This study concerns the use of intonation in a tone language, Taiwanese Mandarin, and a language without phonological lexical stress, French. Declarative, interrogative, surprise and doubt were studied. Perceptual analysis shows that in Mandarin, the absence of a specific lexical marker limits drastically the possibility to identify interrogative and doubt expressions. Surprise is better identified. In French, on the contrary lexical markers seem to be entirely optional, while intonation is decisive. Acoustic analysis shows that in French F0 rises and falls contours are much more modulated than in Mandarin, where F0 contours are quite similar in all modalities and attitudes, and where it is more the pitch level that differs. Nevertheless, there is some similar use of F0 in both languages: it increases from declarative to interrogative then to surprise. Surprise affects more duration and intensity than the other modalities and attitudes.

3. ACoustIC ANALYSIS

3.1. F0

Two parameters have been studied: F0 contour and F0 range of sentence.

3.1.1. F0 contour

To get an image of F0 contour which could enable comparison of sentences in both languages, we have plotted on graphs the values measured in the middle of each syllabic nucleus. One could object that in a tone language, what could be relevant for F0 contour is the shape of tones according to intonation. However, most of the studies on this issue have shown that intonation is superimposed on the sentence as a whole [1].

Figures 1 - 4 show for each speaker the F0 contour of the four sentences uttered. In French the schwa at the end of the word « malade » was not always pronounced, hence, there are two syllabic realizations: [malad] or [malad]. These figures show that in Mandarin, F0 contour seems to keep a similar shape through the different sentences. It is more the general level observed could be anticipation of the final fall of F0. It confirms Ho's conclusions [3]. The pitch level sets from the beginning of the sentence and tends to be neutralized on the last two syllables. The effect is a sharper F0 falls on “bing le” (tone 4 followed by neutral tone) for surprise, which is smoothed for interrogative and declarative. It confirms Ho's conclusions [3], but the question arises then to know whether the general level observed could be anticipation of the final fall of F0.
3.1.2. F0 range
Fig. 4 shows the four sentences F0 range, expressed in musical tones, for each speaker.

In both languages, F0 range decreases from surprise, interrogative and then to declarative sentences. Doubt has the narrowest range in the French realization, while for one speaker in Mandarin, it has the largest range, and the narrowest for the other one. The maximum value of range in the French sentences is comparable of the one in Mandarin. This similarity is surprising. However, F0 range is used in different ways in French and in Mandarin as we have discussed in F0 contour section.

3.2. Duration
We show in Fig. 6 relative sentence’s duration in comparison with P1 for each speaker. In French realizations, surprise has the longest duration, then come equally doubt and declarative, and then interrogation.
In Mandarin realizations, there is no constant order, but surprise is shorter than the other sentences for both speakers.
3. Intensity

We give in Fig. 7 the graph of maximum energy sentences for each speaker, measured in decibels.

For F2, C1 and C2 we can arrange the expressions in the same order by decreasing energy: surprise, declarative, interrogative and doubt. The more prominent fact is that surprise for all speakers is expressed with higher energy than for the other sentences.

4. PERCEPTUAL ANALYSIS

4.1. Method

The recorded sentences and their original context were spread apart. Five listeners per language had to choose the most appropriate context for each sentence heard in isolation.

4.2. Results

Table 1 and 2 show the results, giving for each language the number of successes, and the details of "errors", where P1, P2, P3, P4 stand respectively for declarative, interrogative, surprise and doubt.

Table 1. Number of successes on perception of French sentences, 5 listeners, 2 speakers

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>French</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2. Number of success on perception of Mandarin sentences, 5 listeners, 2 speakers

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandarin</td>
<td>9</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Detail of errors</td>
<td>1 P2</td>
<td>2 P1</td>
<td>2 P2</td>
<td>2 P1</td>
</tr>
</tbody>
</table>

4.3. Interpretation

4.3.1 French

In French listeners have successfully identified the four expressions. Lexical markers seem to be entirely optional, while intonation is decisive. This result is in accordance with the acoustic analysis which shows a specific use of prosody for each sentence.

4.3.2. Mandarin

In Mandarin, only declarative expression has been well identified. It seems that declarative sentence has a characteristic prosody pattern which enables to recognize it. For doubt and interrogative it is far to be the case. Surprise is better recognized. This is in accordance with the acoustic analysis which shows for surprise the highest F0 contour and range, and the shortest duration, while interrogation and doubt don't seem to be characterized so clearly by these parameters. Moreover, as Ho [3] points it out, doubt and interrogative are semantically closer to each other which can bring more confusion; however, the detail of errors shows that these two sentences have also been confused with surprise and declarative sentences.

The fact that listeners had not much trouble to identify declarative while it is not the case with interrogation and doubt could also mean that the prosodic attitude adopted by our speakers is normal for declarative expression, and not really a common one for interrogation and doubt - which are usually lexically marked - and might represent more an attempt to distinguish these sentences with intonation.

5. CONCLUSION

Perceptual analysis shows that in Mandarin, the absence of a specific lexical marker limits drastically the possibility to identify interrogative and doubt sentences. Surprise is better identified: it is prosodically more characterized as well. In French, on the contrary, intonation is sufficient to express these four modalities and attitudes.

Acoustic analysis shows that F0 rises and falls are much more modulated in French in accordance with modality and attitude. In Mandarin, F0 contours are quite similar in all of our sentences. It is more the average pitch level that differs or the final F0 fall of the sentence, anticipated by this pitch level. Nevertheless, there is some similar use of F0 in both languages for declarative, interrogative and surprise. F0 in both languages increases from declarative to interrogative then to surprise. Surprise affects more duration and intensity: it shows the shortest duration in Mandarin while the longest in French, and the highest intensity in both languages.
These results show the interest of comparing prosody in unrelated languages with both acoustic and perceptual data. They must be however confirmed by a further study including a larger number of speakers and listeners.

6. ACKNOWLEDGEMENT
We would like to thank Professor Jacqueline Vaissière for her help.

7. REFERENCES