Processing Local Coherence of Discourse in Centering Theory

HU Jianhua
Dept. of Chinese, Translation & Linguistics,
City University of Hong Kong
Kowloon, Hong Kong
ctjhu@cityu.edu.hk

PAN Haihua
Dept. of Chinese, Translation & Linguistics,
City University of Hong Kong
Kowloon, Hong Kong
cthpan@cityu.edu.hk

Abstract

In this paper we will investigate the centering theory proposed by Grosz, Joshi, and Weinstein (1995) (henceforth GJW) and revised in Walker, Joshi, and Prince (1998) (henceforth WJP), and argue that their theory needs to be further extended and revised. We show that the centering theory proposed by GJW and WJP would make wrong predictions about the preferred transition states in discourse processing since their backward-looking center (Cb) is not primitive and thus cannot be used to adequately model the local coherence of discourse. We propose that Cb should be distinguished from the discourse segment topic (DST), and provide a more restrictive definition of Cb, which restricts $Cb(U_i)$ to be the element in $Cf(U_{i-1})$ that is realized by the subject pronoun or the pronoun contained in the subject in U_i.

1   Centering Theory in GJW and WJP

The term *centers* of an utterance is used to refer to the entities that regulate the local information flow in a discourse. GJW define a set of forward-looking centers (Cf), which are assigned to each utterance in a discourse segment, and a single Cb, which is assigned to each utterance other than the segment initial utterance. The members in the set of Cf are ranked according to discourse salience, and the highest-ranked member is referred to as the Preferred Center, Cp. GJW use the following definition to define the centers of utterance in a sequence:

(1) The Definition of Centers (GJW 1995)

For U_n: $Cb(U_n) = a$, $Cf(U_n) = (e_1, e_2, \dots e_p)$, $a = e_k$, for some k.

For U_{n+1}: $Cb(U_{n+1})$ realizes e_m and, for all j, $j < m$, e_j is not realized in U_{n+1}; i.e., e_m is realized in U_{n+1}, and no higher ranked e_j is realized in U_{n+1}.

Centering Theory also specifies a set of constraints and rules.

(2) Constraints (WJP 1998)

For each utterance U_i in a discourse segment D consisting of utterances $U_1, \dots, U_m$:

a. There is precisely one backward-looking center $Cb(U_i, D)$.

b. Every element of the forward centers list, $Cf(U_i, D)$, must be realized in U_i.

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c. The center, $Cb(U_i, D)$, is the highest-ranked element of $Cf(U_{i-1}, D)$ that is realized in U_i.

(3) Rules (GJW 1995; WJP 1998)

For each U_i in a discourse segment D consisting of utterances $U_1, ..., U_m$.

    a. If some element of $Cf(U_{i-1}, D)$ is realized as a pronoun in U_i, then so is $Cb(U_i, D)$.

    b. Transition states are ordered. The CONTINUE transition is preferred to the RETAIN transition, which is preferred to the SMOOTH-SHIFT transition, which is preferred to the ROUGH-SHIFT transition.

The typology of transitions from one utterance, U_{i-1}, to the next utterance, U_i, is based on two factors: (a) whether the backward-looking center, Cb, is the same from U_{i-1} to U_i, and (b) whether this discourse entity is the same as the preferred center, Cp, of U_i. The definition of transition states from Brennan, Friedman, and Pollard (1987) is summarized in Figure 1. The notation $Cb(U_{i-1})=[?]$ is used for cases where there is no $Cb(U_{i-1})$.

Figure 1. Centering Transition States

	$Cb(U_i) = Cb(U_{i-1})$ OR $Cb(U_{i-1}) = [?]$	$Cb(U_i) \neq Cb(U_{i-1})$
$Cb(U_i) = Cp(U_i)$	CONTINUE	SMOOTH-SHIFT
$Cb(U_i) \neq Cp(U_i)$	RETAIN	ROUGH-SHIFT

Figure 1 predicts four transition states. If the current Cb is not only the same as the previous one, but also the same as the current Cp, we have a CONTINUE transition state. If the current Cb is the same as the previous one, but different from the current Cp, we have a RETAIN transition state. If the current Cb is different from the previous one, but the same as the current Cp, we have a SMOOTH-SHIFT transition state. If the current Cb is neither the same as the previous one, nor the same as the current Cp, we have a ROUGH-SHIFT transition state. These transition states describe the possible ways utterances may be linked. Of these, the most preferred way to make a local segment of discourse coherent is CONTINUE, which means that all the propositions in a local segment of discourse are organized around one particular entity. RETAIN is a way to signal the speaker's intention to shift onto a new entity in the next utterance, and in this case, the current Cb is realized in a lower ranked position on the Cf. SHIFT means that the current Cb is different from the previous Cb. There are two different SHIFT states, which depend on whether the current Cb is the same as the current Cp.

According to GJW and WJP, the interaction between these constraints, rules, and transition states can predict the preferences of the hearers in processing a local segment of discourse. In general, the preferred interpretation is the one that requires the hearer to keep track of one center since a segment of discourse constructed around one center is maximally coherent and is thus much easier to process. Although we accept GJW's and WJP's basic assumptions about centering in discourse, we think that there are problems underlying their centering theory since it would make wrong predictions regarding the preferred transition states. In section 2, we will discuss these problems, and in section 3, we will propose a revised centering theory, which, we believe, can adequately solve the problems found in

GJW's and WJP's analysis.

2 Problems with the Centering Theory in GJW and WJP

The centering theory proposed by GJW and WJP would make wrong predictions regarding the preferred transition states. For instance, in (4) it would wrongly predict that the preferred reading for the subject pronoun *she* is *Betsy* in (4c), since such a reference would maintain a CONTINUE transition, which is preferred to a SMOOTH-SHIFT transition in which the pronoun *she* realizes *Susan*. However, according to the native speakers we have consulted with, the preferred reading for the subject pronoun in (4c) is *Susan*, instead of *Betsy*.

(4) a. Betsy was a good child.

| Cb: [?] |
| Cf: [Betsy] |
| SUBJ |

b. Susan gave her a pet hamster.

| Cb: [Betsy] |
| Cf: [Susan, Betsy, a pet hamster]   RETAIN |
| SUBJ, OBJ$_1$ OBJ$_2$ |

c. She reminded her that such hamsters were quite shy.

1	Cb1: [Susan]
	Cf1: [Susan, Betsy, hamsters] SMOOTH-SHIFT
	SUBJ$_1$ OBJ SUBJ$_2$
2	Cb2: [Betsy]
	Cf2: [Betsy, Susan, hamsters] CONTINUE
	SUBJ$_1$ OBJ SUBJ$_2$

d. She asked Betsy whether she liked the gift.

| Cb: [Susan] |
| Cf: [Susan, Betsy] |
| SUBJ OBJ |
| If Cf1 of 4c is chosen, it is CONTINUE; |
| if Cf2 of 4c is chosen, it is SMOOTH-SHIFT. |

In the following discourse, GJW and WJP will also make wrong predictions:

(5) a. Susan gave Betsy a pet hamster.

| Cb: [?] |
| Cf: [Susan, Betsy, a pet hamster] |
| SUBJ, OBJ$_1$ OBJ$_2$ |

b. She reminded her that such hamsters were quite shy.

| Cb: [Susan] |
| Cf: [Susan, Betsy, hamsters]   CONTINUE |
| SUBJ$_1$ OBJ$_1$ SUBJ$_2$ |

c. John said that she should be very careful about the gift.

1	Cb1: [?] Cf1: [John, Betsy, gift] ROUGH-SHIFT $\quad$ SUBJ$_1$ SUBJ$_2$ OBJ
2	Cb2: [Susan] Cf2: [John, Susan, gift] RETAIN $\quad$ SUBJ$_1$ SUBJ$_2$ OBJ

In (5c) GJW and WJP would predict that the preferred transition state is RETAIN, instead of ROUGH-SHIFT. However, it seems to us that in (5c) the first reading indicated by ROUGH-SHIFT is not worse than the second reading labeled RETAIN, and for some speakers, the first reading is preferred to the second one.

In addition to the above wrong predictions made about the preferred transition states, GJW and WJP would also wrongly predict that the following coherent discourse is not so coherent.

(6) a. In the bedroom, Kate slid open the closet door and knelt to pull a red metal box out from under a pile of scarves.

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Cb: [?]
Cf: [Kate, closet door, red metal box]
     SUBJ   OBJ₁        OBJ₂
```

$\quad$ b. She carried it over to the bed and took the lid off.

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Cb: [Kate]
Cf: [Kate, red metal box, lid]   CONTINUE
     SUBJ   OBJ₁        OBJ₂
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$\quad$ c. The smoky scent of oil rose from the box.

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Cb: [?]
Cf: [scent of oil, the box]   ?
     SUBJ        OBJ
```

$\quad$ d. Inside was her pistol, a Sig Sauer 9 millimeter, wrapped in an oiled cloth.

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Cb: [the box]
Cf: [pistol, box]   RETAIN
     SUBJ  P-OBJ
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$\quad$ e. The gun had been in this box for years.

```
Cb: [box]
Cf: [pistol, box]   RETAIN
     SUBJ  P-OBJ
```

$\quad$ f. She took it out once every six months to clean it and check it over, usually when Joel was at work.

```
Cb: [Kate]
Cf: [Kate,   pistol, Joel]   SMOOTH-SHIFT
     SUBJ₁   OBJ   SUBJ₂
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$\quad$ g. He never liked seeing her handle the gun.

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Cb: [Kate]
Cf: [Joel,   Kate, pistol]   RETAIN
     SUBJ   OBJ₁   OBJ₂
```

h. It bothered him, he said, that she felt the need to keep it.

```
Cb: [Kate]
Cf: [Joel,   Kate,   pistol]   RETAIN
       SUBJ₁   SUBJ₂ OBJ
```

i. He made her store the thing unloaded and partially disassembled in the metal box in the closet.

```
Cb: [Kate]
Cf: [Joel,   Kate, pistol]   RETAIN
       SUBJ   OBJ₁ OBJ₂
```

j. She'd always gone along with this, even though she knew that having a disassembled, unloaded fireman in the house was like having nothing at all.

```
Cb: [Kate]
Cf: [Kate, pistol]   CONTINUE
       SUBJ  OBJ
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The above discourse segment is taken from *Bad Chemistry*, a novel written by Gary Krist (1997: 228-229). Obviously, it is a coherent discourse. But if we apply GJW's and WJP's centering theory to it, we find that their theory would wrongly predict that there is no coherent relation between (6b) and (6c) since there is no Cb in (6c). Of course, we can analyze *box* in (6c) as the Cb, though it is rather awkward and strange to say that *box* in (6c) is a realization of *it* in (6b) since it goes against GJW's and WJP's definition of realization. Nevertheless, if we do analyze *box* in (6c) as the Cb, a ROUGH-SHIFT would occur, which is the least preferred transition state since it is not so coherent. Moreover, if *box* in (6c) is regarded as the Cb, it will violate Constraint (2c), and should thus be ruled out since it is not the highest-ranked element of Cf in (6b).[1] Obviously, this prediction does not conform to our intuition since the transition from (6b) to (6c) is not that worse in coherence.

3   A Revised Centering Theory

GJW and WJP make wrong predictions in center computation because their theory does not distinguish Cb from the discourse segment topic (DST). Although Cb and DST share many properties, we think that they are conceptually different, and should thus be differentiated from each other. Cb is used to process the local coherence of discourse between utterances, while DST is used to process the more global coherence of discourse between discourse segments. We propose that Cb should be distinguished from DST, as defined below:

(7) The Definition of Cb

Cb(U_i) is the element in Cf(U_{i-1}) that is realized as the matrix subject pronoun or the pronoun contained in the matrix subject in U_i.

(8) The Definitions of DST and DST shift

a. The first DST is chosen by pronouns or related elements in the second sentence U_2. If there is more than one pronoun or related element in U_2, then the antecedent of the higher ranked one is chosen as the DST. If there is no pronoun or related element in U_2 or the antecedent is not in U_1, then choose the subject of U_1 as the DST. When the first DST is chosen, go to (b).

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[1] Note that (6d), (6e), and (6j) also violate Constraint (2c).

b. If nothing in U_i is related to DST(U_{i-1}), then DST shift occurs. Push the current DST in (U_{i-1}) into the stack, and go to (a). If some NP in U_i is related to DST(U_{i-1}), then no DST shift occurs.

Note that the establishment of DST is different from that of Cb. DST belongs to the discourse segment, whereas Cb belongs to the sentence. When DST is identified in a discourse segment, it will not change within the same discourse segment. However, Cb needs to be identified in every sentence and it may change from sentence to sentence. That is why we determine the Cb for each sentence, and do not determine the DST for each sentence. Once the DST is chosen, we will only check if there is DST shift in our analysis.

As for relatedness, it is defined below:

(9) X is related to Y iff there is an inferential link[2] between them.

The center transition states are redefined as in Figure 2, where the first table considers all the cases when Cb(U_i) $\neq$[?], and table 2, when Cb(U_i)=[?].

Figure 2.

Center Transition States 1.

	Cb(U_i) = Cb(U_{i-1}) OR Cb(U_{i-1}) = [?]	Cb(U_i) $\neq$ Cb(U_{i-1})
Cb(U_i) = Cp(U_{i-1})	CONTINUE	
Cb(U_i) $\neq$ Cp(U_{i-1})	RETAIN	ROUGH-SHIFT

Center Transition States 2.

	Cb(U_{i-1}) $\neq$[?]$\wedge$some NP in Cf(U_i) = some NP in Cf(U_{i-1})	Cb(U_{i-1}) = [?]$\wedge$some NP in Cf(U_i) = some NP in Cf(U_{i-1})
Cb(U_i)=[?]	SMOOTH-SHIFT	NULL-TRANSITION

(Under our definition, "A=B" means "A refers to or is related to B".)

Under our analysis, the center transition states are classified according to three factors: (a) whether Cb(U_i) = Cb(U_{i-1}); (b) whether Cb(U_i) = Cp(U_{i-1}); (c) whether Cb(U_i) or Cb(U_{i-1}) =[?]. Note that our typology of center transition states predicts that the SMOOTH-SHIFT defined by WJP does not exist. Although we distinguish SMOOTH-SHIFT from ROUGH-SHIFT, our SMOOTH-SHIFT, different from theirs, is a new type of transition state which is not predicted by their theory of centering. Another new type of transition state that does not exist in GJW's and WJP's typology is NULL-TRANSITION. If this type of transition state occurs, DST will replace center transition states

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[2] Inferential links cover cases such as bridging reference, inheritance relations, and other indirect anaphoric relations.

in making the discourse coherent.

Under our analysis, (4) can be represented as in (10):

(10) a. Betsy was a good child.

Cb: [?]
Cf: [Betsy]
SUBJ

b. Susan gave her a pet hamster.

Cb: [?]
Cf: [Susan, Betsy, a pet hamster] NULL-TRANSITION
SUBJ OBJ$_1$ OBJ$_2$
DST: [Betsy]

c. She reminded her that such hamsters were quite shy.

1	Cb1: [Susan]
	Cf1: [Susan, Betsy, hamsters] CONTINUE
	SUBJ$_1$ OBJ SUBJ$_2$
	DST1: [Betsy]
2	Cb2: [Betsy]
	Cf2: [Betsy, Susan, hamsters] RETAIN
	SUBJ$_1$ OBJ SUBJ$_2$
	DST2: [Betsy]

d. She asked Betsy whether she liked the gift.

Cb: [Susan]
Cf: [Susan, Betsy]
SUBJ OBJ
If [Susan] is chosen as Cb in 10c, it is CONTINUE;   DST: [Betsy]
If [Betsy] is chosen as Cb in 10c, it is ROUGH-SHIFT. DST: [Betsy]

Under our analysis, the object pronoun in (10b) is not a Cb, thus avoiding the problem existing in GJW's and WJP's analysis discussed in section 2, which takes *Betsy* as the Cb in (4b=10b), and thus wrongly predicts that the subject pronoun in (4c=10c) prefers to refer to this Cb. According to our analysis, there is no Cb in (10a) or (10b). Hence, there is no center transition between these two sentences. Nevertheless, these two sentences are not so worse in coherence because they are connected by DST. In the first reading of (10c), the subject pronoun refers to the subject of the previous sentence, and the Cb of (10c) is *Susan*. This reading will result in a CONTINUE transition state as predicted by Figure 2. In the second reading of (10c), the subject pronoun refers to the object of the previous sentence, and the Cb of (10c) is *Betsy*. This reading will produce a RETAIN transition state as predicted by Figure 2. That is why the second reading is less preferred than the first reading. If the first reading is chosen in (10c), then the relation between (10c) and (10d) is CONTINUE. Note that the transition state in (10d) is determined by the one chosen in (10c). If the first reading in (10c) is chosen, the transition state in (10d) is CONTINUE, and if the second reading is chosen, it is ROUGH-SHIFT. Hence, our new theory fares better than GJW's and WJP's since it correctly predicts that *Susan* is the Cb in both (10c) and (10d). Notice that the first two sentences show that DST can make a discourse coherent.

Under our analysis, (5) can be represented as in (11):

(11) a. Susan gave Betsy a pet hamster.

| Cb: [?] |
| Cf: [Susan, Betsy, a pet hamster] |
| SUBJ   OBJ   OBJ |

b. She reminded her that such hamsters were quite shy.

| Cb: [Susan] |
| Cf: [Susan, Betsy, hamsters]   CONTINUE |
| $SUBJ_1$ OBJ $SUBJ_2$ |
| DST: [Susan] |

c. John said that she should be very careful about the gift.

1	Cb1: [?] Cf1: [John, Betsy, gift] SMOOTH-SHIFT $SUBJ_1$ $SUBJ_2$ OBJ
	DST1: [Betsy] DST-SHIFT
	Stack: [Susan]
2	Cb2: [?] Cf2: [John, Susan, gift] SMOOTH-SHIFT $SUBJ_1$ $SUBJ_2$ OBJ
	DST2: [Susan]

According to our definition of center transition states, the transition state between (11b) and (11c) (both readings) is SMOOTH-SHIFT. Note that WJP would predict that there is a sharp contrast in interpretation preference between the first reading and the second reading in (11c). Under their typology of center transition states, the first reading in (11c) involves ROUGH-SHIFT, and the second reading involves RETAIN. However, this sharp contrast in interpretation preference does not exist. Our theory would predict that both readings in (11c) have an equal status since both of them involve SMOOTH-SHIFT.

     Another advantage of our centering theory is that under our analysis, Rule (3a) becomes redundant and can thus be abandoned, which will make our theory simpler. Consider the following discourse taken from GJW (1995: 215):

(12) a. He has been acting quite odd.

| Cb: [He=John] |
| Cf: [John]   CONTINUE |

b. He called up Mike yesterday.

| Cb: [He=John] |
| Cf: [John, Mike]   CONTINUE |

c. John wanted to meet him urgently.

| Cb: [John] |
| Cf: [John, Mike]   CONTINUE |

Under GJW's analysis, (12c) is a violation of Rule (3a) since the Cb of (12c) is not realized as a pronoun, but some other entity is realized as a pronoun. Under our analysis, the subject of (12c) is not

a Cb since it is not pronominalized. Hence, the incoherence of the above sequence does not result from the violation of Rule (3a), but from the SMOOTH-SHIFT of the Cb.

GJW's Rule (3a) cannot be applied to explain the incoherence between (13b) and (13c) since there is no Cb in (13c). If we use the center transition state defined by GJW and WJP to account for the following sequence, the second reading of (13c) (RETAIN) would be considered to be preferred to the first one of (13a) (ROUGH-SHIFT), again a wrong prediction.

(13) a. He has been acting quite odd.

| Cb: [He=John] |
| Cf: [He=John] |

b. He called up Mike yesterday.

| Cb: [John=he] |
| Cf: [John, Mike] |

c. Bill wanted to meet him urgently.

| 1 | Cb1: [?]
Cf1: [Bill, him=Mike]   ROUGH-SHIFT |
| 2 | Cb2: [John]
Cf2:[Bill, him=John]   RETAIN |

Under our analysis, both readings in (13c) would result in a SMOOTH-SHIFT of Cb.

Since we distinguish Cb from DST and adopt a more restrictive definition of Cb, we need not assume that there is an implicit Cb in (14b-c) (taken from GJW 1995: 217):

(14) a. The house appeared to have been burgled.

    b. The door was ajar.

    c. The furniture was in disarray.

In order to account for the coherence of the above discourse, GJW have to assume that the *house* is the implicit Cb in (14b-c). Under our analysis, there is no Cb in the above discourse segment since there is no subject pronoun in it. The discourse is coherent because the utterances are connected by DST. According to our definition of DST given in (7), the DST in (14) is the subject of (14a), i.e., *house*. The DST of (14a) is maintained in (14b-c) since there is an NP in (14b-c) that is related to the DST of the previous utterance. *House, door* and *furniture* in (14) are thus related via DST because there is an inferential link or functional relation between them. Hence, according to our definition of center transition given in Figure 2, the transition states between (14a), (14b), and (14c) are null, but these utterances are coherent because they are connected via DST. Note that, when NULL-TRANISTION occurs, DST will play a major role in making a discourse segment coherent, and this has been demonstrated in (10) and (14), and will be further demonstrated in (15).

Finally, our revised centering theory can make better predictions about the preferences of hearers in processing local discourse segments like (6), repeated here as (15):

(15) a. In the bedroom, Kate slid open the closet door and knelt to pull a red metal box out from under a pile of scarves.

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Cb: [?]
Cf: [Kate, closet door, red metal box]
     SUBJ    OBJ₁      OBJ₂
DST: [Kate]
```

b. She carried it over to the bed and took the lid off.

```
Cb: [Kate]
Cf: [Kate, red metal box, lid]    CONTINUE
     SUBJ  OBJ₁       OBJ₂
DST: [Kate]
```

c. The smoky scent of oil rose from the box.

```
Cb: [?]
Cf: [scent of oil, the box]    SMOOTH-SHIFT
      SUBJ       OBJ
DST: [box]       DST-SHIFT
Stack: [Kate]
```

d. Inside was her pistol, a Sig Sauer 9 millimeter, wrapped in an oiled cloth.

```
Cb: [?]
Cf: [pistol, box]     NULL-TRANSITION
     SUBJ  P-OBJ
DST: [box]
Stack: [Kate]
```

e. The gun had been in this box for years.

```
Cb: [?]
Cf: [pistol, box]     NULL-TRANSITION
     SUBJ  P-OBJ
DST: [box]
Stack: [Kate]
```

f. She took it out once every six months to clean it and check it over, usually when Joel was at work.

```
Cb: [Kate]
Cf: [Kate,    pistol, Joel]    RETAIN
     SUBJ₁   OBJ    SUBJ₂
DST: [pistol]    DST-SHIFT
Stack: [box]
        [Kate]
```

g. He never liked seeing her handle the gun.

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Cb: [Joel]
Cf: [Joel,    Kate, pistol]    ROUGH-SHIFT
     SUBJ   OBJ₁   OBJ₂
DST: [pistol]
Stack1: [Kate]
         [box]
```

h. It bothered him, he said, that she felt the need to keep it.

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Cb: [Joel]
Cf: [Joel,   Kate,   pistol]   CONTINUE
      SUBJ₁   SUBJ₂ OBJ
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Cb: [Joel] Cf: [Joel,   Kate,   pistol]   CONTINUE   SUBJ₁   SUBJ₂ OBJ
DST[pistol]
Stack1: [Kate]   [box]

i. He made her store the thing unloaded and partially disassembled in the metal box in the closet.

Cb: [Joel] Cf: [Joel,   Kate, pistol]   CONTINUE   SUBJ₁   OBJ₁ OBJ₂
DST: [pistol]
Stack1: [Kate]   [box]

j. She'd always gone along with this, even though she knew that having a disassembled, unloaded fireman in the house was like having nothing at all.

Cb: [Kate] Cf: [Kate, pistol]   ROUGH-SHIFT   SUBJ OBJ
DST: [pistol]
Stack: [box]

Under GJW's and WJP's centering analysis, the transition states between (15c), (15d), and (15e), and those between (15g), (15I), and (15j) are all treated as RETAIN, but under our analysis, they are analyzed as NULL-TRANSITION and CONTINUE, respectively. Note that NULL-TRANSITION does not mean incoherence. Instead, it means that DST will play a major role in making the discourse coherent. Obviously, our analysis makes better predictions than GJW's and WJP's theory since the relations between these utterances are not in any sense less coherent. Note that our revised entering theory also makes different predictions regarding some less coherent transition states between utterances. According to GJW and WJP, the transition state between (15f) and (15g) is RETAIN, and the one between (15i) and (15j) is CONTINUE, but under our analysis, these transition states are both ROUGH-SHIFT since in each case, a center shift occurs.

4 Conclusion

In this paper we have argued that the centering theory proposed by GJW (1995) and revised in WJP (1998) needs to be further extended and revised. We have proposed to distinguish the backward-looking center (Cb) from the discourse segment topic (DST), and provided a more restrictive definition of Cb. We argue that $Cb(U_i)$ is the element in $Cf(U_{i-1})$ that is realized by the matrix subject pronoun or the pronoun contained in the subject in U_i. The analysis of the relevant data has shown that our revised centering theory consisting of the restrictive definition of Cb, the revised definition of Center Transition States and the adoption of DST can adequately avoid the center transition problems found in GJW and WJP and provide a more satisfactory algorithm for processing the local coherence of discourse.

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