Collecting responses through Web page drag and drop

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This article describes how to collect responses from experimental participants using drag and drop on a Web page. In particular, we describe how drag and drop can be used in a text search task in which participants read a text and then locate and categorize certain elements of the text (e.g., to identify the main claim of a persuasive paragraph). Using this technique, participants respond by clicking on a text segment and dragging it to a screen field or icon. We have successfully used this technique in both the argument element identification experiment that we describe here and a tutoring system that we created to teach students to identify source characteristics while reading historical texts (Britt, Perfetti, Van Dyke, & Gabrys, 2000). The implementation described here exploits the capability of recent versions of Microsoft's Internet Explorer Web browser to handle embedded XML documents and drag and drop events.

Over the past 5 years, there has been a substantial increase in the number of research studies conducted over the Internet (Birnbaum, 2000; Buchanan, 2000; Krantz & Dalal, 2000; Wolfe & Reyna, 2002). This increase is partially due to the diversity and size of the population available through the Internet, as well as to more practical issues of researchers' lab space and time requirements (Bailey, Foote, & Throckmorton, 2000; Krantz & Dalal, 2000; Reips, 2000). Another reason for the increase has been the advances in the power and ease of use of Web browsers and servers. Even research conducted in more controlled settings can now take advantage of the powerful scripting capabilities built into Web browsers and the ease of deploying an experiment program on a single server, rather than on multiple workstations. The latter benefit is especially important in school environments, where the file systems of individual machines are frequently locked to prevent student tampering and access to file servers may require special procedures or personnel. Our own experiences in schools (Britt & Aglinskias, 2002; Britt, Perfetti, Van Dyke, & Gabrys, 2000) have motivated us to look for techniques that exploit such browser-based solutions to both experimental tasks and tutorial environments. The drag and drop technique described in this article is one that enables re-

searchers to present a text search and identification task through a Web browser. Participants read a text and then search for answers to questions or identify particular discourse elements by clicking on the text and dragging a text unit to a screen target, where the unit can be displayed and feedback presented. The use of this technique in our research and tutorials has shown it to be both effective and enjoyable for our participants.

The use of drag and drop with text segments came out of our work on the *Sourcer's Apprentice* (Britt & Gabrys, 2001; Britt et al., 2000), an application that trains students to attend to source information while reading historical documents. Students using the *Sourcer's Apprentice* read short documents and filled in on-screen notecards by dragging phrases from the documents to screen icons. When the students dropped a response, it was automatically scored and then entered into a notecard. The participants generally found this to be an enjoyable activity, and studies of their use of the *Sourcer's Apprentice* (Britt & Aglinskias, 2002) showed it to be an effective learning activity.

Drag and drop is particularly well suited to search-and-categorize tasks in which participants view some number of screen items that need to be classified into multiple categories. It is possible to present the items as a list and repeat the response categories for each list item or to present the items freely and place input boxes by each category choice, into which the participants can type their responses (see Figure 1), but these methods either break up the continuity of the items and impose an order on the task or make automatic checking difficult because of the problem of dealing with free responses. Drag and

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The screenshot shows a Microsoft Internet Explorer window with the address bar displaying 'C:\briitt\JF grant\exp3a\bmric_exp\linear_table4.htm'. The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The main content area is titled 'Multiple-Choice Example' and contains five numbered items, each with four radio button options: 'Who', 'Where', 'When', and 'Other'.
 1. Samuel Yellen. ☒ Who ☐ Where ☐ When ☐ Other
 2. is a Professor of History. ☐ Who ☐ Where ☐ When ☒ Other
 3. at Indiana University. ☐ Who ☒ Where ☐ When ☐ Other
 4. He received his M.A. from Oberlin College. ☐ Who ☐ Where ☐ When ☒ Other
 5. in 1932. ☐ Who ☐ Where ☒ When ☐ Other
 Below the multiple-choice section is a 'Free-input Example' section. It contains a paragraph of text: 'Samuel Yellen is a Professor of History at Indiana University. He received his M.A. from Oberlin College in 1932.' Underneath this text are three input fields labeled 'Who', 'Where', and 'When'. The 'Who' field contains the text 'Samuul Yellen', the 'Where' field contains 'Indiana', and the 'When' field contains '1932'. The browser's status bar at the bottom shows 'Done' and 'My Computer'.

Figure 1. Example of interface for presenting a multiple response task as multiple choice and free input.

drop enables items to be displayed naturally, and it enables automatic checking and immediate feedback, because the response is restricted (see Figure 2). It is also a fairly natural way to respond: The specific item is “picked up” and “placed” on the desired response.

In this article, we describe a technique for collecting data, using drag and drop on a Web page. We also briefly describe how we used this technique in a research study in which students’ ability to identify argument elements in a persuasive essay was examined.

Web Page Drag and Drop of Text Segments

The technique we have developed takes advantage of two features of Version 5 of Microsoft’s Internet Explorer (IE) Web browser¹—namely, XML data islands and drag and drop event handling.

XML documents and data islands. XML (extensible markup language) is a standard for specifying user-defined commands and data that can be sent as text files through Web servers, to be processed by some application. It has a syntax similar to that of the HTML language used to define Web pages, but the bracketed elements are defined by the user, rather than by a standards committee. The value of XML is that it defines a systematic format for specifying structured data. For exam-

ple, consider the XML document in Table 1. This XML document specifies a Book element that contains information about a book, such as a title, an author name, publisher information, and an “about the author” page.² As in HTML, XML elements enclose information with begin and end tags, and they can have attributes. The Book element, for example, specifies an *id* attribute. This *id* attribute is arbitrary and is simply a useful way to uniquely identify the Book. The other embedded elements provide specific information about the document’s author and publisher, and the Page element specifies the content of the “about the author” page. Keep in mind that this document and its elements are completely arbitrary; we could have used different labels, such as “Stimulus” for “Book,” “Passage” for “Page,” and so forth. All that is required is agreement among the users of the document format.

Although XML resembles HTML, it is syntactically more strict. First, all the elements must have matching opening (e.g., <Book>) and closing (e.g., </Book>) tags. Second, XML is case sensitive, so “Book” is not the same as “book.” Third, the values of all attributes must be quoted (e.g., rank=“1”). Fourth, when elements contain any text that can be interpreted as markup, such as the characters: <, >, -, &, and so forth, the section

Figure 2. Example of interface for presenting a multiple response task, using drag and drop.

must be enclosed within the special CDATA element, delimited by brackets (see the example in Table 1). The CDATA element instructs the XML parser to ignore any markup characters contained within it.

Normally, XML documents are sent as stand-alone files from a client to a Web server for processing, or they may be returned from a Web server and displayed using templates written in a special style language (XSL). However, an interesting new way to use XML documents is to insert them into Web pages as *data islands*. IE Versions 5 and later support a new HTML tag that enables the page's author to embed and reference an XML document within a Web page. To embed our example XML document in a Web page, we have enclosed it within the new `<XML></XML>` tags. Once inserted into a Web page, the data island will be automatically parsed when the page is loaded into the client's browser, but it is not displayed. Scripts embedded in the page can then access this structured data, using a standard set of built-in functions (known collectively as the document object model, or DOM). For example, loading a Web page that contains the data island from Table 1 and the script in Table 2³ will display a button that, if pressed, will cause a message box to pop up, displaying the text of the first Answer element from Table 1.

The JavaScript⁴ code in Table 2 defines a function called *checkAnswer* that performs a simple hierarchical lookup of information in the data island. "MyDocument" refers to the HTML element that contains the XML document. "XMLDocument" references the root node of the hierarchy. Each node contains a collection called *childNodes*. The root node has a collection of one child node that corresponds to our Book element. The *checkAnswer* function accesses the root node and as-

signs the root node's child to the *bookNode* variable. It then calls a DOM function called *getElementsByTagName*, which searches for all elements named *Question* and returns a collection of all matches. The script iterates through each question until it finds one whose id attribute matches the one passed into the function ("Who-Drop"). It then iterates through all the child nodes of the question until it finds one whose id matches the passed-in answer id ("auth_dt1"). If it finds the answer, it returns the text associated with it ("Prof. Samuel Yellen"). The actual text of the answer is contained in a text node child of the Answer element and is accessed via the *nodeValue* property. If a matching answer is not found, the function returns a null string. The script code at the bottom of Table 2 calls the *checkAnswer* function and pops up an alert box with the result. Note that if the XML document contains any syntax errors, the root node will be null.

A drag and drop document. Our drag and drop technique exploits data islands in order to create a text that contains uniquely identifiable text segments, along with possible response answers. Examining the Page element of the XML document in Table 1 shows that the contents of the page have been broken up into uniquely identifiable units. The HTML SPAN element provides a way to do this. A SPAN element has no default effect on the way the browser displays the text it encloses. By adding an id attribute to the SPAN, we can uniquely identify a text segment. SPAN elements can also be assigned styles that can be used to highlight the text unit, change its color, or alter its appearance in some other way. The CDATA section wrapped around these SPAN elements enables HTML to be embedded within the contents of the XML Page element without having the XML parser try to in-

Table 1
An XML Document Embedded as a Data Island in a Web Page

```

<XML id="MyDocument">
<Book id="4">
  <Title>American Labor Struggles.</Title>
  <Author rank="1">
    <Lastname>Yellen</Lastname>
    <Firstname>Samuel</Firstname>
    <Middlename></Middlename>
  </Author>
  <Publisher>Monad Press</Publisher>
  <Place>New York</Place>
  <Year>1936</Year>
  <Page type="about the author">
    <![CDATA[
      <P>
        <SPAN id="auth_dt1">Samuel Yellen</SPAN>
        <SPAN id="auth_dt2">is a Professor of History</SPAN>
        <SPAN id="auth_dt3">at Indiana University.</SPAN>
        <SPAN id="auth_dt4">He received his M.A. from Oberlin College</SPAN>
        <SPAN id="auth_dt5">in 1932.</SPAN>
      </P>
    ]]>
  </Page>
  <Question id="WhoDrop">
    <Answer id="auth_dt1">Prof. Samuel Yellen</Answer>
  </Question>
  <Question id="WhereDrop">
    <Answer id="auth_dt3">Indiana University</Answer>
  </Question>
  <Question id="WhenDrop">
    <Answer id="auth_dt5">1932</Answer>
  </Question>
</Book>
</XML>

```

Note—The source code is available at <http://www3.niu.edu/psychology/britt>.

interpret it. We can later extract this content and assign it to a displayable HTML control.

The document in Table 1 breaks the Page text into five uniquely identified SPAN elements. The SPAN's identifier is used to associate each text segment with a response to our drag and drop operation. The bottom part of Table 1 defines Question and Answer elements. Question elements correspond to questions. These elements have an id attribute that we will use to associate each Question with a visible HTML object that will serve as a drop target. Contained within each Question is one or more Answer elements. Each Answer element has an id that corresponds to the ids of the SPANs in the document's Page element. In the example, there is one Answer element for each correct answer to the corresponding question. We assume that any responses not contained as answers are incorrect.

Drag and drop handling in Internet Explorer. IE Versions 5 and later define special events and objects to handle drag and drop operations. To enable drag and drop operations, the Web page must define script functions to handle these events and associate the functions with HTML objects. Tables 3 and 4 show how this works. If the contents of Table 3 are added to those of Tables 1 and 2, we get a Web page that looks like Figure 2. The code in Table 3 defines an HTML SPAN element named *theDoc* and provides some JavaScript that looks up the

contents of the XML document's Page elements and assigns it to the *theDoc* element. Note that this SPAN element also associates the handlers *myMouseDown* and *myDragStart* to the *onmousedown* and *ondragstart* events. The *onmousedown* event is triggered when the user clicks anywhere in the text. The *ondragstart* event is triggered when the user holds the mouse button down and begins to move the mouse pointer.

The code in Table 3 next defines an HTML table. This table contains three rows for each of three author characteristics. The first column of these rows provide the name of the characteristic. The second column contains a space character to force the cell borders to draw when the cell is empty. The TD elements for the second column have an id attribute whose names correspond to the Question elements of our XML document. They also associate the *myDragOver* function to the *ondragenter* and *ondragover* events. The Table element itself associates the *myDrop* function with the *ondrop* event. The *ondragenter* event is triggered when the user moves the mouse pointer into the cell while dragging. While the mouse pointer is inside the cell, the *ondragover* event is triggered whenever the mouse moves until it leaves the cell. The *ondrop* event is triggered when the user releases the mouse button while inside the table.

The code for the handler functions is shown in Table 4.⁵ The first handler is *myMouseDown*, which handles the

Table 2
Script That Retrieves a Question Answer From an XML Data Island

```

<script language="JavaScript">
<!--
function checkAnswer(answerId, questionId)
{
    var answerText = "";
    // access the top-level document node.
    // note: MyDocument is the name of the data island
    var docNode = MyDocument.XMLDocument;

    // get the book
    if (docNode != null && docNode.childNodes.length > 0)
    {
        var bookNode = docNode.childNodes(0);
        if (bookNode != null)
        {
            // get all the Question elements
            var questions = bookNode.getElementsByTagName("Question");
            var i, found=false;

            // find the question that matches the questionId
            for (i=0; i < questions.length; i++)
            {
                var qattr = questions(i).getAttributeNode("id");
                if (qattr.nodeValue==questionId && questions(i).childNodes.length > 0)
                {
                    // now search the Answers for the answerId
                    var j;
                    for (j=0; j < questions(i).childNodes.length; j++)
                    {
                        var idattr=questions(i).childNodes(j).getAttributeNode("id");
                        if (idattr.nodeValue==answerId &&
                            questions(i).childNodes(j).childNodes.length > 0)
                        {
                            // we found it, so this is a correct answer
                            found=true;
                            answerText = questions(i).childNodes(j).childNodes(0).nodeValue;
                            break;
                        }
                    }
                    if (found)
                        break;
                }
            }
        }
    }
    return answerText;
}

function doCheckAnswer()
{
    var result = checkAnswer("auth_dt1", "WhoDrop");
    if (result == "")
        alert("That is incorrect");
    else
        alert("That is correct: "+result);
}
-->
</script>
<H1>Drag and Drop Example</H1>
<input type="button" name="checkAnswer" value="Check Answer" onclick="doCheckAnswer()">

```

Note—The source code is available at <http://www3.niu.edu/psychology/britt>.

onmousedown event. This function selects the text in the SPAN element where the mouse was clicked. The next handler, myDragStart, handles the ondragstart event by copying the id of the selected SPAN element to the system-

defined *dataTransfer* object and setting the event object's eventAllowed property to “copy,” to set the drag cursor appearance. Next comes the myDragOver function, which handles both the ondragenter and ondragover

Table 3
HTML and Script Code to Display the Data Island Content and a Table of Drop Targets

```

<H1>Drag and Drop Example</H1>
<br>
<!-- This is where our text is displayed
-->
<SPAN id="theDoc" onmousedown="myMouseDown()" ondragstart="myDragStart()"></SPAN>

<br>

<script>
<!--
// script code that retrieves the page contents from the
// data island and inserts it into our SPAN object when the page is loaded

var docNode = MyDocument.XMLDocument;
if (docNode != null && docNode.childNodes.length > 0)
{
    var bookNode = docNode.childNodes(0);
    if (bookNode != null)
    {
        var pageNodes = bookNode.getElementsByTagName("Page");
        if (pageNodes.length > 0 && pageNodes(0).childNodes.length > 0)
        {
            theDoc.innerHTML = pageNodes(0).childNodes(0).nodeValue;
        }
    }
}

//-->
</script>

<h3>Author Characteristics</h3>
<table border=1 cols=2 width="400" ondrop="myDrop()" >
<tr>
<th width="50%">Who</th>
<td width="50%" id="WhoDrop" ondragenter="myDragOver()" ondragover="myDragOver()" >&nbsp;&nbsp;&</td>
</tr>
<tr>
<th width="50%">Where</th>
<td width="50%" id="WhereDrop" ondragenter="myDragOver()" ondragover="myDragOver()" >&nbsp;&nbsp;&</td>
</tr>
<tr>
<th width="50%">When</th>
<td width="50%" id="WhenDrop" ondragenter="myDragOver()" ondragover="myDragOver()" >&nbsp;&nbsp;&</td>
</tr>
</table>

```

Note—The source code is available at <http://www3.niu.edu/psychology/britt>.

events. This handler enables the table cell to function as a drop target by setting the dataTransfer object's dropEffect property to "copy" and setting the function's returnValue to false so that the default handler is not called. The final handler is myDrop, which handles the table's ondrop event. This function retrieves the id of the dragged SPAN element from the dataTransfer object and the id of the cell where the drop occurred from the event object's srcElement property. It then calls the checkAnswer function and displays the results. If the result is correct, it also inserts the answer text into the cell where the drop occurred.

It is important to note that the technique we have described takes place completely on the client side (i.e., the user's browser). For obvious security reasons, Web pages cannot write responses to files on the client. Instead, the response must be sent back to the server and recorded

there. The Appendices contain a complete example that collects event times, posts the response and response times to the server, and logs the data to a file on the server. We will describe in general terms how this works in the next section.

Recording data. The most common method for transferring response data from the client to the Web server is through a form submission. Forms are HTML elements that name and encapsulate data transferred from a Web browser to a server. Although forms are most commonly used to display controls, such as drop lists and edit boxes, there are also hidden form elements that can be populated and submitted from scripts. When a user makes a drag and drop response, the script writer has the option of immediately filling in a form element and submitting the data to the server or of collecting the results of several drops and submitting all the results at

Table 4
Drag and Drop Event Handlers

```

<script>
<!--
// myMouseDown
// this function is called when the user holds the mouse button down over
// one of our document's span elements
function myMouseDown()
{
    // Select the SPAN range where the mousedown occurs. This highlights the span.
    var rng = document.body.createTextRange();
    rng.moveToElementText(event.srcElement);
    rng.select();
}

// myDragStart
// this function is called when the user starts dragging one of our document's SPAN elements
function myDragStart()
{
    // copy the id of the SPAN element to the dataTransfer object
    event.dataTransfer.setData("Text", event.srcElement.id);
    event.dataTransfer.effectAllowed = "copy";
}

// myDragOver
// this function is called when the user drags something over the drop target
function myDragOver()
{
    // Cancel default action and manage the drop effect.
    var oEvent = window.event;
    oEvent.dataTransfer.dropEffect = "copy";
    oEvent.returnValue = false;
}

// myDrop
// this function is called when the user drops something on a drop target
function myDrop()
{
    // set the return value to false so the default drop handler doesn't
    // try to copy the text in the dataTransfer to the drop target
    event.returnValue = false;
    event.dataTransfer.dropEffect = "copy";

    // get the answer id from the dataTransfer object
    var answerId = event.dataTransfer.getData("Text");

    // get the questionId from the srcElement field of the event object
    var questionId = event.srcElement.id;

    // check the answer and pop an alert box
    var result = checkAnswer(answerId, questionId);
    if (result == "")
        alert("That is incorrect");
    else
    {
        event.srcElement.innerText = result;
        alert("That is correct");
    }
}

-->
</script>

```

Note—The source code is available at <http://www3.niu.edu/psychology/britt>.

once. One important consideration is that form submission causes the browser window to refresh. This may be perceived as an interruption, especially when the page renders slowly because of its size or the client's slow

connection to the server. Sometimes, however, submissions after each drop are necessary, as in the case in which the response requires extensive analysis on the server.

The complete example, given in Appendix A,⁶ performs a form submission after every drop. An HTML form element named *dropForm* has been added to the page. This form contains hidden input elements for returning the document identifier, the id and contents of the dropped text unit, and the time of the drop operation on the client. The *ondrop* handler (*myServerDrop*) calls *fillFormAndSubmit* to insert values into the hidden form elements and then submit the form. The submission must now be unpacked and recorded by the server. There are several server-side technologies for handling Web form submissions (Schmidt, 2000), such as CGI, ASP, ISAPI, and JSPs. Our example (in Appendix B)⁷ uses an Active Server Page (ASP) page written in VBScript to extract the data from the form, store it in a file, and redisplay the page. ASP pages are text files containing script code that is interpreted by Microsoft's IIS Web server. CGI scripts (usually written in Perl) are the more common choice on Unix-based servers, such as Apache. Alternatively, a Java Server Page (JSP) server, such as the open-source Tomcat, may be used on both platforms.

Timing. Our example scripts and the experiment that follows record the time stamp of the drag and drop events. We collect these time stamps on the client and transfer them to the server because the client time, although subject to the vagaries of the browser and operating system, is still a better estimate than the time on the server, which is subject to network speed and congestion and server load. Because we are interested only

in the duration between two time stamps, it is not important that time might differ among clients. It should be kept in mind, however, that the accuracy of timing with this or any browser-based application is limited to seconds or, at best, tenths of seconds.

AN EXPERIMENT USING DRAG AND DROP DATA COLLECTION

We have recently used the technique we have described to collect data for a study on argument comprehension. The participants read paragraph-long arguments and were asked to identify the main claim, reasons, backings (evidence), and counterreasons. They entered their responses by clicking on a phrase from the argument and then dragging and dropping it into a cell of a table labeled with the appropriate argument element (see Figure 3). Because of the length of the arguments, the drop table was presented in a separate frame below the passage, enabling the passage to be independently scrolled. The passage identifier, the *dropTarget* (table cell), the dropped element, and time of the drop were submitted to the server on each drop and recorded in a file. When the page refreshed after the submission, the dropped text was displayed in the table cell where the element was dropped. No feedback was provided. When the participants considered themselves finished with a passage, they clicked a button below the drop table to move on to the next passage.

Figure 3. Screen capture from the experiment demonstrating the drag and drop procedure for an argument element classification task.

Method

Participants. Twelve students from a psychology course on research methods participated in this experiment for course credit.

Materials. Two practice and six experimental arguments were presented to the participants, using a Web browser. Each argument consisted of at least a main claim and one reason. The arguments varied in length from 33 to 630 words. On average, the passages contained 1.33 claim statements, 4.67 reason statements, 1.5 counter-reasons statements, 6.50 backing statements, and 4.33 statements of other types. Each experimental argument had two versions: implicit and explicit. The explicit arguments added clear cues to signal the presence of each argument element, such as “We propose that . . .” and “The first reason is . . .”

Design and Procedure. The participants were randomly assigned to one of two cue conditions, explicit or implicit. The participants read one screen page of instructions describing each argument component. Then they were given an example argument that contained one of each argument component, along with the correct classification of each text element that corresponded to one of the components. Finally, they were given instructions on using the drag and drop procedure. All the participants were familiar with drag and drop, and no one required additional assistance. They were told that they could fill the boxes in any order and were given a practice argument. The participants completed the eight arguments and then were given an opportunity to critique the interface.

Results and Discussion

The focus of the Results presentation is on the type and nature of the data logged by the server. Table 5 shows 1 participant's data file output. This output indicates the time the server logged the item, the ASP session id, the argument number (5), the drop location (claim, reason, backing, or counterreason), the type of argument (policy), the element dropped (p1), whether the drop was correct or incorrect (crt), the drag start time, and the drop time.

The proportion of each type of argument element correctly answered is shown in Table 6. The participants were able to correctly identify claims with 70% accuracy but had more difficulty with the other components (40%, 52%, and 33% accuracy for the reasons, counterreasons, and backing, respectively). Table 7 presents the average latency of their first drop and the percentage of first drops that were claims. The relatively short latency indicates that the participants did not read the entire passage prior to submitting their first responses. They read for an average of only 6.31 sec before responding. The most frequent initial drop was the main claim of the argument (85% of the time). This provides an important insight into the participants' approach to the task. In addition to collecting information on the segment dropped into a particular box and the response time, a qualitative analysis of errors can be preformed.

Table 6
Mean Percentage of Correct Responses
for Each Argument Category by Condition

Argument Category	Explicit Argument	Implicit Argument
Claims	59.52	78.33
Reasons	35.21	44.82
Backing	30.16	35.05
Counterreasons	50.60	53.75

To get a measure of usability, the final 7 participants evaluated the application on a 7-point scale. The average rating for overall experience was 2.71 (with 1 being *wonderful* and 7 being *terrible*). They found the application easy to use ($M = 2.29$) and mildly enjoyable ($M = 3.00$). Finally, they judged it to be a worthwhile educational experience ($M = 2.00$). When asked what they would improve, several participants recommended enabling the removal of responses from the table. In fact, some tried to drag the items in the table back to the text as a way of undoing their responses. This feature could be enabled with additional scripting.

CONCLUSIONS

This article has described a technique for collecting drag and drop responses to a text search task and has presented a small experiment in which this technique was used to learn about students' ability to comprehend written arguments. Many variations of this technique are possible: The drop target can be a table, an edit field, an icon, or any other displayable HTML object; dynamic styles and cascading style sheets (CSSs) can be used to display which text elements are draggable; and hint elements can be added to the document to provide graduated help when wrong elements are dropped. One should also look beyond the text-based nature of the task we have described. Drag and drop is more commonly used in graphical environments, and there is no reason why images could not be as easily associated with XML elements in our examples.

In general, drag and drop responding is appropriate for situations in which participants can make multiple consistent responses for text or graphic screen elements. It is also valuable for interfaces where one wants to convey a sense of “movement” or transfer of location for some element. Finally, it is useful for exploiting the semantics of the drop action—dropping a file on a folder icon might signify moving the file, whereas dropping it on a printer icon might signify printing the file. Conversely, drag and drop is not particularly well suited for

Table 5
Sample of Data Collected on the Server (Logged Time, ASP Session ID, Argument, Drop Location, Argument Type, Element Dropped, Accuracy, Drag Start Time, and Drop Time)

1/29/2003 3:27:41 PM,738327737,5,,,NewPage,,,
1/29/2003 3:28:26 PM,738327737,5,Claim,Tbac,policy,Drop,p1,crt,104387628193Q1043876283140
1/29/2003 3:28:32 PM,738327737,5,Reason,Tbac,policy,Drop,p2,incrt,1043876287480,1043876289950
1/29/2003 3:28:36 PM,738327737,6,,,NewPage,,,

Table 7
Mean Response Times (in Seconds) and Percentages of
Claim Responses for the First Dropped Items

Condition	Response Time	Percentage of Claim Responses
Explicit argument	7.4	83
Implicit argument	5.2	86

making single category responses or answering questions where the response categories frequently change. For instance, if in the experiment we conducted we had wanted the participants only to identify the reasons, it would have been much simpler to have them click on each reason. Similarly, drag and drop would be a cumbersome way to respond to a multiple-choice exam. Finally, drag and drop requires that the response item be present on the screen. For many tasks in which inferences or recall is required, it would not be possible to use this technique.

This article has also illustrated the use of XML data islands for storing complex stimulus descriptions in a Web page. Such descriptions can be embedded in an application page or stored in a database or in separate files and selected at runtime. We have used them to associate drag and drop responses and answers, but they can be used with any response method to enable client-side presentation of data or handling of responses.

Drag and drop responding and XML data islands are two new tools available to researchers and instructional designers. Now that they are available in Web browsers, they can be easily used by researchers who conduct studies with the Internet or by those who simply exploit the convenience of browser-based applications in their own lab.

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NOTES

1. Although we hope that Netscape will eventually add similar features to Navigator, the reality is that the vast majority of Web surfers use Internet Explorer. According to an August 2, 2002 report from WebSideStory.com, IE is now used by 96% of users world wide. Of particular relevance to the technique described in this article, w3schools.com reports that IE Versions 5 and 6 now account for 91% of users. Even when IE is not a user's browser of choice, it is still available on all Windows-based computers.
2. Normally, the first line of an XML document is the standard header `<?xml version="1.0"?>`, which identifies the following text as an XML document and provides the XML specification version. In our example, we have dropped this header and put `<XML></XML>` tags around the document, because we are inserting it into a Web page.
3. The information from the combined Tables 1 and 2 is available at <http://www3.niu.edu/psychology/britt>.
4. Although all of the examples we present use JavaScript, VBScript can also be used to access XML data and handle drag and drop events.
5. The information from the combined Tables 1-4 is available at <http://www3.niu.edu/psychology/britt>.
6. The information from Appendix A is available at <http://www3.niu.edu/psychology/britt>.
7. The information from Appendix B is available at <http://www3.niu.edu/psychology/britt>.

APPENDIX A

Example of a Web Page That Can Do Both Client-Side and Server-Side Drag and Drop

Server-side drops require the server-side ASP page given in Appendix B. These pages must be run from a Microsoft IIS Server. This page is available at <http://www.niu.edu/psychology/britt>.

```
<%
' This is a Microsoft Active Server Page (ASP).
' It must be accessed from a Microsoft IIS server.

' Get the value of our form submission variables so
' we can refresh our state

Dim whoText, whereText, whenText, correct, procLoc

whoText = Request.Form("whoText")
whereText = Request.Form("whereText")
whenText = Request.Form("whenText")
```

APPENDIX A (Continued)

```

correct = Request.Form("correct")
procLoc = Request.Form("ProcessLocation")

if procLoc=null or procLoc="" then
    procLoc="Client"
end if

%>
<HTML>
<HEAD>
<TITLE>Drag and Drop Example</TITLE>
</HEAD>
<BODY >
<h1>Drag and Drop Example</h1>
<br>
<!-- XML Data Island
This element contains our XML document.
-->
<XML id="MyDocument">
<Book id="4">
    <Title>American Labor Struggles.</Title>
    <Author rank="1">
        <Lastname>Yellen</Lastname>
        <Firstname>Samuel</Firstname>
        <Middlename></Middlename>
    </Author>
    <Publisher>Monad Press</Publisher>
    <Place>New York</Place>
    <Year>1936</Year>
    <Page type="author">
        <![CDATA[
            <P>
                <SPAN id="auth_dt1">Samuel Yellen</SPAN>
                <SPAN id="auth_dt2">is a Professor of History</SPAN>
                <SPAN id="auth_dt3">at Indiana University.</SPAN>
                <SPAN id="auth_dt4">He received his M.A. from Oberlin
College</SPAN>
                <SPAN id="auth_dt5">in 1932.</SPAN>
            </P>
        ]]>
    </Page>
    <Question id="WhoDrop">
        <Answer id="auth_dt1">Prof. Samuel Yellen</Answer>
    </Question>
    <Question id="WhereDrop">
        <Answer id="auth_dt3">Indiana University</Answer>
    </Question>
    <Question id="WhenDrop">
        <Answer id="auth_dt5">1932</Answer>
    </Question>
</Book>
</XML>

<script language="JavaScript">
<!--

// setup variables for collecting times
var loadTime, dragTime, dropTime;
var date = new Date();

////////////////////////////////////
// checkAnswer(answerId,questionId)
// searches the XML data island for a particular question answer

function checkAnswer(answerId, questionId)
{
    var answerText = "";

    // access the top-level document node.
    // note: MyDocument is the name of the data island

```

APPENDIX A (Continued)

```

var docNode = MyDocument.XMLDocument;

// get the book
if (docNode != null && docNode.childNodes.length > 0)
{
    var bookNode = docNode.childNodes(0);
    if (bookNode != null)
    {
        // get all the Question elements
        var questions = bookNode.getElementsByTagName("Question");
        var i, found=false;

        // find the question that matches the questionId
        for (i=0; i < questions.length; i++)
        {
            var qattr = questions(i).getAttributeNode("id");
            if (qattr.nodeValue==questionId &&
questions(i).childNodes.length > 0)
            {
                // now search the Answers for the answerId
                var j;
                for (j=0; j < questions(i).childNodes.length; j++)
                {
                    var
idattr=questions(i).childNodes(j).getAttributeNode("id");
                    if (idattr.nodeValue==answerId &&
                        questions(i).childNodes(j).childNodes.length > 0)
                    {
                        // we found it, so this is a correct answer
                        found=true;
                        answerText =
questions(i).childNodes(j).childNodes(0).nodeValue;
                        break;
                    }
                }
                if (found)
                    break;
            }
        }
    }
}
return answerText;
}

////////////////////////////////////
///
/// Drag and Drop Event Handlers

// myMouseDown
// this function is called when the user holds the mouse button
// down over one of our document's span elements
function myMouseDown()
{
    // Select the SPAN range where the mousedown occurs.
    // This highlights the span. You could also use styles to
    // change the text color or some other attribute
    var rng = document.body.createTextRange();
    rng.moveToElementText(event.srcElement);
    rng.select();
}

// myDragStart
// this function is called when the user starts dragging one of our
// document's SPAN elements
function myDragStart()
{
    // record the dragTime
    dragTime = date.getTime();

    // copy the id of the SPAN element to the dataTransfer object
    event.dataTransfer.setData("Text", event.srcElement.id);
}

```

APPENDIX A (Continued)

```

    event.dataTransfer.effectAllowed = "copy";
}

// myDragOver
// this function is called when the user drags something over
// the drop target
function myDragOver()
{
    // Cancel default action and manage the drop effect.
    var oEvent = window.event;
    oEvent.dataTransfer.dropEffect = "copy";
    oEvent.returnValue = false;
}

// myClientDrop
// this function is called when the user drops something
// on a drop target this version does not send any information
// to the server, it just pops an alert box and copies the
// response to the drop target
function myClientDrop()
{
    // set the return value to false so the default drop handler
    doesn't
    // try to copy the text in the dataTransfer to the drop target
    event.returnValue = false;
    event.dataTransfer.dropEffect = "copy";

    // get the answer id from the dataTransfer object
    var answerId = event.dataTransfer.getData("Text");

    // get the questionId from the srcElement field of the event
    // object
    var questionId = event.srcElement.id;

    // check the answer and pop an alert box
    var result = checkAnswer(answerId,questionId);
    if (result == "")
        alert("Client: That is incorrect");
    else
    {
        event.srcElement.innerHTML = result;
        alert("Client: That is correct");
    }
}

// fillFormAndSubmit
// fills in hidden form values and submits the form
function fillFormAndSubmit(found,dropText,idval,qval)
{
    // save our table values and set the answer text
    var whoText, whereText, whenText;
    whoText = document.all("WhoDrop").innerHTML;
    whereText = document.all("WhereDrop").innerHTML;
    whenText = document.all("WhenDrop").innerHTML;
    if (found)
    {
        if (qval=="WhoDrop")
        {
            whoText = dropText;
        }
        else
        {
            if (qval=="WhereDrop")
                whereText = dropText;
            else // if (qval=="WhenDrop")
                whenText = dropText;
        }
    }
}

// fill in the hidden form fields and submit the form
theForm.spanId.value = idval;

```

APPENDIX A (Continued)

```

    theForm.targetId.value = qval;
    theForm.correct.value = (found) ? "1" : "0";
    theForm.loadTime.value = loadTime;
    theForm.dragTime.value = dragTime;
    theForm.dropTime.value = dropTime;
    theForm.whoText.value = whoText;
    theForm.whereText.value = whereText;
    theForm.whenText.value = whenText;
    theForm.submit();
}

// myServerDrop
// this function is called when the user drops something on the
// drop target. this version fills in hidden form fields and
// submits the form to the server
function myServerDrop()
{
    // record the dropTime
    dropTime = date.getTime();

    // set the return value to false so the default drop handler
    // doesn't try to copy the text in the dataTransfer to the
    // drop target
    event.returnValue = false;
    event.dataTransfer.dropEffect = "copy";

    // get the answer id from the dataTransfer object
    var answerId = event.dataTransfer.getData("Text");

    // get the questionId from the srcElement field of the event
    // object
    var questionId = event.srcElement.id;

    // check the answer and pop an alert box
    var result = checkAnswer(answerId,questionId);
    var found = (result != "");

    // submit response to server
    fillFormAndSubmit(found,result,answerId,questionId);
}

// selects which drop handler to use depending on setting of
// radio button
function myDrop()
{
    if (document.all("ProcessLocationClient").checked)
        myClientDrop();
    else
        myServerDrop();
}

function clearTable()
{
    document.all("WhoDrop").innerHTML="&nbsp;";
    document.all("WhereDrop").innerHTML="&nbsp;";
    document.all("WhenDrop").innerHTML="&nbsp;";
}
-->
</script>

<!--
////////////////////
// the form
-->
<form id="theForm" method="post" action="appserver.asp">
<input type="hidden" id="spanId" name="spanId">
<input type="hidden" id="targetId" name="targetId">
<input type="hidden" id="loadTime" name="loadTime">
<input type="hidden" id="dragTime" name="dragTime">
<input type="hidden" id="dropTime" name="dropTime">
<input type="hidden" id="correct" name="correct">

```

APPENDIX A (Continued)

```

value="<%=correct%>">
<input type="hidden" id="whoText" name="whoText"
value="<%=whoText%>">
<input type="hidden" id="whereText" name="whereText"
value="<%=whereText%>">
<input type="hidden" id="whenText" name="whenText"
value="<%=whenText%>">

Process drop on:
<input type="radio" id="ProcessLocationClient"
name="ProcessLocation" value="Client" <% if procLoc="Client" then
%>checked<% end if %>>Client
<input type="radio" id="ProcessLocationServer"
name="ProcessLocation" value="Server" <% if procLoc="Server" then
%>checked<% end if %>>Server
</form>
<br>
<br>
<!--
////////////////////////////////////
// Instructions
-->
<i>Read the following passage. Identify each author characteristic
by
locating the text in the passage that corresponds to each
characteristic
and dragging it to the appropriate row in the table below the
passage. </i>
<br>
<br>
<!--
////////////////////////////////////
// This is where our text is displayed
-->
<SPAN id="theDoc" onmousedown="myMouseDown()"
ondragstart="myDragStart()"></SPAN>
<br>

<script language="JavaScript">
<!--
// this script code runs when the page is loaded. It retrieves the
// page contents from the XML data island and inserts it into the
// "theDoc" SPAN object so the viewer can see it.

var docNode = MyDocument.XMLDocument;
if (docNode != null && docNode.childNodes.length > 0)
{
    var myDocNode = docNode.childNodes(0);
    if (myDocNode != null)
    {
        var pageNodes = myDocNode.getElementsByTagName("Page");
        if (pageNodes.length > 0 && pageNodes(0).childNodes.length > 0)
        {
            theDoc.innerHTML = pageNodes(0).childNodes(0).nodeValue;
        }
    }
}

//-->
</script>

<!--
////////////////////////////////////
// Here we define a table of author characteristics that will
// serve as a drop target
-->
<h3>Author Characteristics</h3>
<table border=1 cols=2 width="400" ondrop="myDrop()" >
<tr>
<th width="50%">Who</th>
<td width="50%" id="WhoDrop" ondragenter="myDragOver()" >

```

APPENDIX A (Continued)

```

ondragover="myDragOver()" ">&nbsp;</td>
</tr>
<tr>
<th width="50%">Where</th>
<td width="50%" id="WhereDrop" ondragenter="myDragOver()" "
ondragover="myDragOver()" ">&nbsp;</td>
</tr>
<tr>
<th width="50%">When</th>
<td width="50%" id="WhenDrop" ondragenter="myDragOver()" "
ondragover="myDragOver()" ">&nbsp;</td>
</tr>
</table>

<input type="button" name="Clear" value="Clear"
onclick="clearTable()" ">

<script language="JavaScript">
<!--

// record the load time
loadTime = date.getTime();

// if we did a form submission to the server and this is a reload,
// populate our table with the stored responses and pop the alert
// box

var txt;
txt = theForm.all("whoText").value;
if (txt != null && txt != "" && txt != "undefined")
{
    document.all("WhoDrop").innerHTML = txt;
}
txt = theForm.all("whereText").value;
if (txt != null && txt != "" && txt != "undefined")
{
    document.all("WhereDrop").innerHTML = txt;
}
txt = theForm.all("whenText").value;
if (txt != null && txt != "" && txt != "undefined")
{
    document.all("WhenDrop").innerHTML = txt;
}
txt = theForm.all("correct").value;
if (document.all("ProcessLocationServer").checked && txt != null &&
txt != "")
{
    if (txt == "1")
    {
        alert("Server: That is correct");
    }
    else if (txt == "0")
    {
        alert("Server: That is incorrect");
    }
}

//-->
</script>

</BODY>
</HTML>

```

APPENDIX B
Server-Side ASP Page for Handling Form Submissions
From Page Given in Appendix A

```

<%
' This ASP file written in VBScript demonstrates
' How to handle the server-side of a drag and drop event
'

' Declare our form variables and extract them from the form

Dim spanId, targetId
Dim loadTime, dragTime, dropTime
Dim whoText, whereText, whenText
Dim correct

whoText = ""
whereText = ""
whenText = ""

spanId  = Request.Form("spanId")
targetId = Request.Form("targetId")
correct  = Request.Form("correct")
loadTime = Request.Form("loadTime")
dragTime = Request.Form("dragTime")
dropTime = Request.Form("dropTime")
whoText  = Request.Form("whoText")
whereText = Request.Form("whereText")
whenText = Request.Form("whenText")

' Construct the results string
Dim sData
sData = FormatDateTime(Now(), vbGeneralDate) & _
        "," & CStr(Session.SessionID) & _
        "," & spanId & _
        "," & targetId & _
        "," & correct & _
        "," & loadTime & _
        "," & dragTime & _
        "," & dropTime

' Save results string to File
Dim dataFileName
dataFileName = "C:\Inetpub\brmicdata\Eg" & Cstr(Session.SessionID) _
        & ".dat"

Dim oFSO, oTxtStream
Set oFSO = Server.CreateObject("Scripting.FileSystemObject")
Set oTxtStream =
oFSO.OpenTextFile(dataFileName, ForAppending, True, TristateFalse)

oTxtStream.WriteLine(sData)
oTxtStream.Close

Set oTxtStream = Nothing
Set oFSO = Nothing

're-write the page
Server.Transfer("appendix.asp")

%>

```

Note—The source code is available at <http://www.niu.edu/psychology/britt>.

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