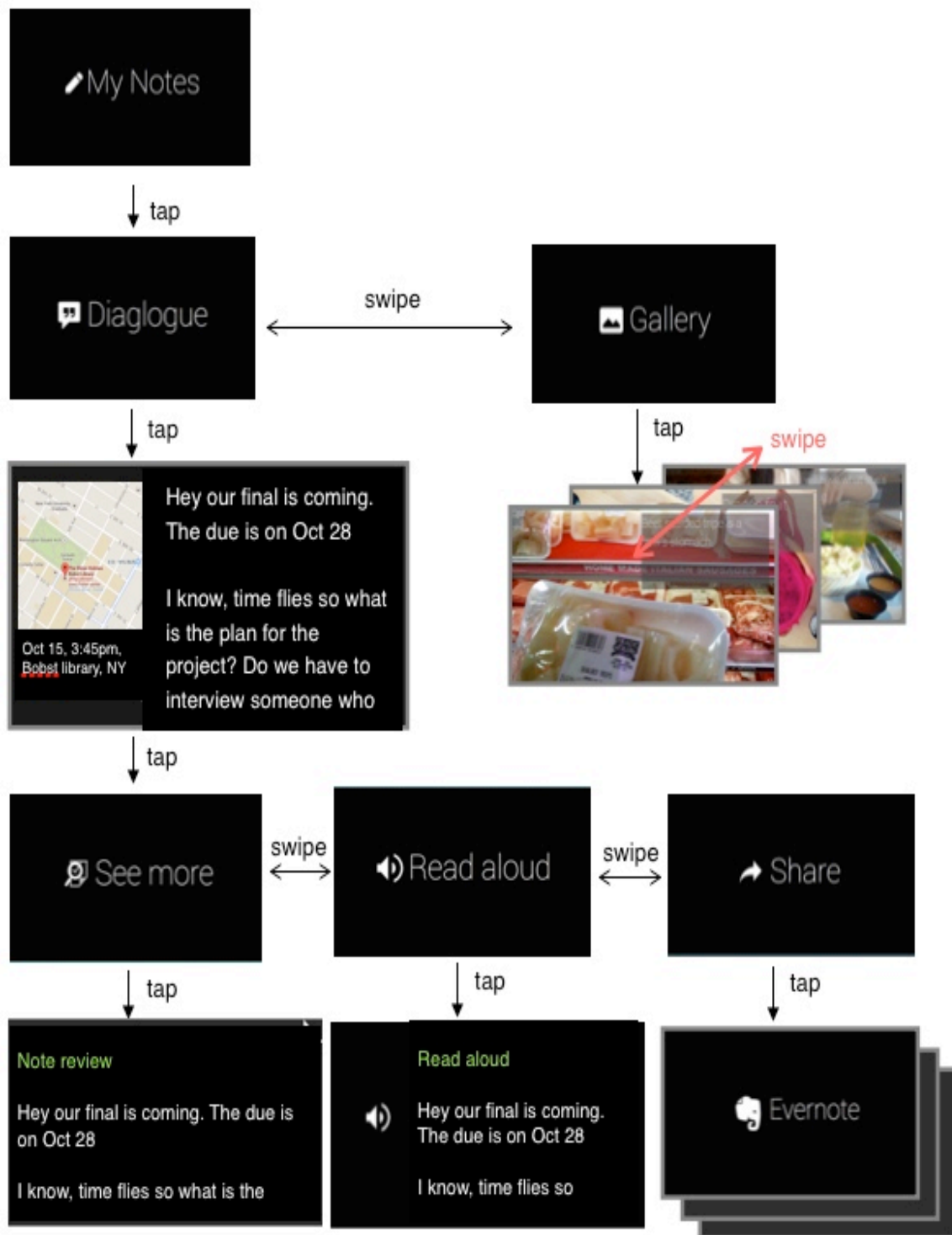
Figure. Flowchart of MyNotes: if there are more than two pages at the screen, learners can navigate the multiple pages by swiping forward and backward their touch pad. Refer to the figure to see the Dialogue pages in large
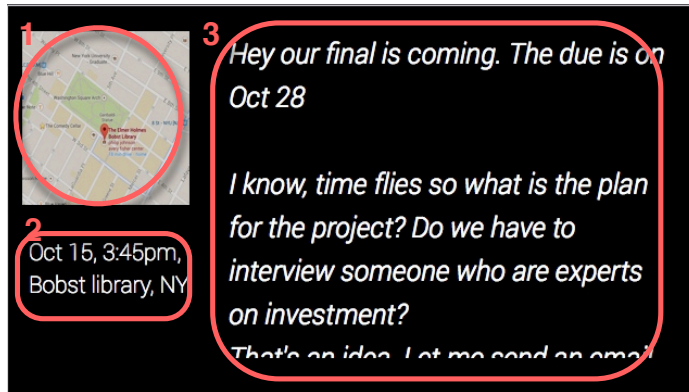
Figure. Layout of Dialogue, it provides information: 1.Location map, 2. Time of the dialogue was made, 3. Preview of the dialogue. These information will be automatically produced based on users' geographical and time information via Google Glass.

If learners want to see the entire dialogue in the Glass, they have to choose the See More menu. If they want to listen to the recorded dialogue, they can go to the Read Aloud menu. Learners can share their dialogues with Share. When learners are reviewing a dialogue that they no longer want, they can tap the touch pad and pull up the Delete menu.

The second menu of MyNotes is Gallery: a photo album. Learners can review pictures taken by using Wink (explained later), and navigate the photo gallery by swiping. When learners do not want to keep a picture, they can delete it. By tapping their touch pad, they can pull up the Delete menu.

C. *Vocab*

Vocab manages and customizes vocabulary in Outro. Vocab has three submenus (see figure).

Figure. Flowchart of the Vocab: Two-finger-tap control can be used to go to the next step on word selection page. This is applied into the Highlight in the same fashion. On the upper right hand, the highlighted words are seen in colored texts as they are set on the word selection page. Refer to the figures to see the pages in large.

The Add menu adds new words by pronouncing the target words and putting their definitions of L2 expressions in the device (see figure).
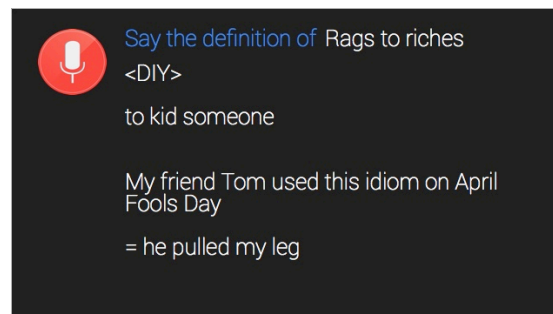

Figure. Add page. The voice recognition is turning on and it makes a DIY definition of "rags to riches" (voice-to-text transcription).
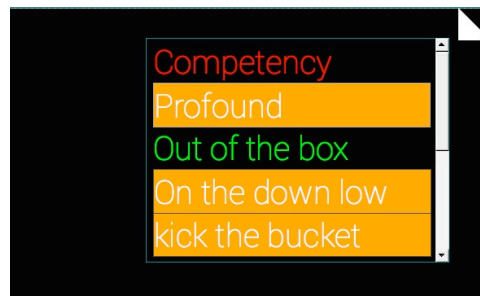

Figure. Word selection page, highlighted words are colored as they set. If there are more than five words in a page, scroll bar will be appeared on the eight, and if there are more than ten words, it will make additional page. Learners can navigate the pages by swiping forward and backward

There are three ways to add definitions. Do It Yourself (DIY) supports L2 learners can make their own descriptions of new expressions by speaking to the device, Dictionary draws definitions from online references, and Google translation adds definitions in the user's mother language.

The other submenu is Review Vocab to review, delete, and share the words saved in the Glass. Delete removes certain words from Glass, and Share adds vocabulary to websites like Evernote or Facebook. All of the Share menus in Outro have the same purpose. To review the words in the device, learners must select the

target words to be reviewed by tapping the touch pad. If there are more than five items on the word selection page, a scroll bar will appear on the right; if there are more than ten items, new pages will be added. Learners can navigate the pages by swiping the touch pad forward or backward, or by nodding (Google supports head-direction-based control). After selecting the target words, learners have to tap with two fingers to go to the next step. At this stage, learners can choose among See More, Delete, and Share. If they select See More, they can see the full definitions of the words.

Highlight adds color cueing to Vocabulary. L2 learners can assign different colors, for instance, for difficult or especially relevant words.

D. Wink: A feature to take a photo with an eye gesture command

Wink allows learners to take a photo by a gesture command. This feature is set as a super (override) class, which means that wherever learners are in the application, they can use this feature to take a photo and then use Captioning (see figure).
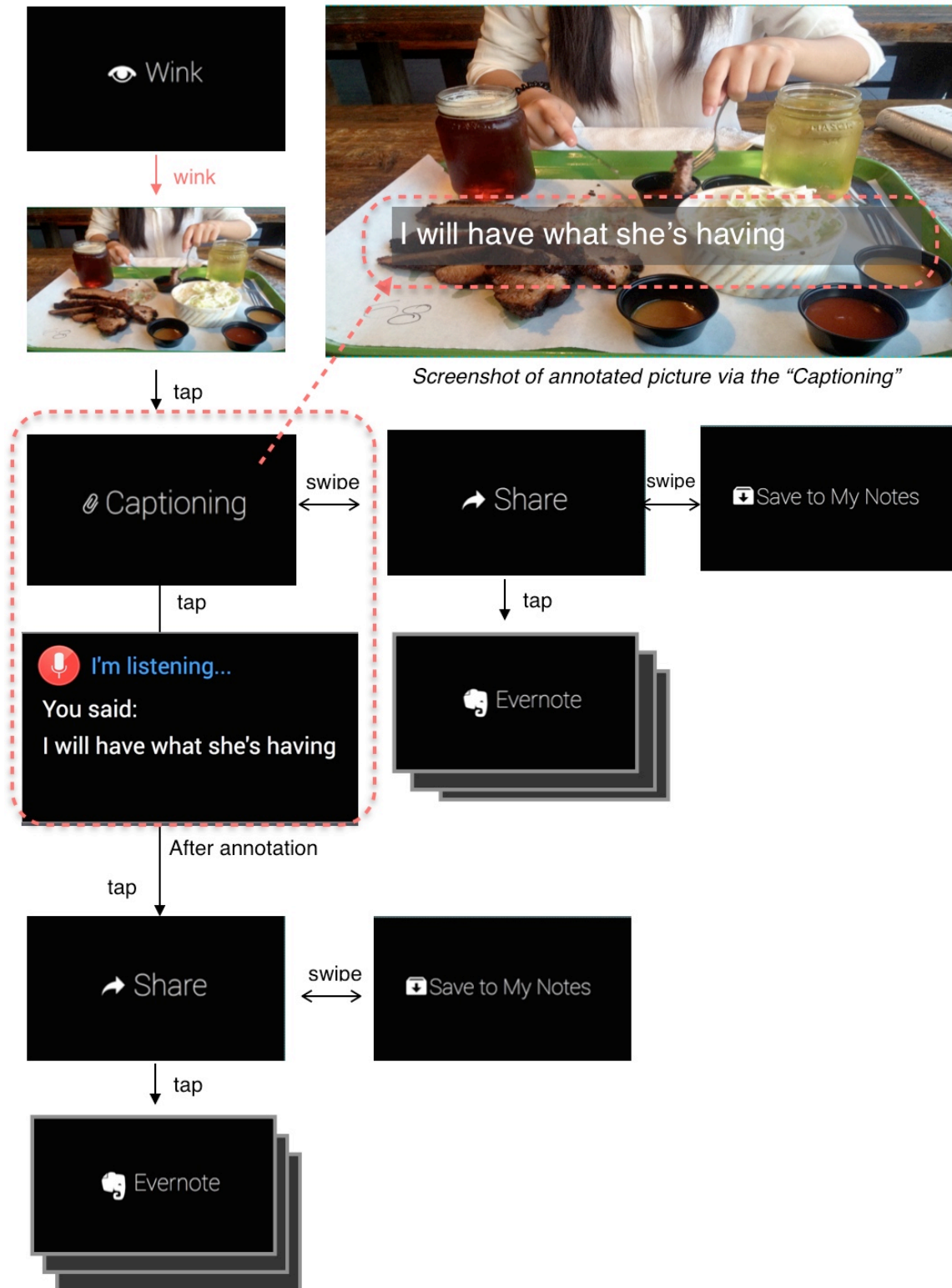
Screenshot of annotated picture via the "Captioning"

Figure. Flowchart of Wink: if users choose a Captioning feature, they can add comments in pictures, then they can share or save it.

Using Captioning activates Google Glass's voice recognition feature. They can speak

out the sentences to add them to the picture. The picture can then be shared via the

Share feature and saved into the MyNotes. If they do not want to add captioning,

learners can choose a Share or Save to MyNote. Learners may also use Wink to make

a photo flashcard of the new vocabulary word.

E. Interconnection of features in *Outro*

Some features in Outro work in tandem. One example is the use of ShowMe

with MyNotes. After real-time captioning, if learners save a dialogue, it will be sent to
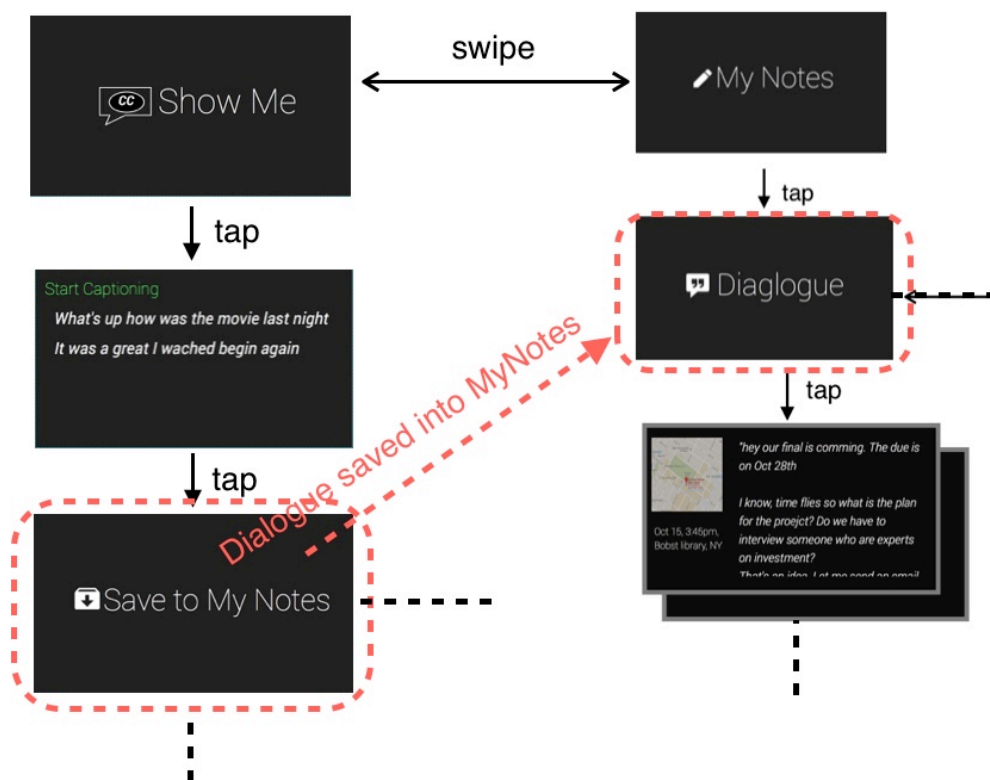
Dialogue of MyNotes (see figure).

Figure. This flowchart shows where dialogues made by ShowMe will be saved: it will be saved into Dialogue of MyNotes

The second example is the combination of ShowMe, Wink, and Vignette to make annotated pictures. Once learners make comments through real-time captioning, they can take a picture with Wink and use Vignette to combine the text with the picture (see figure).
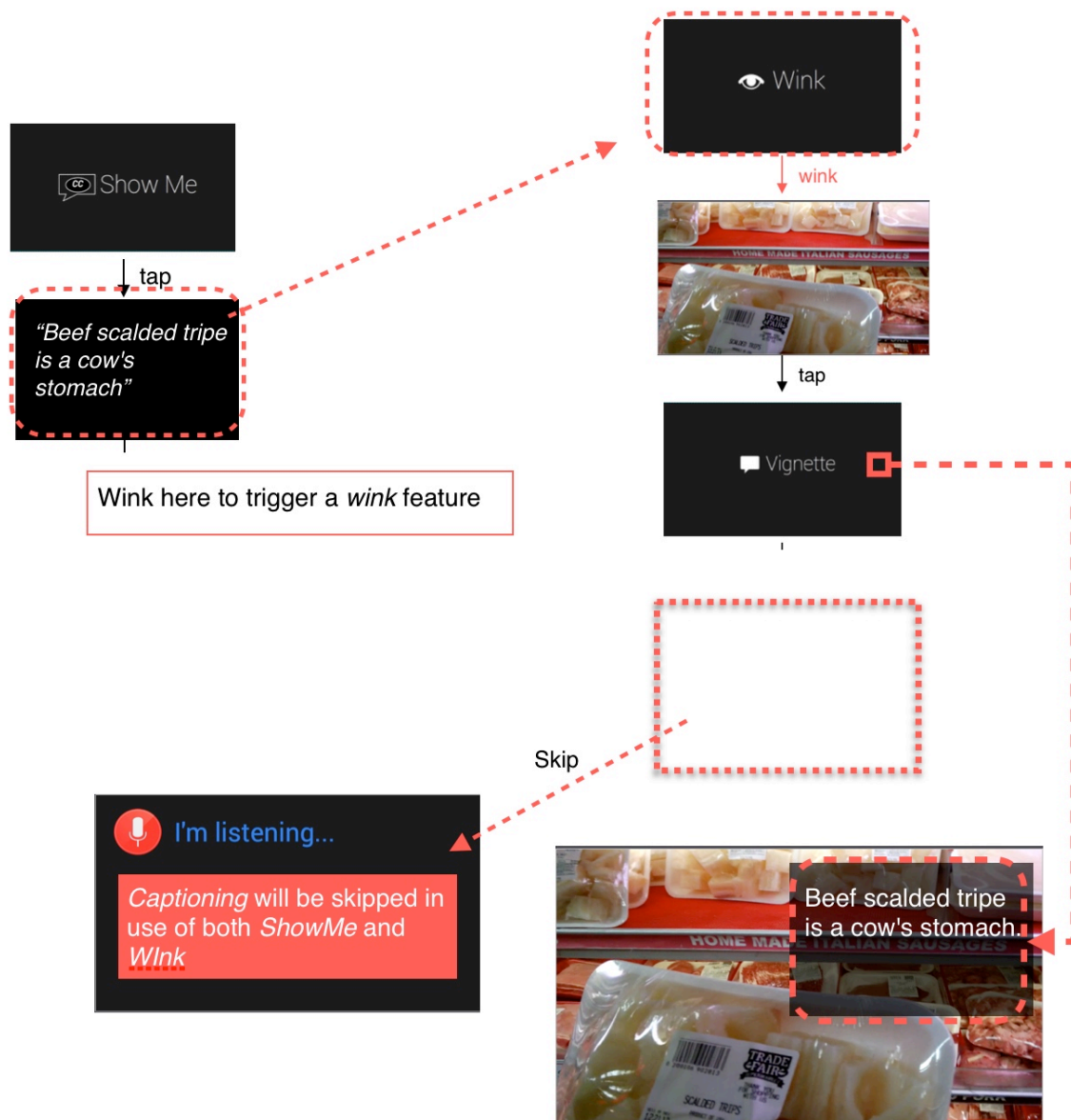

Figure. This flowchart shows how to make annotated pictures by using ShowMe and Wink features. First, learners finish captioning on ShowMe, and then wink to take a picture, then choose vignette to combine the text and picture. Learners do not need to use Captioning here since they used ShowMe to make a note already for the picture

The picture taken by Wink can be saved into Gallery of MyNotes. Learners can study and review their photos either online or offline (see figure).
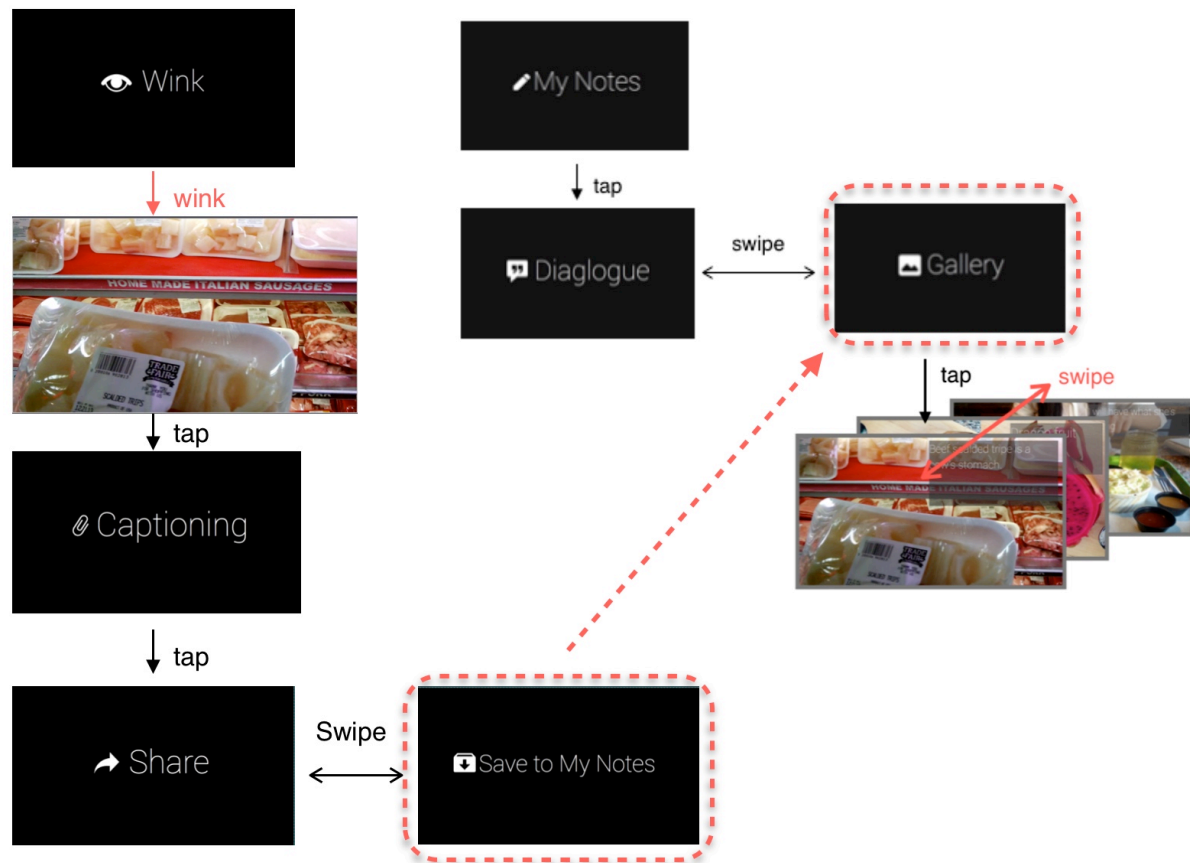
Figure. This flow shows where the (annotated) pictures will be saved: annotated pictures will be saved into Gallery of MyNotes

Add in Vocab and real-time captioning is similarly correlated. Specifically, users can use words in Vocab as a database of definitions of the target words with real-time captioning. Users can manage the Vocab library without mixing it up with dialogues. The Vocab menu is separated from MyNotes since dialogues in MyNotes is literally recorded text to be reviewed later. To get definitions of target words in real time captioning, vocabulary has to be added into Vocab (see figure).

Show Me

Hi I want to go to Starbucks now do you want to go

Hi I want to go to Starbucks now do you want to go

When there is NO target word in vocabulary database on Google Glass, no extra information will come up

Vocab

tap

Review vocab ←swipe→ + Add

Starbucks

Definition:
Starbucks is a big coffee chain

New word with definition is added into vocabulary database, via Vocab feature.

hi I want to go to Starbucks now do you want to go

starbucks is a big coffee chain

After the target word is added into the vocabulary database, the information about the word will be displayed on the screen during real-time captioning
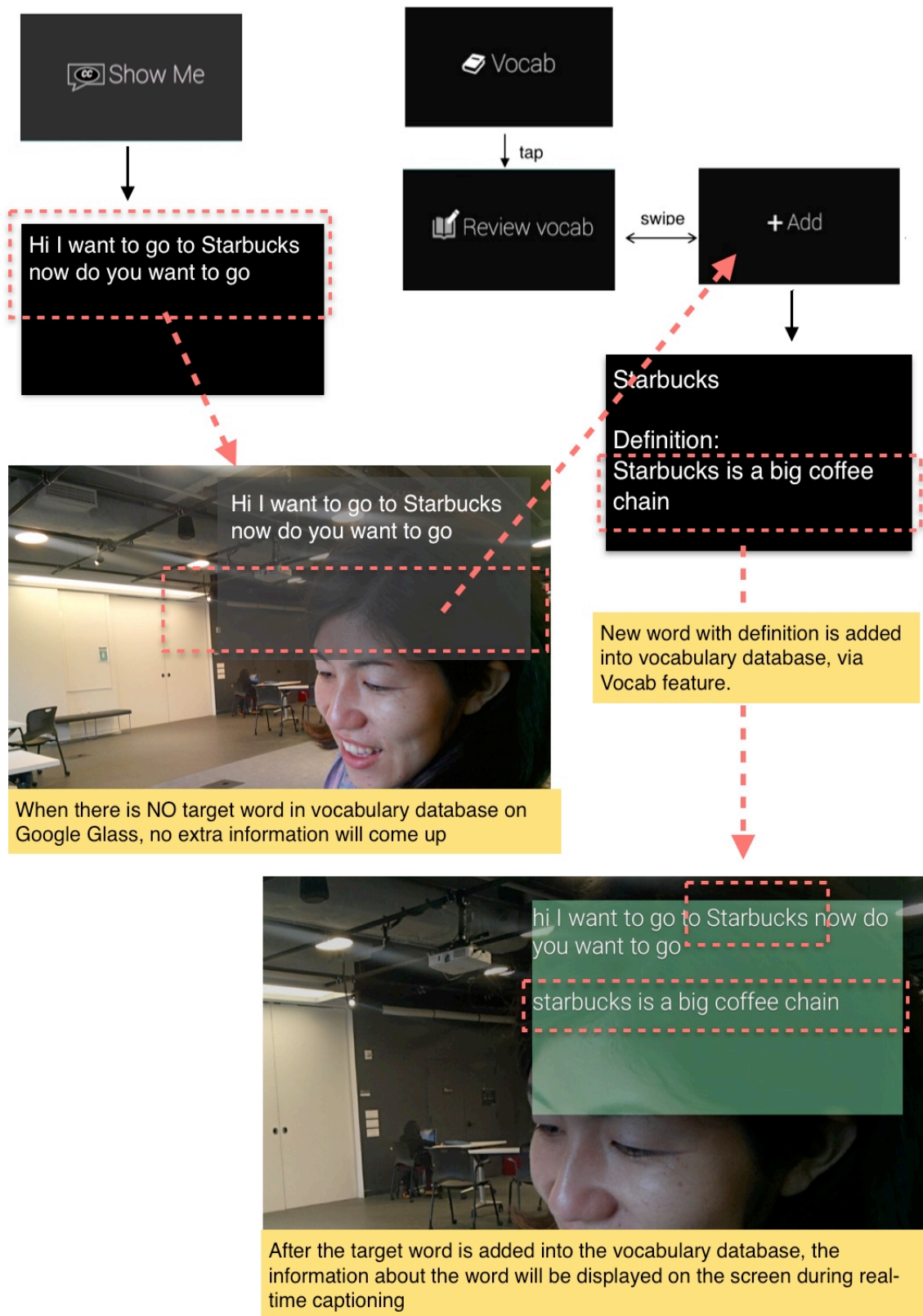
Figure. This flow shows how users can have extra information of their target words in real time captioning

F. Collaboration of Evernote and Outro

Outro can integrate with other applications, like Evernote so that students can edit their vocabulary and manage data on their desktops. On the left side of the Evernote window is a list of notes made and shared via Google Glass. Learners can review or edit their notes with the editing window on the right. They can change fonts or colors. The edited texts can be saved to their computers or Google Glass and users can organize their notes in their notebooks on Evernote. In order to use these features, users need Evernote on Google Glass and their other devices (see figure).
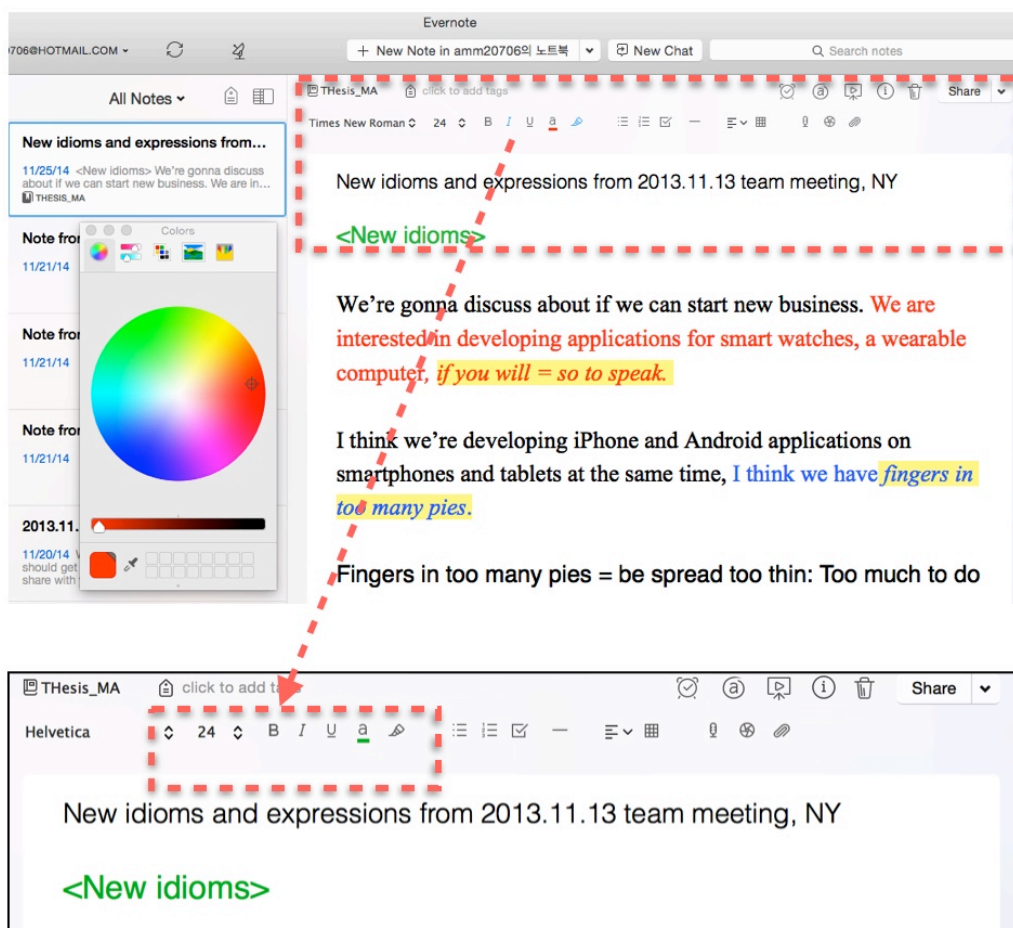

Figure. On the top, the screenshot of a dialogue on Evernote with an editing tool. Learners can change text style, such as color, size, and highlight.

With Evernote for desktop, learners can save time editing or organizing their vocabulary notes. Although Outro provides an editing tool that users can use without a wireless Internet connection, it will take longer to edit a lot of new words without a full-size keyboard. Evernote also gives users wider selection of options in text editing, for instance, text size, color, and align. By using Evernote for desktop, learners can eliminate technical limitation in Google Glass, such as the limited (13 GB) storage. Learners can back up their files to their desktop computer. The most recent version of Evernote, version 6.0, provides a picture-editing tool (see figure).
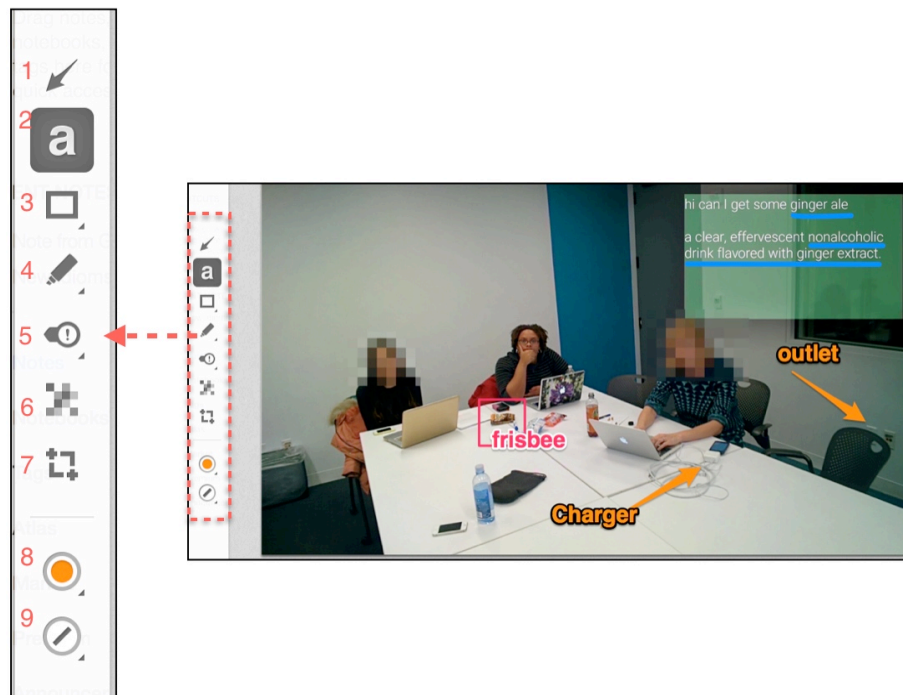

Figure. On the left of the window, there is an editing tool. From the top, 1.add arrows, 2. text box, 3. shapes, 4.highlighter, 5. stamps, 6.pixelate images, 7. crow images, 8. color, 9. change line size
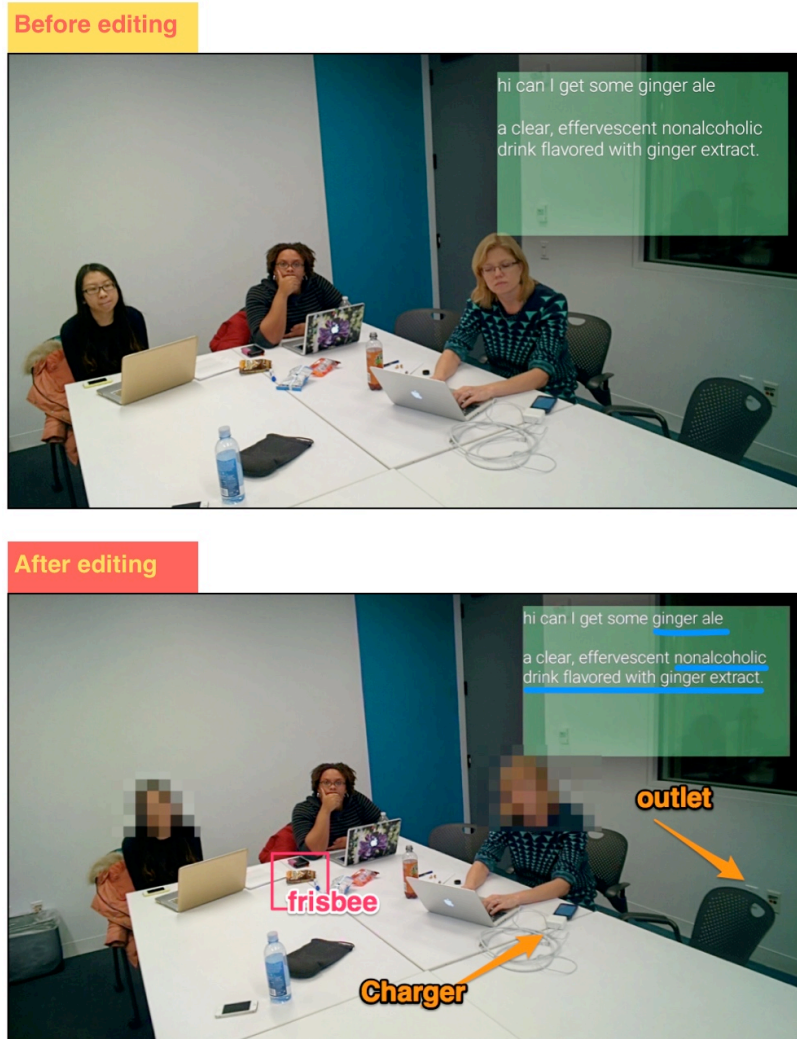
Figure. The screenshot on the top is a picture before edited. The screenshot on the bottom is one after edited: highlighted some words on the upper right hand, arrows, text boxes, shapes, are added to the image. To avoid privacy issue, faces of the people are pixelated by the tool.

3.5. User scenario and persona

In this section, two user personas will be introduced as examples of how end users may use Outro at work. Tae-Yang Lee is an engineer in California, and Amy Zhou is a chef at a Chinese restaurant in New York. These personas are created to typify two target users, and to put developers and designers into their shoes. Their occupation and education are based on demographics of our target audience: Korean and Chinese students or workers in the United States. "Personas are archetypes built

to identify our real users' profiles, needs, wants and expectations in order to design

the right experience for them" (Jenkinson, 1994).

Scenario A

Tae-Yang Lee

"I realized that communication skill is gold at workplace"

Digital device usage

- Desktop 24%
- Smartphone 41%
- Tablet 6%
- Laptop 29%

Averages, of the group aged 25 - 35 in the U.S. (male & female)
Tae-Yang Lee

	Averages	Tae-Yang Lee
Technology skills	70	90
Language skills	65	70
Weekly leisure time	55	45

Goals

- Learning business English: idiomatic expressions, and phrasal verbs
- To be promoted to junior manager

Profile	Data	Features
Age	31	
Nationality	Korean	
Occupation	Engineer (2nd year)	IT company
Residence	Santa Clara,	Driving / Business trips (every quarter)
Education	B.S.: computer science (in Korea) M.S.: Data science (in US)	
Skills	Bilingual	English (advance) Korean(native)
Interests	Film, Shopping, Travel	

Lifestyle

TaeYang is a Korean engineer at a tech company in the States. Although he is an advance English speaker, he often cannot understand what natives colleagues say at work. Depending on topics, he may understand only from 50 to 70 percent in conversations. He has some difficulty in learning idioms and phrasal verbs with limited cultural experience in the States. This causes him have a challenge following up team meetings, especially, when people speak fast. He strongly feels that he has to enhance communication skills at work. This will contribute him to be promoted at the company as ell. But he does not enough time for language learning like he was at school.

Lee is having trouble learning American idiomatic and colloquial expressions due to his limited cultural experience in the States. He is eager to improve his English for enhanced communication at work. He starts with a mobile app that defines common idioms and expressions for ESL students. However, there is a problem in learning idioms with a smartphone app. Since there are thousands of idioms in his references, he does not know where to start. Even if he could memorize all of those idioms, he may never use most of them. He believes that it would be a waste of time to learn idioms or expressions that are unrelated to his job. He needs customized and personalized content and so he turns to *Outro* for Google Glass.

Before attending a meeting at work, he turns on the device and launches the application. The application starts voice dictation what he and everyone else in the meeting are saying in a text form on the display on the Glass in real time. Lee can look at the display to read what his colleagues are saying.

With the device, Lee is able to understand of most of the items at the meeting. In the middle of the meeting, however, his manager says, "We're gonna discuss about if we can start new business. We are interested in developing applications for smart watches, a wearable computer*, if you will.*" His colleague, Tom, responds, "I think we have *fingers in too many pies*. We have limited resources, so we should focus." Although Lee can read what his colleagues are saying, he does not know what the idioms "if you will" and "fingers in too many pies" mean. Such expressions often make it difficult for him to communicate with his colleagues. Obviously, he cannot follow up the meeting after this, and he misses much of the significant information for work at the meeting (see figure).
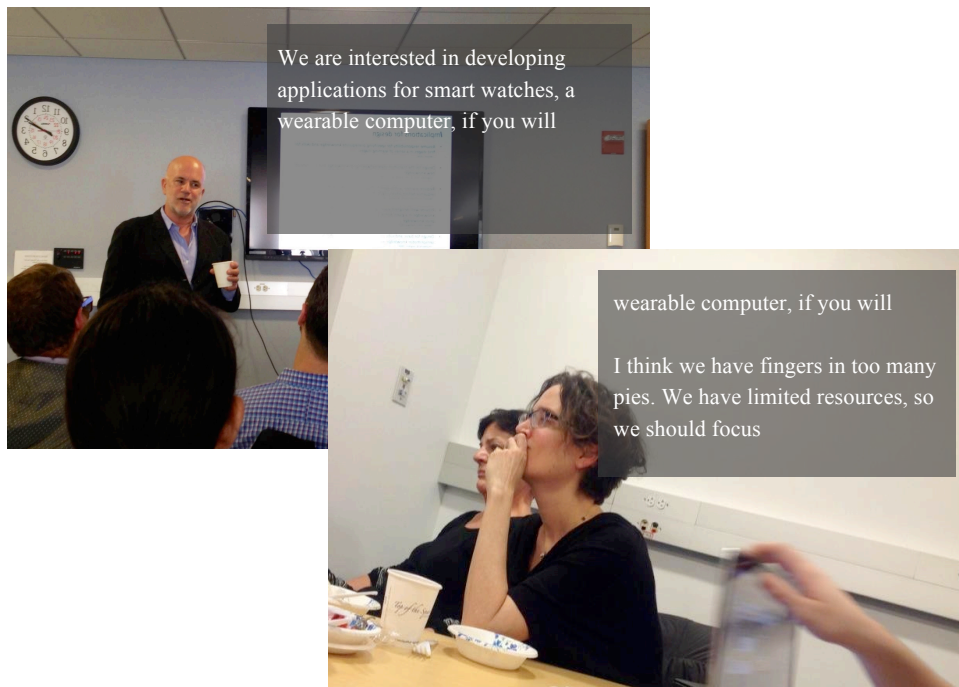
Figure. Lee is using real-time captioning feature, ShowMe, at the meeting

Lee is able to read the dialogue with Outro. Outro not only provides real time captioning, but also saves the dialogue with Save to My Notes. After the meeting, Lee just taps the touch pad on the right side of the Glass to stop and save the real-time captioning. Then, he swipes forward and backward to Share and sends it to Evernote (see figure).
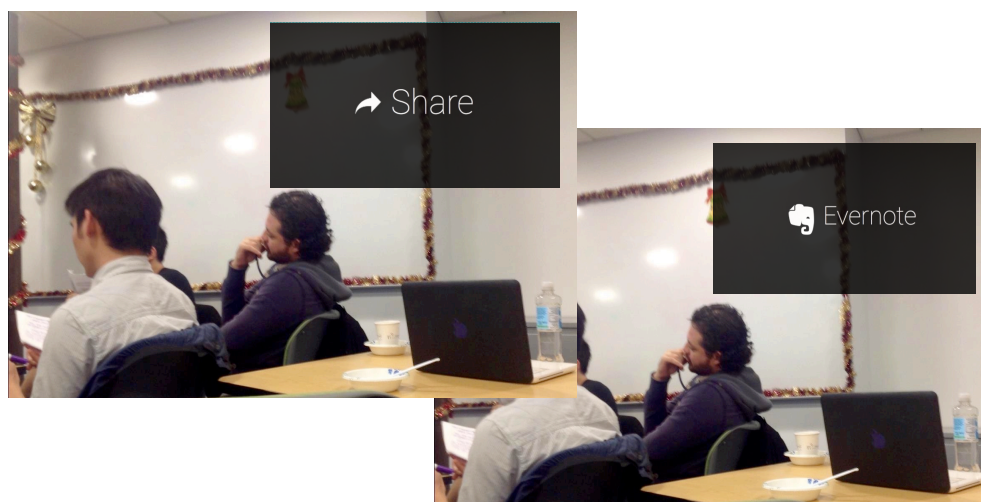

Figure. Lee saves the dialogue and sends it to his Evernote

When Lee returns to his desk, he uses a desktop computer to checks the note he just saved on Evernote (see figure).
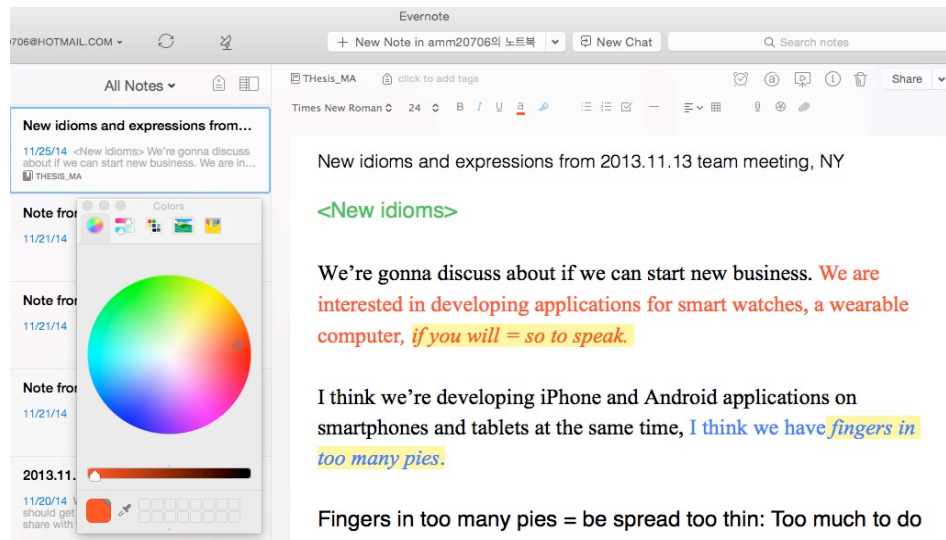

Figure. Lee reviews and edits his dialogue on Evernote by desktop

He can review the note and all items that he has to know for his work. In addition, he is able to find the parts he did not understand at the meeting, and look up online references or he can ask his native friends with the notes. Evernote provides an editing tool so that he can add, remove, save, and share his vocabulary and dialogues. He types, "Fingers in too many pies = be spread too thin: Too much to do." Additionally, he adds some relevant idioms and phrasal verbs to the new idioms, like antonym or synonym. He uses combination of diverse applications and features, especially when he wants to add a lot of words and change color, font, and size of texts. To apply these changes to his devices, he pushes the sync button on the left top corner of the Evernote window.

After work, he studies English at home for an hour. He wants to organize the new expressions by using Vocabulary. He goes to the Add submenu. He can add new

expressions to his device by saying them in English. The Glass shows how his voice

sounds in a text form on its screen based on his voice wave. Although this activity

takes longer, he can check his pronunciation for accuracy. Once he selects what words

to add into the Glass, he can add descriptions or definitions. He uses Google

translation to save the definitions of the selected words in his native Korean. He says

the phrase, "If you will," and it is translated into Korean, "말하자면." After

translating the new words he adds them to his device.

  The next day is rainy and Lee is driving to work. In the car, he wakes up his

Glass and uses voice control to select Review Vocab. He reviews his dialogues by

using the Read Aloud feature. He can drive while listening to them (see figure).

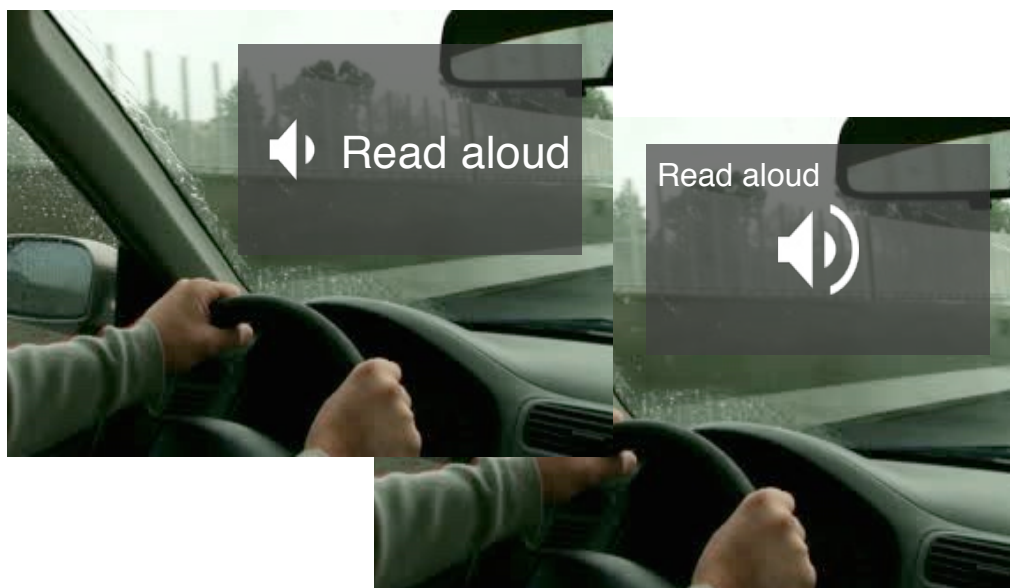*Figure. Read aloud feature supports listening to the dialogue, while he is driving.*

  After driving for 20 minutes, he arrives at company. He starts using the real

time captioning before going to the team meeting. At the meeting, his manager says,

"I agree with that we will *have fingers in too many pies* if we start new business for

Apple products. *By a show of hands*, how many of you want to only focus on the

projects we're working on? And how many of you go for a new project, wearable computing?" Lee can see the description on the screen of Glass "F*ingers in too many pies* = be *spread too thin: Too much to do,"* and "*By a show of hands"*, he can see its definition: "Raise your hand, 손들다." Since he had added descriptions of the expressions, if someone says one of them, he can see the definition on the screen. The text on the screen will follow the pace of speech, as a teleprompter does. With *Outro*, he acquires a better and relevant understanding of the conversation at the meetings (see figure).
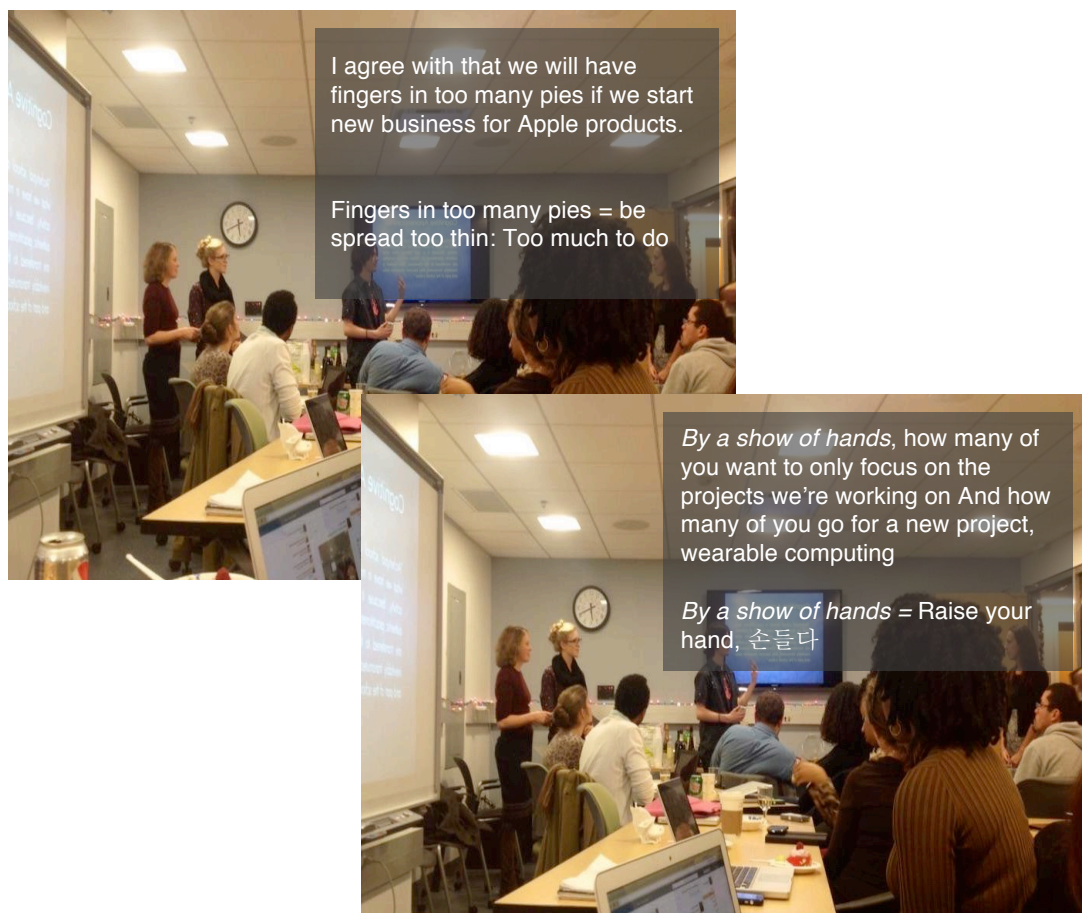

Figure. He can see the descriptions of idioms in Korean and English as well on the screen of the Glass in real time.
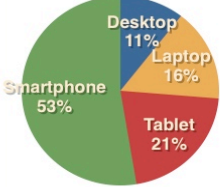
Scenario B

Amy Zhou

"Please teach me what Perrier and star anise are?"

Averages of the group aged 25 - 35 in the U.S. (male & female)
Amy Zhou

Digital device usage

Desktop 11%
Laptop 16%
Smartphone 53%
Tablet 21%

Technology skills	70 / 75
Language skills	65 / 70
Weekly leisure time	55 / 55

Goals

- Effectively leaning English: authentic words and language culture
- seamlessly communicate with colleges at working place

Profile	Data	Features
Age	26	
Nationality	Chinese	
Occupation	*Apprentice cook* (1st year)	
Residence	New York	
Education	B.A.: Culinary Arts (In China)	
Skills	Bilingual	English (advance) Chinese(native)
Interests	Photography, travel, games	

Lifestyle

Amy is a Chinese chef in the States, she lived in China for her whole life time before coming to New York four months ago. Even though she is good at English in general, she is not familiar with American brand and food names, which are not used in China. She wants to learn a lot of words and expressions related to her job as a chef and daily life. Most of ESL textbooks are to teach general or test-preparation words. She can learn what soda and coffee are, but she cannot learn what Ginger Ale and Americano are. She wants improve English skills for work and introduces her Chinese cuisines to more people in NewYork.

Most vocabulary books do not provide rich contexts with pictures, audio effects, and full dialogue, but simple definitions and a few sample sentences. Amy finds English difficult and confusing. She needs a way to organize and remember new vocabulary words. She uses Google Glass and *Outro.*

In the morning, she is in line at a coffee shop to get a cup of coffee and some cookies. There are so many more kinds of coffees and cookies than in China. She has never heard of most of them, and is nervous when she places an order. She is not confident speaking and listening in English yet. Before going to order, she turns on her Glass, and the real-time captioning feature. The barista asks, "What can I get you?" She is not able to understand the whole sentence because the barista speaks quickly. Amy sees the completed sentence on the display of the Glass.

"Can I have a cup of coffee?"

"What size?"

"Big."

"We don't have big. We have short, tall, Grande, Venti size."

She chooses a Venti size, and asks for a cookie.

"What kind of cookie do you want? We have oatmeal, pumpkin, chocolate giner cookie…"

Amy has no idea what any of this means. Although there are the labels and descriptions on the cookies, she does not have time to study them all and she does not want to hold up the line. She picks an oatmeal cookie and pays for her order. This is a daily frustration for her. However, she hopes that she can learn all those names and expressions with Outro. While waiting for her coffee, she taps the touch pad of the Glass to stop the captioning and save the dialogue.

Additionally, Amy uses Wink to take a photo of the menu and the labels on the cookies. Then, she chooses Vignette to add her own descriptions to the pictures. She annotates, "Oatmeal cookie, and a Venti size coffee." She saves the pictures into MyNotes. She can then make her own pictorial flash cards and authentic dialogues with rich context (see figure).
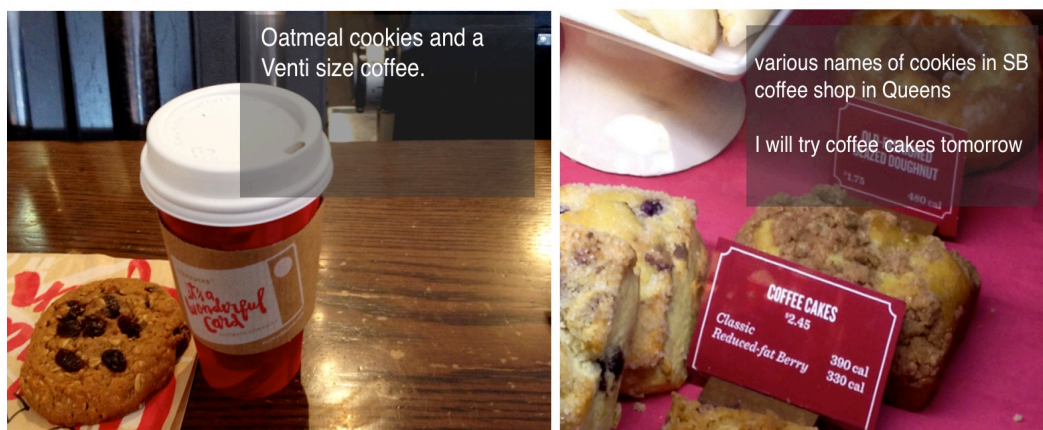

Figure. Pictures taken by Wink feature of the Glass

On the way going to work, she wants to share her pictures and dialogues on Facebook with friends in her English and Chinese language exchange communities. She uses Facebook as an online journal to learn and practice authentic English with friends (see figure).
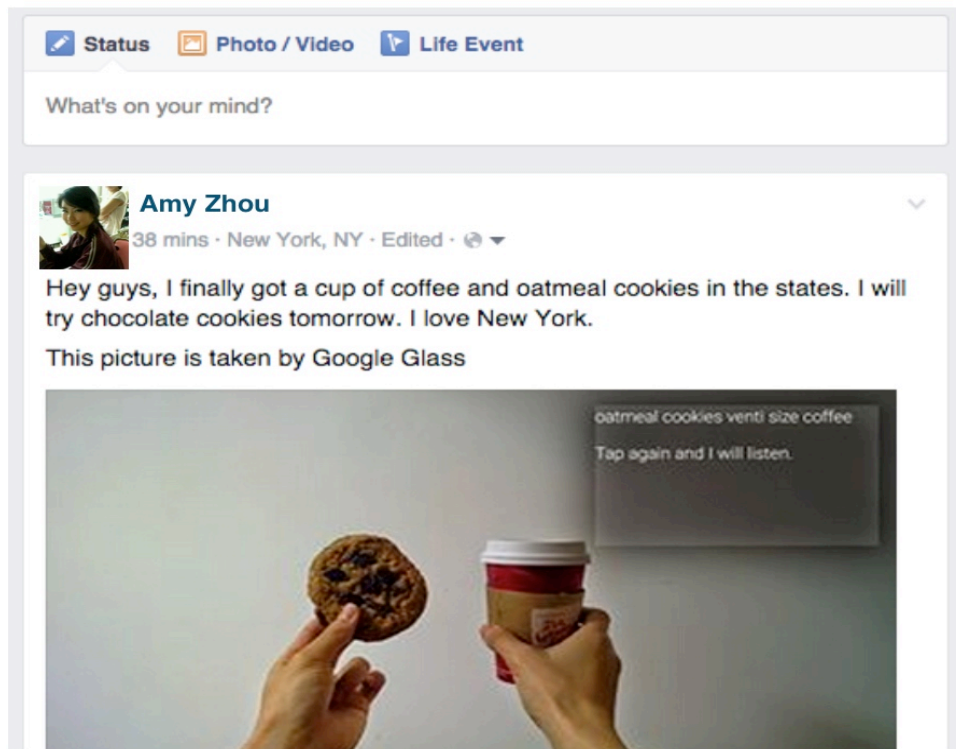
Figure. Picture taken by Wink and shared with selected friends on Facebook via her Glass

After she arrives at the restaurant where she works, she has to talk with other American chefs while cooking for the diners. However it is difficult for her to communicate with her American colleagues because the names of the ingredients in the States are different from the ones used in China. She has to learn the English names of the ingredients. Google Glass gesture and voice comments enable her to cook and learn English at the same time. She turns her device on and launches the real-time captioning. Whenever she finds an ingredient whose name she has to know in English, she uses Wink to take a photo of it and annotates it in English.

One day Jennifer asks Amy for some star anise. Amy does not know what star anise is, so she checks the word on the Glass screen and asks, "What is star anise?" Jennifer points at the spice and says, "We call this star anise." At the moment, Amy uses Wink to take a photo of it, adds "Star anise," and saves it into MyNotes (see figure).

Figure. Photo taken by Wink feature in the kitchen

Jennifer then needs Amy to help her make soup. "Amy, can you trim the bamboo shoots and Chicken over there?" Since Amy has already added the words to her vocabulary database, she can see the description of it in real time. Her Glass immediately provides the information in both English and Chinese, "Bamboo shoots 竹笋" (see figure).
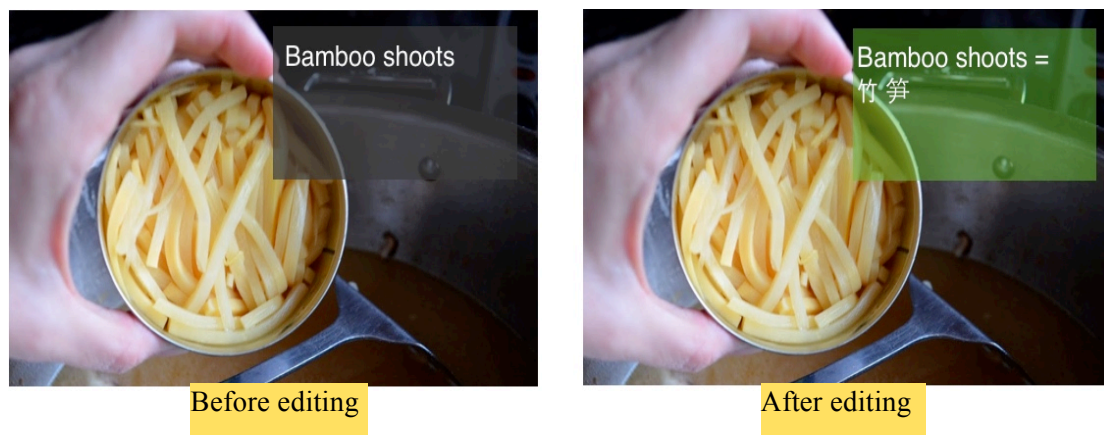
Figure. Before and after editing the pictures taken by the Wink: On the right, the picture edited and background color becomes green since she uses a highlight feature of Outro and she added the target word, Bamboo shoots with the definition. Amy can get extra information when she encounters the target words she added in real time captioning like the picture.

Amy answers, "I am working on it!" She is getting more comfortable speaking English with the aid of Outro. She does not have to go to ESL classes, since she can learn English by using it.

4. Theoretical Framework

Outro for Google Glass is built on four theoretical foundations: language acquisition, multimedia, mobile-assisted learning, and cognitive load theories. Chappelle's model will be introduced to explain language acquisition. Plass's integrated model based on the cognitive theory of multimedia learning (CTML) will be discussed. The model will illustrate how using multimedia resources can improve effectiveness and efficiency in second-language acquisition. Then, mobile-assisted language learning theory will be applied to the integrated model. Mobile technology will improve authentic language learning by increasing access to online resources. Lastly, cognitive load theories will explain how Outro design can minimize cognitive load on learners so that they can use cognitive resources on comprehension and integration with prior and new knowledge.

Each section will consist of two parts. The first part explains the theories. The second part describes how and why the theories are applied to Outro to enhance second-language acquisition.

4.1. Chappelle's Model of Interaction Hypothesis

According to Chappelle's hypothesis (Long & Gass, 1997), the crucial functions of language acquisition are comprehensible input, interaction (Long, 1985), and comprehensible output (Swain, 1985; Swain & Lapkin, 1995). Based on the components of second-language acquisition (see figure), *input* is noticed (*apperception*), comprehended and transformed into *intake* so that it can be integrated into inter-language and made available for production (*output*).
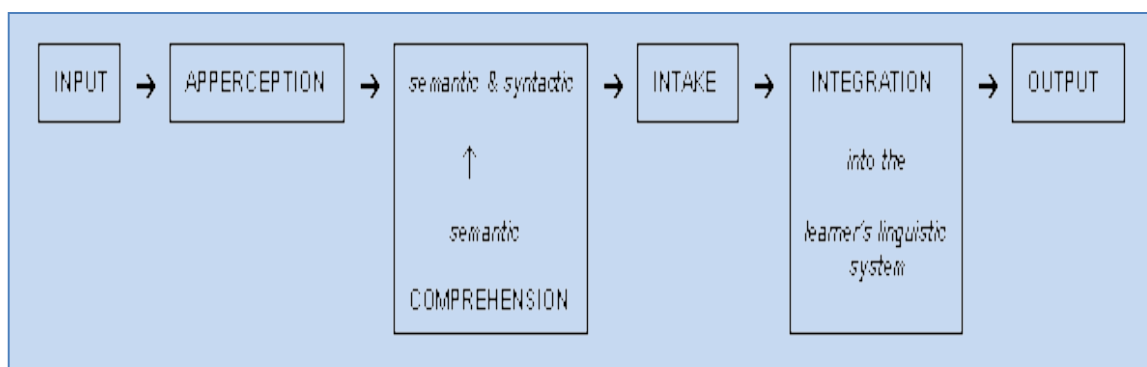
Figure. Chappelle's model describes language acquisition process

In the figure, *input* is the first step. This is where learners notice new information that they may need to learn before proceeding to comprehension.

The next stage, *comprehension*, represents the hypothesis that "understanding of the semantic content of a message can be accomplished either with or without any comprehension of the syntax" (Long, 1996, p. 23). Semantic comprehension is not enough to acquire the target language since leaners have to accomplish a syntactic system with lexical items and interpretation of non-linguistic information (Long, 1996). Long (1996) explains, "When comprehension takes place through a combination of semantic and syntactic processing, the linguistic characteristics of the input can become *intake*, that is, comprehended language that holds the potential for developing the learners' linguistic system" (Long, 1996, p. 23).

Integration consists of the processes for using or holding the intake in short-term memory. This will influence the development of the linguistic system and affects the L2 *output* that the learner produces (Long, 1996).

The *output* is "an observable result of the process" (Long, 1996, p. 23). Output contributes to linguistic development in two ways. First, since students are forced to use their syntactic ability in the target language to make outputs, such as building

sentences in speaking and writing. Second, by making outputs, learners can monitor the output results, which can indicate what mistakes they are making with the target language. This will stimulate learners to correct their errors and make more efforts to improve their inputs to produce better outputs in L2 development (Long, 1996).

Referring to Chappelle's hypotheses, one of the focal points of Outro design is to alert language learners. The application prompts learners to notice important aspects and information of their target languages with rich linguistic and non-linguistic information. For instance, ShowMe's real-time captioning aids learners to see the definitions of target words in both L1 and L2 and in different colors at the place and time they may use. In addition, the application encourages learners to monitor and review their work. Chappelle insists that learners can enhance L2 acquisition by correcting themselves and checking their progress. Outro's Save feature allows learners to save and review their dialogues with pictorial and verbal information via Google Glass. By noticing and monitoring, learners are shown what they still do not know in L2. The hypothesis is that these features and activities may stimulate learners' desire to improve their second-language skills, and to continue learning.

4.2. Multimedia Learning Theory in Second Language Acquisition

Chappelle's model explains the essential elements and processes of language acquisition. Plass's integrated model (2005) illustrates a way of second-language acquisition with multimedia support. This model explains how multimedia resources can accelerate second-language acquisition, and he incorporates elements of second-language acquisition with elements of the cognitive theory of multimedia learning (see figure). In his model, the multimedia resources will enhance comprehensible

input, facilitate meaningful interaction, and elicit comprehensible output (Plass, 2005).
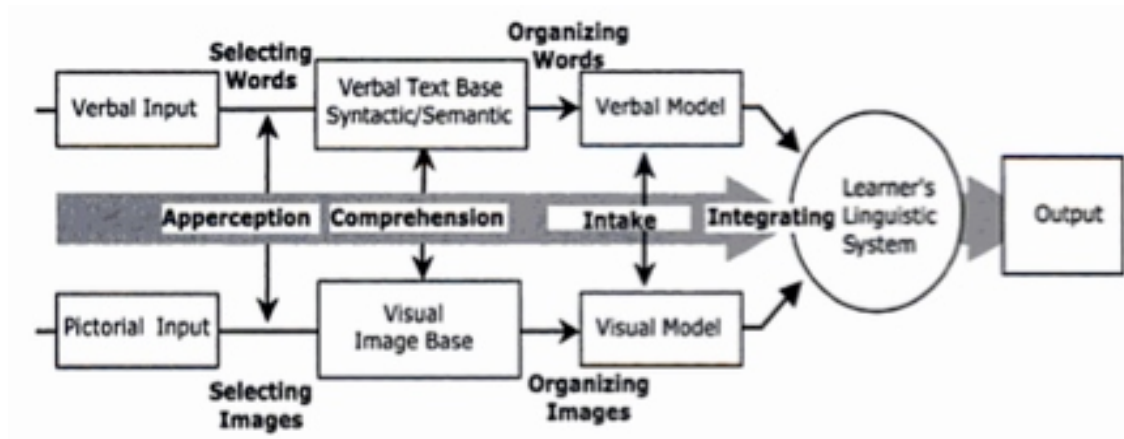
Figure. Plass's integrated multimedia learning into Chappelle's model for second language acquisition ("Multimedia learning in second language acquisition," p.471)

In the figure, learners direct their attention to the relevant linguistic and nonlinguistic information they receive. In Chappelle's model, this process is described as *apperception*, and the process of target language is *noticing* (Schmidt, 1990). In this stage, video and audio aids can enhance the input and increase noticing to facilitate the acquisition of L2.

Once visual and verbal materials have been selected (comprehension stage), it needs to be depicted as a visual or verbal mental representation. In second-language acquisition, these processes focus on understanding the semantic content of the input, forming a verbal model that may include syntactic information, and developing a pictorial model that includes linguistic and nonlinguistic pictorial information. In this stage, rich interactions with material are essential to help students construct meaning (Faerch & Kaspar, 1986).

In the *intake* and *integration* stages, verbal and pictorial mental representations must be integrated. This process of integration involves the development of the linguistic system based on the intake, which, in multimedia learning, consists of verbal and pictorial components (Chapelle, 1998). Multimedia-based approaches that support the integration of newly acquired information with prior knowledge include the use of advanced organizers (Ausubel, 1968).

Lastly, understanding the input is not enough, but learners also need to produce comprehensible output, such as conversational exchanges (Swain, 1985). In this phase, external feedback brought learners' attention to linguistic problems, and being alerted to this problem will push learners to modify their output (Swain and Lapkin, 1995). Noticing the gap leads them to produce modified output and to integrate their new knowledge into their current knowledge. Thus, meaningful interaction with output can enhance second-language acquisition. Many researchers have found that it is important to help students modify their output because it allows for corrective feedback that encourages self-correction, which then leads to more precise output rather than just simple comprehension (Lyster & Ranta, 1997; Pica, 1988, 1994; Swain, 1997; Van de Branden, 1997).

In terms of comprehensible outputs, multimedia can be used to facilitate communication, and to act as a communication partner (Chapelle, 1998) by helping students see their errors, correct them, and engage in a conversation (Plass, 2005). Students may use video, online communication, Web-based authentic materials in the target language, and speech recognition to elicit meaningful output in language acquisition (Bernstein, Najimi, & Ehsami, 1999; Chun, 2001, Herron, Dubreil, Cole, & Corrie, 2000; Lee, 1998; Nelson, & Oliver, 1999).

By taking Plass's hypotheses into consideration, we can enhance second-language acquisition by using multimedia. Students learn better from words and pictures than from words alone (Fletcher & Tobias, 2011; Mayer, 2005). Wink can provide learners with visual information of the target words. In addition, learners can use Evernote to edit their vocabulary and dialogues and change the colors, font, and size of text presented on the display of the Glass. This gives learners control of their learning materials and the pace of their language learning. Not only Plass, but also other researchers have demonstrated that learner control over pace, content, or representation in a multimedia environment can have beneficial effects (Mayer & Chandler, 2001; Schwan & Riempp 2004; see also Scheiter, 2013, chapter 21).

4.3. Mobile-Assisted Language Learning

Definition of mobile-assisted language learning

Mobile learning was traditionally defined as learning with the use of mobile devices. Winters (2006) has re-conceptualized the definition: learning is mediated through mobile technologies, which are in themselves interwoven with other learning tools. A more recent definition of mobile learning is learning anytime and anywhere by emphasizing connectivity, social activity, and a learner-centered approach (Petersen et al., 2012).

Benefits of using mobile technology for second-language acquisition

Integrating multimedia learning into Chapelle's model can improve L2 acquisition by offering a variety of rich input, interaction, and feedback (Plass, 2005). Yet, the integrated model is created to support in-classroom settings. "Even though in-classroom learning is essential to language acquisition, the rage of discourse that the students can be exposed to in a classroom is quite limited, no matter how natural we make it" (Krashen, 1982, page 59). He emphasized that the goal of ESL classes is

not to substitute for the outside world, but to bring students to the point where they can begin to use the outside world for further acquisition. Therefore, L2 learners are supposed to explore and interact with people in diverse places and situations where they use their second languages. By doing so, L2 learners can be fluent and confident in their target languages.

Along with mobile technology, students can enhance learning continuity and reduce the limitation of in-classroom settings. This means that language learners can continue studying out of school via improved accessibility to a wide range of resources online (Stockwell, 2013). Students may ask questions by sharing messages and image files on social networking sites or websites for language learning, and they can receive immediate feedback from multiple resources about their topics via mobile devices (Arthur, 2006; Bernstein et al. 2011; Bumgarner, 2007; Junco, 2011; Schwartz, 2009). The immediacy will reduce the waiting time for their feedback and language learning can be attractive to students (Arthur, 2006; Bumgarner, 2007; Junco, 2011). Furthermore, multiple perspectives and interactions can be key factors to expand their lexicon and authentic knowledge in L2. With mobile learning environments, it is possible for L2 learners to have "on-demand' and 'in-time' learning (Clark, 2010).

With the assistance of mobile devices, L2 learners can have improved learning continuity (Stockwell, 2013). Even when learners are at team meetings, in restaurants, and in parks, they can continue learning with context. Particularly, using real-time captioning of Outro can promote face-to-face conversations for L2 acquisition by giving better accessibility to references online. This may stimulate L2 learners to interact more with native speakers, thus enabling learners to acquire second languages (Swain, 1985). Moreover with mobile technology, learners can make authentic

dialogues made by real-time captioning of the application and study with customized and personalized learning materials. This is a better way for learning authentic language than the use of textbooks, because if learning materials are related to learners' personal goals, they can increase motivation, and sustain attention (Driscoll, 2005; Mayer, 2001). L2 learners also can use a Share feature via Google glass to engage in collaborative online learning. These activities can help L2 learners to learn and practice authentic language (Jonassen, Lee, Yang, & Laffey, 2005).

Based on the theories of language acquisition, multimedia and mobile assisted learning, Outro can be an effective cognitive tool for second-language acquisition, since it supports improved and greater noticing, diverse and appropriate visual and audio media, control over learning, and rich interactions and immediate feedback.

4.4. Cognitive Load Theories and Principles

Outro uses cognitive load theories and principles to provide information to students. We have to take two main theories into consideration here: redundancy and schematic learning.

The redundancy effect occurs when one source allows understanding and learning while the other merely reiterates that information in a different form (Chandler & Sweller, 1991). To reduce the required cognitive resources and keep this load within the learner's cognitive capacity, the chain of instructional sub-goals and corresponding sequence of learning tasks could be defined in smaller step-size with manageable load within each step. The amount of information presented at any one time must be managed to avoid overloading working memory (Sweller, 1999). Working memory is the ability we have to "hold in mind and mentally manipulate information over short periods of time" (Alloway, 2014). Working memory is often thought of as a mental workspace that we can use to store important information in

the course of our mental activities. It is a particularly important consideration in a situation of real time conversation, since it requires the user to perform specific interactive behaviors, each of which may demand significant cognitive resources (Domagk, Schwartz, & Plass, 2010).

Since using real-time captioning of Outro in conversations could cause redundancy effect and cognitive overload, it is designed to display less text, but more graphic information. Color cues and annotated pictures can reduce cognitive load (Mayer, 2009). The user interfaces of the application display small chunks of information in several steps, instead of pouring all information at once onto a single page.

In addition, it is important to build new knowledge gradually on top of existing schemas or to teach appropriate schematic frameworks by linking them to something that the students already know (Driscoll, 2005). Learners have a longer retention span for new information, for instance, vocabulary and expressions in L2, by integrating their prior and new knowledge (Driscoll, 2005).

Outro frequently gives learners opportunities to review and practice their target words. For instance, the captioning feature provides information about target words that have been added to Google Glass with the Add menu. When learners see the target words, they also see their definitions. The target words are presented to the learners more frequently. The repetition of target words in L2 is an essential part of language acquisition and of longer retention (Driscoll, 2005). The Do It Yourself feature asks learners to create their own descriptions of target words to build their own vocabulary library in the Glass, and they have to use their L1 skills in translation. When learners are encouraged to generate self-explanations during learning, they will

take more ownership of that learning. Therefore, they will put more sustained effort into learning with ownership in learning (Driscoll, 2005; Roy & Chi, 2005).

5. Evaluation

In order to evaluate and improve upon Outro, interviews and beta test were conducted with a group of designers, engineers, teachers, and ESL students. They offered feedback on Outro's strengths and weaknesses, in addition to the potentiality of using wearable computers for second-language acquisition.

The first group of people to evaluate Outro were graduate students in the master's program in Digital Media Design for Learning at New York University: Ruth Sherman, Hildur Rudolfsdóttir, Michiyo Oda, and Zhou Hua. Ruth was an ESL teacher in Mexico. Michiyo was a furniture designer. Hildur was a sociology teacher in Iceland. Zhou studied media design in China. All of them used Google Glass and an Outro prototype. They used the application in real conversations. After using the application, they shared their opinions in verbal and written forms.

Hildur's initial reaction was, "Voice recognition is very accurate than I thought."

Zhou said, "I really want this. I like the wink feature. This is what I need!"

They also gave feedback on user interface design and cognitive load management. They said that if heavy text was put into the small screen of Google Glass at one time, L2 students could be overwhelmed. Ruth asked, "How you gonna manage heavy text on the small screen?"

 Google Glass does have a small screen, 0.75 inch deep and 0.375 inch by 0.375 inch wide and tall. Using more pictorial data, like pictures, icons, and colors, and less text was one way to reduce the cognitive load.

However, too much pictorial data could interfere with the visual information on the screen in real conversations. Since using different colors will give different emotional

experiences, they can affect cognitive processes related to academic performance. Erez (2002, p. 487) states, "Positive emotions have a crucial effect on cognitive processes that are relevant for learning, such as information processing, communication processing, negotiation processing, decision-making processing, category sorting tasks and even then creative problem-solving process."

Isen (1987) agreed that a positive emotional state improves recall and retrieval cues for long-term memory. Based on color-coding theory, Outro adds proper colors to information to improve learning efficiency. This improved learning experience may give students a positive attitude to second-language learning (Isen,1987).

The colors and icons were chosen for *Outro* design: green, blue, and red for highlight and white color for all icons and text. We avoided bright colors like pink, orange, and purple. Based on the feedback, the Outro user interface design and flowchart were revised several times. The layout and other design principles of Outro are based on the design guidelines on the Google developer website (see figure).

Card regions

Glass defines dimensions for a set of common regions to make it easy to design and display different cards consistently.

640 x 360
560 x 240
560 x 40
240 x 360
40 x 40
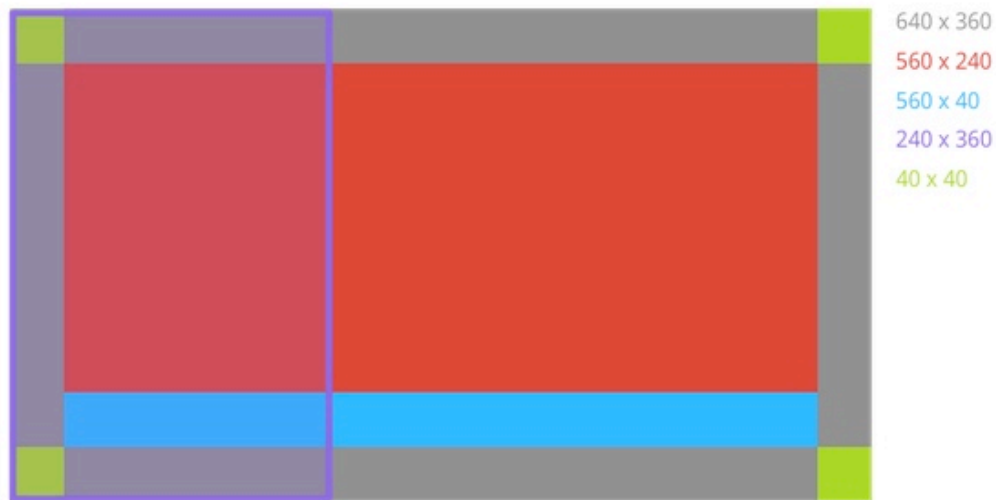
Main Content

The main text content of the card is in Roboto Light with a minimum size of 32 pixels and is bounded by padding. Text that is 64 pixels and larger uses Roboto Thin.

Footer

The footer shows supplementary information about the card, such as the source of the card or a timestamp. Footer text is 24 pixels, Roboto Regular, and white (#ffffff) in color.

Full-bleed image

Images work best when full-bleed and do not require the 40px of padding that text requires.

Left image or column

Left image or columns require modifications to padding and text content.

Padding

Timeline cards have 40 pixels of padding on all sides for the text content. This allows most people to see your content clearly.

Figure. Design layout for Outro of Google Glass follows Google guidelines on Google developers' website (images and instructions are retrieved from https://developers.google.com/glass/design/style#color)

Color

Glass displays most text in white and uses the following standard colors to denote urgency or importance. You can make use of these colors for your timeline cards as well:

Figure. Colors used for Outro follows Google guidelines on Google developers' website (images and instructions are retrieved from https://developers.google.com/glass/design/style#color)

In terms of functionality, the original Outro design had five features: ShowMe, MyNotes, Vocab, Wink, and HeyPal. HeyPal enables real-time video call. The purpose of using real time video was for learners to get help from English-speaking friends anytime and anywhere. Even when shopping or working, they can receive instant feedback from native speakers who can see what the learner is looking at. However, when HeyPal was introduced in class, the target group was skeptical. They thought that it was "creepy" because the people to whom users were talking might not know there is someone behind the device. Even though video calls can be helpful in learning the target language, social norms and privacy issues are as important as Outro's functionality. Therefore HeyPal, was removed (see figure).

Selection screen of HeyPal for video call, users can navigate the page to find people online and see their level and expertise

Screenshot how real time video call works and looks like
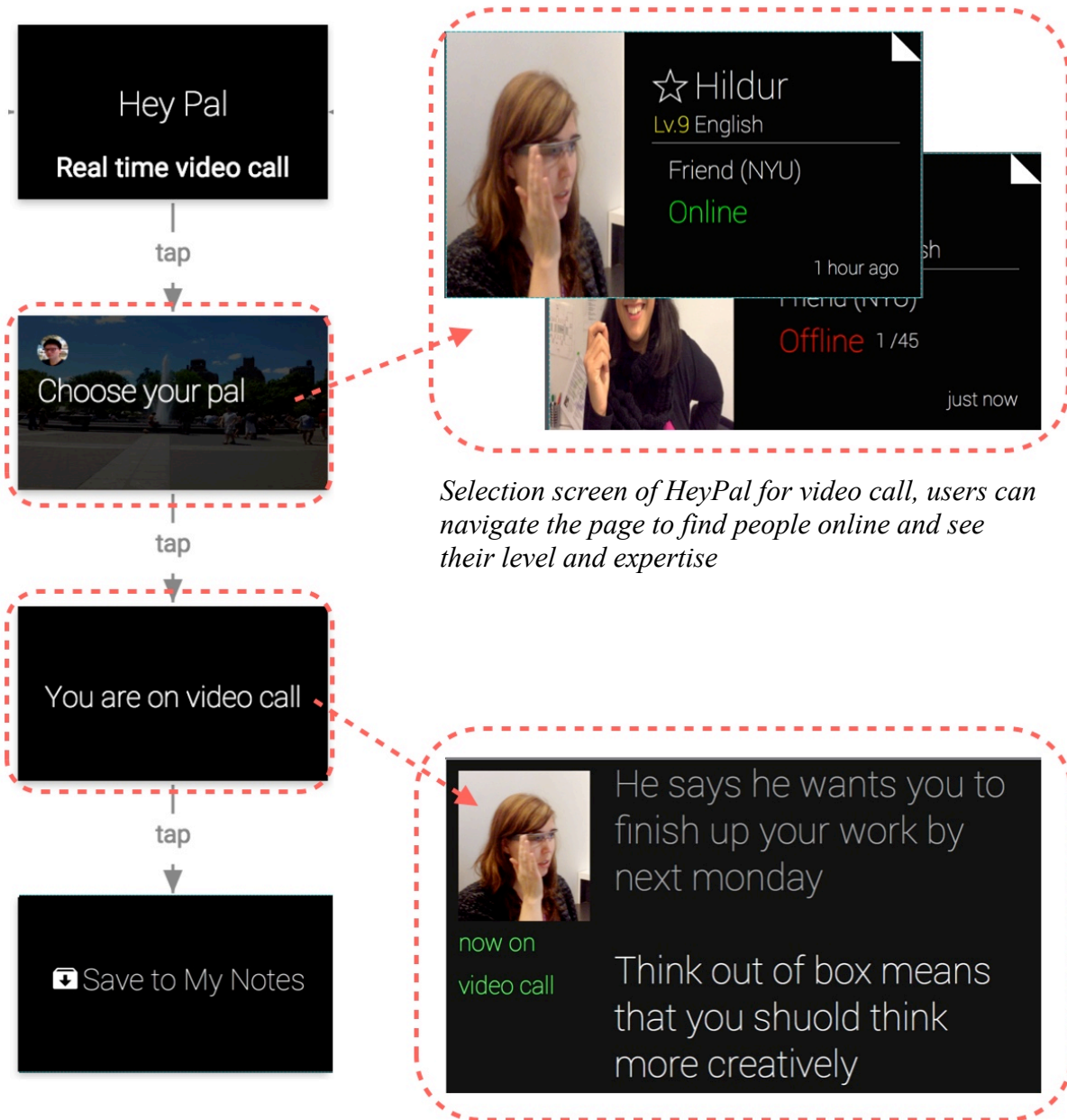
Figure. HeyPal flowchart: it is a feature for real time video call. This feature is removed from Outro due to a privacy issue

The second group consisted of graduate students in engineering at the same school in New York. Rui Quo is one of the evaluators and majored in computer science. He said, "My pronunciation is not good. Voice recognition does not work well." He said that it would be better to increase the accuracy of voice recognition and mentioned Microsoft Cortana, an intelligent personal assistant on Windows Phone. He believes that Corana has superior voice recognition accuracy and that he can use its voice command well. (In fact, voice recognition for Outro uses Google's database via cloud computing, so it could not solve the technical issue). Outro does need an alternative way of solving this problem. For instance, L2 learners can type into a Bluetooth keyboard or smartphone to control the device, instead of relying solely on voice command.
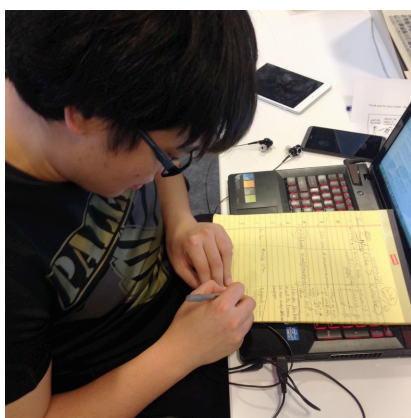
Rui Quo pointed out technical issues as an engineer and shared his experience as an international student from China.

The third group comprised professional teachers of English as a second language online and offline. Rachel Smith and Tom Kelly teach English pronunciation to students around the globe. They have five years of teaching experience and 200,000 subscribers on YouTube. They were interviewed in person, and the interview was videotaped. They agreed that using authentic and realistic materials could be more effective than traditional ones and they said one of the best ways to learn authentic language is to learn from everyday life. In

this context, they said that Outro helps L2 students learn authentic language in real situations. They also said that saving pictures and dialogues would be a great feature for language learning since students often need to review their target words several times before mastering them. This is related to schematic learning by which a conscious activity becomes subconscious. So, students can speak the target words in real situation at native pace without depleting their cognitive resources. They also pointed out that L2 learners' individual ability and motivation in learning language would make a big difference in their learning. *Outro* does not provide learning content, but expects students to make their own definitions and materials. Therefore, instructions or guidelines would be helpful for L2 learners, for example, how to make good learning materials and why they are so important in language acquisition.

The last group was international students in ESL classes. They are the main target audience for this project. Three students tested a prototype of *Outro*: Shon Khor, Iza Asker, and Siyad Dhaihalah. The test was conducted at the American Language Institute in New York. They reported that using *Outro* of Google Glass would be useful for their study of English. They liked using gesture and voice command to take pictures and make annotations instantly, and found the app intuitive, easy and fast. For instance, to take a picture, people need to wink and say what they want to annotate. Most international students and professionals do not have much spare time for learning English. For them, *Outro* can increase learning efficiency since they can learn English anywhere and anytime.

Iza Asker commented, "I don't wear glasses, so it's not comfortable to put Google Glass on my face every time." Siyad Dhaihalah commented that he likes using wearable computer for educational purposes although it would be great if the device supported not only English, but also other languages.
Shon Khor asked, "What if multiple people are speaking at the same time?" He wondered if he could use real-time captioning when he talking to several people in the same place. The

faculty advisor and other members of the group had the same question. When several people were speaking, sentence building was not accurate because the speakers' words would be mixed up. This would be the next step in future research: how to enable Outro to manage multiple speakers, multiple accents, and when there is a distance between the user and the speakers**.**

Iza Asker is participating play test in American Language Institute. He is an international student learning English as a second language.

6. Reflection and Conclusion

Although it is a cliché to say that there is no one-size-fits-all solution, relying exclusively on *Outro* for Google Glass will not solve all of the problems associated with L2 learning. With this in mind, I focused on specific problems that could be mitigated or solved by *Outro* in L2 learning. As a digital media designer who has also been an engineer and teacher, I wanted to figure out and share the vision of how we can use wearable computers in ways that are better than from those of other smart devices. Thus, it was interesting to know if Google Glass could outperform any other devices. Through this project, I arrived at a better understanding of the wearable device, and realized that Google Glass has a great deal of potential in providing information via transparent display and gesture command in seconds. Thus, the device minimizes interruptions to the flow of real conversation or work, but at the same time it provides users with information more seamlessly than other smart devices can.

Since this thesis project started in the spring of 2013, the Google Glass application design and development was a bit radical. That said, there were many problems, such as no wireless Internet connectivity, short battery life, privacy concerns, and limited references on Google Glass. Developer programming software for Google Glass is still at beta test stage as of this writing (December 2014). With these limitations, the current version of *Outro* may not yet satisfy its designers and users. However, these issues would be solved if Google and other IT companies improve their technical specifications and wireless connections. This would improve the performance of the application and the user experience.

Google (2014) has announced that new Google Glass will be released as a consumer product in 2015, featuring customized and faster Intel processors. According to *TechTimes* (2014), Google is working on a Google Glass 2.0, and patents filed by Google show that this version looks slimmer and lighter than the device it currently offers (See figure).
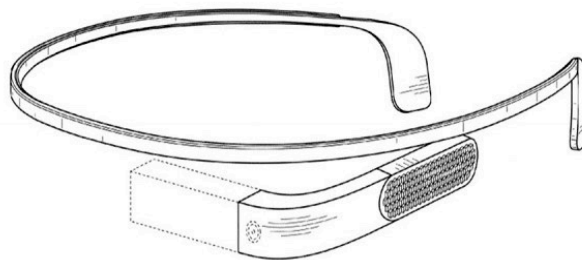

Figure. New design of Google Glass, patent filed

In terms of Internet connectivity, the government of South Korea announced that $1.5 billion will be invested into upgrades to mobile communications as a 5G by 2017, 1,000 times faster than 4G LTE (CNN, 2014). Another Glass-type of computer, called K-Glass developed by Korea Advanced Institute of Science and Technology (KAIST, 2014), has a 76%

improvement on power consumption than Google Glass. With the expectations for wearable technology, this project was conducted as an initial step with the vision on the future educational technology, not the final step in the development of *Outro*.

In conclusion, in the past teachers said that educational technology has fallen behind the technology in other fields. Sivakumar (2014, p.17) emphasized that "Innovations in education has always been a little stagnant and people have always stuck with the known, tried, tested and traditional methods in case of education." However, today, educational technology has been changed innovatively and this phenomenon will be here-to-stay. This project presents and describes some radical uses of futuristic educational technology, which can lead other fields. Although more research has to be conducted to measure the effectiveness of wearable devices as a cognitive tool, the possibilities and potentiality of *Outro* show how cutting-edge technology can enhance second-language acquisition. Outro facilitates effective and enjoyable learning by enabling users to master a language by engaging in the world of and with native speakers.

Entire Flowchart of Outro: white-colored cards stand for menu pages, blue-colored ones stand for gesture-based control, yellow-colored ones stand for some options that users have to choose, and green-colored ones stand for what events goes on of the display
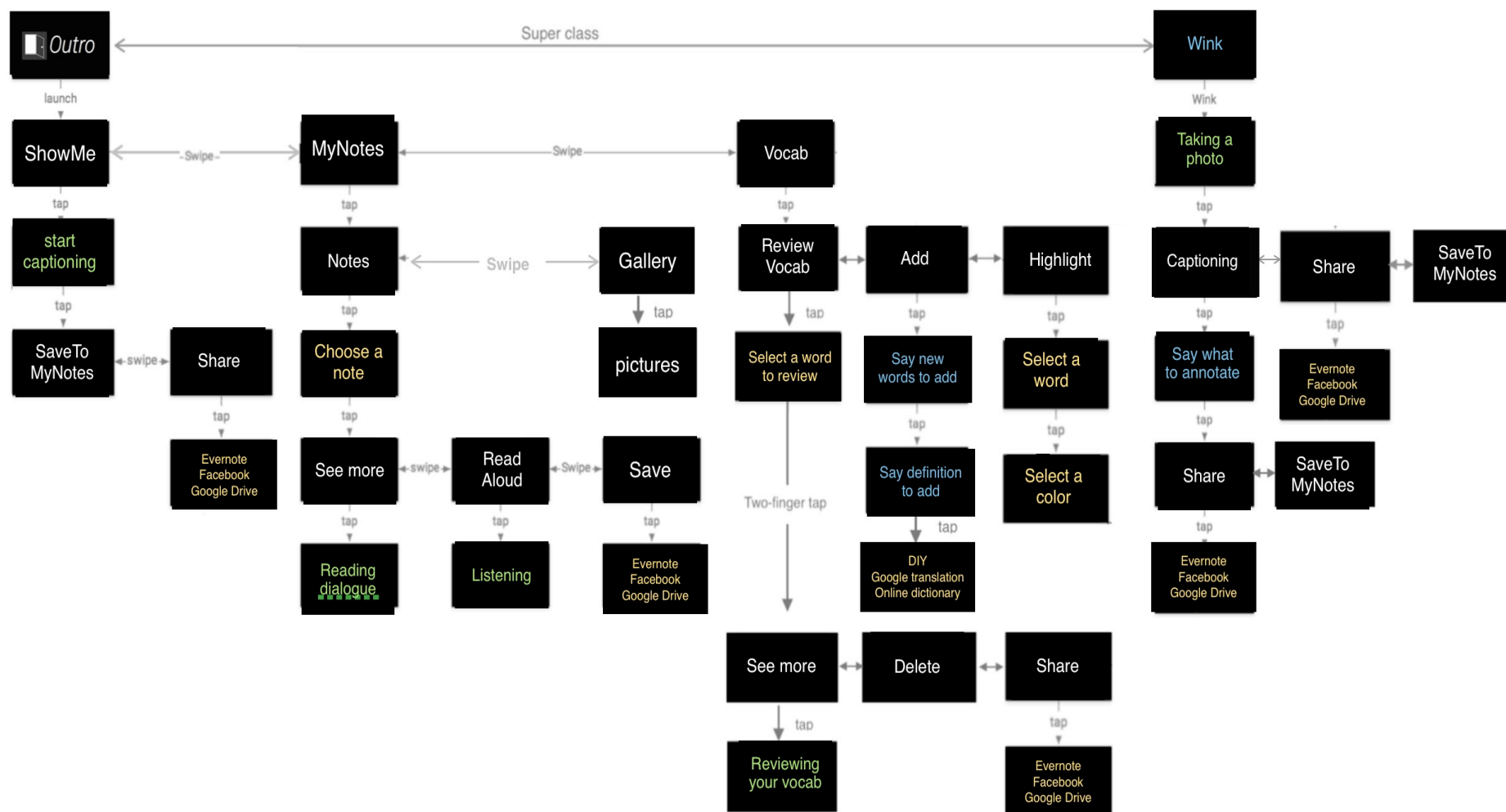
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